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# Introduction to ASP.NET Core

6/28/2018 • 2 minutes to read • [Edit Online](#)

By [Daniel Roth](#), [Rick Anderson](#), and [Shaun Luttin](#)

ASP.NET Core is a cross-platform, high-performance, [open-source](#) framework for building modern, cloud-based, Internet-connected applications. With ASP.NET Core, you can:

- Build web apps and services, [IoT](#) apps, and mobile backends.
- Use your favorite development tools on Windows, macOS, and Linux.
- Deploy to the cloud or on-premises.
- Run on [.NET Core](#) or [.NET Framework](#).

## Why use ASP.NET Core?

Millions of developers have used (and continue to use) [ASP.NET 4.x](#) to create web apps. ASP.NET Core is a redesign of ASP.NET 4.x, with architectural changes that result in a leaner, more modular framework.

ASP.NET Core provides the following benefits:

- A unified story for building web UI and web APIs.
- Integration of [modern, client-side frameworks](#) and development workflows.
- A cloud-ready, environment-based [configuration system](#).
- Built-in [dependency injection](#).
- A lightweight, [high-performance](#), and modular HTTP request pipeline.
- Ability to host on [IIS](#), [Nginx](#), [Apache](#), [Docker](#), or self-host in your own process.
- Side-by-side app versioning when targeting [.NET Core](#).
- Tooling that simplifies modern web development.
- Ability to build and run on Windows, macOS, and Linux.
- Open-source and [community-focused](#).

ASP.NET Core ships entirely as [NuGet](#) packages. Using NuGet packages allows you to optimize your app to include only the necessary dependencies. In fact, ASP.NET Core 2.x apps targeting .NET Core only require a [single NuGet package](#). The benefits of a smaller app surface area include tighter security, reduced servicing, and improved performance.

## Build web APIs and web UI using ASP.NET Core MVC

ASP.NET Core MVC provides features to build [web APIs](#) and [web apps](#):

- The [Model-View-Controller \(MVC\)](#) pattern helps make your web APIs and web apps [testable](#).
- [Razor Pages](#) (new in ASP.NET Core 2.0) is a page-based programming model that makes building web UI easier and more productive.
- [Razor markup](#) provides a productive syntax for [Razor Pages](#) and [MVC views](#).
- [Tag Helpers](#) enable server-side code to participate in creating and rendering HTML elements in Razor files.
- Built-in support for [multiple data formats and content negotiation](#) lets your web APIs reach a broad range of clients, including browsers and mobile devices.
- [Model binding](#) automatically maps data from HTTP requests to action method parameters.
- [Model validation](#) automatically performs client- and server-side validation.

## Client-side development

ASP.NET Core integrates seamlessly with popular client-side frameworks and libraries, including [Angular](#), [React](#), and [Bootstrap](#). For more information, see [Client-side development](#).

## ASP.NET Core targeting .NET Framework

ASP.NET Core can target .NET Core or .NET Framework. ASP.NET Core apps targeting .NET Framework aren't cross-platform—they run on Windows only. There are no plans to remove support for targeting .NET Framework in ASP.NET Core. Generally, ASP.NET Core is made up of [.NET Standard](#) libraries. Apps written with .NET Standard 2.0 run anywhere that .NET Standard 2.0 is supported.

There are several advantages to targeting .NET Core, and these advantages increase with each release. Some advantages of .NET Core over .NET Framework include:

- Cross-platform. Runs on macOS, Linux, and Windows.
- Improved performance
- Side-by-side versioning
- New APIs
- Open source

We're working hard to close the API gap from .NET Framework to .NET Core. The [Windows Compatibility Pack](#) made thousands of Windows-only APIs available in .NET Core. These APIs weren't available in .NET Core 1.x.

## Next steps

For more information, see the following resources:

- [Get started with Razor Pages](#)
- [ASP.NET Core tutorials](#)
- [ASP.NET Core fundamentals](#)
- [The weekly ASP.NET community standup](#) covers the team's progress and plans. It features new blogs and third-party software.

# What's new in ASP.NET Core 2.1

6/28/2018 • 6 minutes to read • [Edit Online](#)

This article highlights the most significant changes in ASP.NET Core 2.1, with links to relevant documentation.

## SignalR

SignalR has been rewritten for ASP.NET Core 2.1. ASP.NET Core SignalR includes a number of improvements:

- A simplified scale-out model.
- A new JavaScript client with no jQuery dependency.
- A new compact binary protocol based on MessagePack.
- Support for custom protocols.
- A new streaming response model.
- Support for clients based on bare WebSockets.

For more information, see [ASP.NET Core SignalR](#).

## Razor class libraries

ASP.NET Core 2.1 makes it easier to build and include Razor-based UI in a library and share it across multiple projects. The new Razor SDK enables building Razor files into a class library project that can be packaged into a NuGet package. Views and pages in libraries are automatically discovered and can be overridden by the app. By integrating Razor compilation into the build:

- The app startup time is significantly faster.
- Fast updates to Razor views and pages at runtime are still available as part of an iterative development workflow.

For more information, see [Create reusable UI using the Razor Class Library project](#).

## Identity UI library & scaffolding

ASP.NET Core 2.1 provides [ASP.NET Core Identity](#) as a [Razor Class Library](#). Apps that include Identity can apply the new Identity scaffolder to selectively add the source code contained in the Identity Razor Class Library (RCL). You might want to generate source code so you can modify the code and change the behavior. For example, you could instruct the scaffolder to generate the code used in registration. Generated code takes precedence over the same code in the Identity RCL.

Apps that do **not** include authentication can apply the Identity scaffolder to add the RCL Identity package. You have the option of selecting Identity code to be generated.

For more information, see [Scaffold Identity in ASP.NET Core projects](#).

## HTTPS

With the increased focus on security and privacy, enabling HTTPS for web apps is important. HTTPS enforcement is becoming increasingly strict on the web. Sites that don't use HTTPS are considered insecure. Browsers (Chromium, Mozilla) are starting to enforce that web features must be used from a secure context. [GDPR](#) requires the use of HTTPS to protect user privacy. While using HTTPS in production is critical, using HTTPS in development can help prevent issues in deployment (for example, insecure links). ASP.NET Core 2.1 includes a number of

improvements that make it easier to use HTTPS in development and to configure HTTPS in production. For more information, see [Enforce HTTPS](#).

## On by default

To facilitate secure website development, HTTPS is now enabled by default. Starting in 2.1, Kestrel listens on `https://localhost:5001` when a local development certificate is present. A development certificate is created:

- As part of the .NET Core SDK first-run experience, when you use the SDK for the first time.
- Manually using the new `dotnet dev-certs` tool.

Run `dotnet dev-certs https --trust` to trust the certificate.

## HTTPS redirection and enforcement

Web apps typically need to listen on both HTTP and HTTPS, but then redirect all HTTP traffic to HTTPS. In 2.1, specialized HTTPS redirection middleware that intelligently redirects based on the presence of configuration or bound server ports has been introduced.

Use of HTTPS can be further enforced using [HTTP Strict Transport Security Protocol \(HSTS\)](#). HSTS instructs browsers to always access the site via HTTPS. ASP.NET Core 2.1 adds HSTS middleware that supports options for max age, subdomains, and the HSTS preload list.

## Configuration for production

In production, HTTPS must be explicitly configured. In 2.1, default configuration schema for configuring HTTPS for Kestrel has been added. Apps can be configured to use:

- Multiple endpoints including the URLs. For more information, see [Kestrel web server implementation: Endpoint configuration](#).
- The certificate to use for HTTPS either from a file on disk or from a certificate store.

## GDPR

ASP.NET Core provides APIs and templates to help meet some of the [EU General Data Protection Regulation \(GDPR\)](#) requirements. For more information, see [GDPR support in ASP.NET Core](#). A [sample app](#) shows how to use and lets you test most of the GDPR extension points and APIs added to the ASP.NET Core 2.1 templates.

## Integration tests

A new package is introduced that streamlines test creation and execution. The [Microsoft.AspNetCore.Mvc.Testing](#) package handles the following tasks:

- Copies the dependency file (`*.deps`) from the tested app into the test project's `bin` folder.
- Sets the content root to the tested app's project root so that static files and pages/views are found when the tests are executed.
- Provides the `WebApplicationFactory` class to streamline bootstrapping the tested app with `TestServer`.

The following test uses [xUnit](#) to check that the Index page loads with a success status code and with the correct Content-Type header:

```

public class BasicTests
    : IClassFixture<WebApplicationFactory<RazorPagesProject.Startup>>
{
    private readonly HttpClient _client;

    public BasicTests(WebApplicationFactory<RazorPagesProject.Startup> factory)
    {
        _client = factory.CreateClient();
    }

    [Fact]
    public async Task GetHomePage()
    {
        // Act
        var response = await _client.GetAsync("/");

        // Assert
        response.EnsureSuccessStatusCode(); // Status Code 200-299
        Assert.Equal("text/html; charset=utf-8",
            response.Content.Headers.ContentType.ToString());
    }
}

```

For more information, see the [Integration tests](#) topic.

## [ApiController], ActionResult

ASP.NET Core 2.1 adds new programming conventions that make it easier to build clean and descriptive web APIs. `ActionResult<T>` is a new type added to allow an app to return either a response type or any other action result (similar to `IActionResult`), while still indicating the response type. The `[ApiController]` attribute has also been added as the way to opt in to Web API-specific conventions and behaviors.

For more information, see [Build Web APIs with ASP.NET Core](#).

## IHttpClientFactory

ASP.NET Core 2.1 includes a new `IHttpClientFactory` service that makes it easier to configure and consume instances of `HttpClient` in apps. `HttpClient` already has the concept of delegating handlers that could be linked together for outgoing HTTP requests. The factory:

- Makes registering of instances of `HttpClient` per named client more intuitive.
- Implements a Polly handler that allows Polly policies to be used for Retry, CircuitBreakers, etc.

For more information, see [Initiate HTTP Requests](#).

## Kestrel transport configuration

With the release of ASP.NET Core 2.1, Kestrel's default transport is no longer based on Libuv but instead based on managed sockets. For more information, see [Kestrel web server implementation: Transport configuration](#).

## Generic host builder

The Generic Host Builder (`HostBuilder`) has been introduced. This builder can be used for apps that don't process HTTP requests (Messaging, background tasks, etc.).

For more information, see [.NET Generic Host](#).

## Updated SPA templates

The Single Page Application templates for Angular, React, and React with Redux are updated to use the standard project structures and build systems for each framework.

The Angular template is based on the Angular CLI, and the React templates are based on `create-react-app`. For more information, see [Use the Single Page Application templates with ASP.NET Core](#).

## Razor Pages search for Razor assets

In 2.1, Razor Pages search for Razor assets (such as layouts and partials) in the following directories in the listed order:

1. Current Pages folder.
2. `/Pages/Shared/`
3. `/Views/Shared/`

## Razor Pages in an area

Razor Pages now support [areas](#). To see an example of areas, create a new Razor Pages web app with individual user accounts. A Razor Pages web app with individual user accounts includes `/Areas/Identity/Pages`.

## Migrate from 2.0 to 2.1

See [Migrate from ASP.NET Core 2.0 to 2.1](#).

## Additional information

For the complete list of changes, see the [ASP.NET Core 2.1 Release Notes](#).

# What's new in ASP.NET Core 2.0

6/28/2018 • 5 minutes to read • [Edit Online](#)

This article highlights the most significant changes in ASP.NET Core 2.0, with links to relevant documentation.

## Razor Pages

Razor Pages is a new feature of ASP.NET Core MVC that makes coding page-focused scenarios easier and more productive.

For more information, see the introduction and tutorial:

- [Introduction to Razor Pages](#)
- [Get started with Razor Pages](#)

## ASP.NET Core metapackage

A new ASP.NET Core metapackage includes all of the packages made and supported by the ASP.NET Core and Entity Framework Core teams, along with their internal and 3rd-party dependencies. You no longer need to choose individual ASP.NET Core features by package. All features are included in the [Microsoft.AspNetCore.All](#) package. The default templates use this package.

For more information, see [Microsoft.AspNetCore.All metapackage for ASP.NET Core 2.0](#).

## Runtime Store

Applications that use the `Microsoft.AspNetCore.All` metapackage automatically take advantage of the new .NET Core Runtime Store. The Store contains all the runtime assets needed to run ASP.NET Core 2.0 applications. When you use the `Microsoft.AspNetCore.All` metapackage, no assets from the referenced ASP.NET Core NuGet packages are deployed with the application because they already reside on the target system. The assets in the Runtime Store are also precompiled to improve application startup time.

For more information, see [Runtime store](#)

## .NET Standard 2.0

The ASP.NET Core 2.0 packages target .NET Standard 2.0. The packages can be referenced by other .NET Standard 2.0 libraries, and they can run on .NET Standard 2.0-compliant implementations of .NET, including .NET Core 2.0 and .NET Framework 4.6.1.

The `Microsoft.AspNetCore.All` metapackage targets .NET Core 2.0 only, because it's intended to be used with the .NET Core 2.0 Runtime Store.

## Configuration update

An `IConfiguration` instance is added to the services container by default in ASP.NET Core 2.0. `IConfiguration` in the services container makes it easier for applications to retrieve configuration values from the container.

For information about the status of planned documentation, see the [GitHub issue](#).

## Logging update

In ASP.NET Core 2.0, logging is incorporated into the dependency injection (DI) system by default. You add providers and configure filtering in the *Program.cs* file instead of in the *Startup.cs* file. And the default `ILoggerFactory` supports filtering in a way that lets you use one flexible approach for both cross-provider filtering and specific-provider filtering.

For more information, see [Introduction to Logging](#).

## Authentication update

A new authentication model makes it easier to configure authentication for an application using DI.

New templates are available for configuring authentication for web apps and web APIs using [Azure AD B2C] (<https://azure.microsoft.com/services/active-directory-b2c/>).

For information about the status of planned documentation, see the [GitHub issue](#).

## Identity update

We've made it easier to build secure web APIs using Identity in ASP.NET Core 2.0. You can acquire access tokens for accessing your web APIs using the [Microsoft Authentication Library \(MSAL\)](#).

For more information on authentication changes in 2.0, see the following resources:

- [Account confirmation and password recovery in ASP.NET Core](#)
- [Enable QR Code generation for authenticator apps in ASP.NET Core](#)
- [Migrate Authentication and Identity to ASP.NET Core 2.0](#)

## SPA templates

Single Page Application (SPA) project templates for Angular, Aurelia, Knockout.js, React.js, and React.js with Redux are available. The Angular template has been updated to Angular 4. The Angular and React templates are available by default; for information about how to get the other templates, see [Create a new SPA project](#). For information about how to build a SPA in ASP.NET Core, see [Use JavaScriptServices for Creating Single Page Applications](#).

## Kestrel improvements

The Kestrel web server has new features that make it more suitable as an Internet-facing server. A number of server constraint configuration options are added in the `KestrelServerOptions` class's new `Limits` property. Add limits for the following:

- Maximum client connections
- Maximum request body size
- Minimum request body data rate

For more information, see [Kestrel web server implementation in ASP.NET Core](#).

## WebListener renamed to HTTP.sys

The packages `Microsoft.AspNetCore.Server.WebListener` and `Microsoft.Net.Http.Server` have been merged into a new package `Microsoft.AspNetCore.Server.HttpSys`. The namespaces have been updated to match.

For more information, see [HTTP.sys web server implementation in ASP.NET Core](#).

## Enhanced HTTP header support

When using MVC to transmit a `FileStreamResult` or a `FileContentResult`, you now have the option to set an

`ETag` or a `LastModified` date on the content you transmit. You can set these values on the returned content with code similar to the following:

```
var data = Encoding.UTF8.GetBytes("This is a sample text from a binary array");
var entityTag = new EntityTagHeaderValue("\"MyCalculatedEtagValue\"");
return File(data, "text/plain", "downloadName.txt", lastModified: DateTime.UtcNow.AddSeconds(-5), entityTag:
entityTag);
```

The file returned to your visitors will be decorated with the appropriate HTTP headers for the `ETag` and `LastModified` values.

If an application visitor requests content with a Range Request header, ASP.NET will recognize that and handle that header. If the requested content can be partially delivered, ASP.NET will appropriately skip and return just the requested set of bytes. You don't need to write any special handlers into your methods to adapt or handle this feature; it's automatically handled for you.

## Hosting startup and Application Insights

Hosting environments can now inject extra package dependencies and execute code during application startup, without the application needing to explicitly take a dependency or call any methods. This feature can be used to enable certain environments to "light-up" features unique to that environment without the application needing to know ahead of time.

In ASP.NET Core 2.0, this feature is used to automatically enable Application Insights diagnostics when debugging in Visual Studio and (after opting in) when running in Azure App Services. As a result, the project templates no longer add Application Insights packages and code by default.

For information about the status of planned documentation, see the [GitHub issue](#).

## Automatic use of anti-forgery tokens

ASP.NET Core has always helped HTML-encode content by default, but with the new version an extra step is taken to help prevent cross-site request forgery (XSRF) attacks. ASP.NET Core will now emit anti-forgery tokens by default and validate them on form POST actions and pages without extra configuration.

For more information, see [Prevent Cross-Site Request Forgery \(XSRF/CSRF\) attacks](#).

## Automatic precompilation

Razor view pre-compilation is enabled during publish by default, reducing the publish output size and application startup time.

For more information, see [Razor view compilation and precompilation in ASP.NET Core](#).

## Razor support for C# 7.1

The Razor view engine has been updated to work with the new Roslyn compiler. That includes support for C# 7.1 features like Default Expressions, Inferred Tuple Names, and Pattern-Matching with Generics. To use C# 7.1 in your project, add the following property in your project file and then reload the solution:

```
<LangVersion>latest</LangVersion>
```

For information about the status of C# 7.1 features, see [the Roslyn GitHub repository](#).

## Other documentation updates for 2.0

- [Visual Studio publish profiles for ASP.NET Core app deployment](#)
- [Key Management](#)
- [Configure Facebook authentication](#)
- [Configure Twitter authentication](#)
- [Configure Google authentication](#)
- [Configure Microsoft Account authentication](#)

## Migration guidance

For guidance on how to migrate ASP.NET Core 1.x applications to ASP.NET Core 2.0, see the following resources:

- [Migrate from ASP.NET Core 1.x to ASP.NET Core 2.0](#)
- [Migrate Authentication and Identity to ASP.NET Core 2.0](#)

## Additional Information

For the complete list of changes, see the [ASP.NET Core 2.0 Release Notes](#).

To connect with the ASP.NET Core development team's progress and plans, tune in to the [ASP.NET Community Standup](#).

# What's new in ASP.NET Core 1.1

6/28/2018 • 2 minutes to read • [Edit Online](#)

ASP.NET Core 1.1 includes the following new features:

- [URL Rewriting Middleware](#)
- [Response Caching Middleware](#)
- [View Components as Tag Helpers](#)
- [Middleware as MVC filters](#)
- [Cookie-based TempData provider](#)
- [Azure App Service logging provider](#)
- [Azure Key Vault configuration provider](#)
- [Azure and Redis Storage Data Protection Key Repositories](#)
- [WebListener Server for Windows](#)
- [WebSockets support](#)

## Choosing between versions 1.0 and 1.1 of ASP.NET Core

ASP.NET Core 1.1 has more features than 1.0. In general, we recommend you use the latest version.

## Additional Information

- [ASP.NET Core 1.1.0 Release Notes](#)
- To connect with the ASP.NET Core development team's progress and plans, tune in to the [ASP.NET Community Standup](#).

# Get started with ASP.NET Core

6/28/2018 • 2 minutes to read • [Edit Online](#)

1. Install the [.NET Core 2.1 SDK or later](#).
2. Create an ASP.NET Core project. Open a command shell and enter the following command:

```
dotnet new webapp -o aspnetcoreapp
```

## NOTE

In ASP.NET Core 2.1 or later, `webapp` is an alias of the `razor` argument. If the `dotnet new webapp <OPTIONS>` command loads the `dotnet new` command help instead of creating a new Razor Pages app, install the [.NET Core 2.1 SDK](#).

3. Trust the HTTPS development certificate:

- [Windows](#)
- [macOS](#)
- [Linux](#)

```
dotnet dev-certs https --trust
```

The preceding command displays the following dialog:



Select **Yes** if you agree to trust the development certificate.

1. Install the [.NET Core SDK 2.0 or later](#).
2. Create a new ASP.NET Core project.

Open a command shell. Enter the following command:

```
dotnet new razor -o aspnetcoreapp
```

- Run the app with the following commands:

```
cd aspnetcoreapp  
dotnet run
```

- Browse to <http://localhost:5000>.

- Open *Pages/About.cshtml* and modify the page to display the message "Hello, world! The time on the server is @DateTime.Now":

```
@page  
@model AboutModel  
{  
    ViewData["Title"] = "About";  
}  
<h2>@ViewData["Title"]</h2>  
<h3>@Model.Message</h3>  
  
<p>Hello, world! The time on the server is @DateTime.Now</p>
```

- Browse to <http://localhost:5000/About> and verify the changes.

## Next steps

- An ASP.NET Core app can use the .NET Core or .NET Framework Base Class Library and runtime. For more information, see [Choosing between .NET Core and .NET Framework](#).
- [Getting started tutorials](#)
- [Introduction to ASP.NET Core](#)
- [ASP.NET Core architecture and fundamentals](#).

- Install the .NET Core **SDK Installer** for SDK 1.0.4 from the [.NET Core All Downloads](#) page.

- Create a folder for a new ASP.NET Core project.

Open a command shell. Enter the following commands:

```
mkdir aspnetcoreapp  
cd aspnetcoreapp
```

- If you have installed a later SDK version on your machine, create a *global.json* file to select the 1.0.4 SDK.

```
{  
    "sdk": { "version": "1.0.4" }  
}
```

- Create a new ASP.NET Core project.

```
dotnet new web
```

- Restore the packages.

```
dotnet restore
```

## 6. Run the app.

```
dotnet run
```

The [dotnet run](#) command builds the app first, if needed.

## 7. Browse to <http://localhost:5000>.

### Next steps

- An ASP.NET Core app can use the .NET Core or .NET Framework Base Class Library and runtime. For more information, see [Choosing between .NET Core and .NET Framework](#).
- [Getting started tutorials](#)
- [Introduction to ASP.NET Core](#)
- [ASP.NET Core architecture and fundamentals](#).

# Introduction to Razor Pages in ASP.NET Core

7/6/2018 • 20 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Ryan Nowak](#)

Razor Pages is a new aspect of ASP.NET Core MVC that makes coding page-focused scenarios easier and more productive.

If you're looking for a tutorial that uses the Model-View-Controller approach, see [Get started with ASP.NET Core MVC](#).

This document provides an introduction to Razor Pages. It's not a step by step tutorial. If you find some of the sections too advanced, see [Get started with Razor Pages](#). For an overview of ASP.NET Core, see the [Introduction to ASP.NET Core](#).

## Prerequisites

Install **one** of the following:

- CLI tooling: Windows, Linux, or macOS: [.NET Core SDK 2.0 or later](#)
- IDE/editor tooling
  - Windows: [Visual Studio for Windows](#)
    - **ASP.NET and web development** workload
    - **.NET Core cross-platform development** workload
  - Linux: [Visual Studio Code](#)
  - macOS: [Visual Studio for Mac](#)

## Creating a Razor Pages project

- [Visual Studio](#)
- [Visual Studio for Mac](#)
- [Visual Studio Code](#)
- [.NET Core CLI](#)

See [Get started with Razor Pages](#) for detailed instructions on how to create a Razor Pages project using Visual Studio.

## Razor Pages

Razor Pages is enabled in *Startup.cs*:

```

public class Startup
{
    public void ConfigureServices(IServiceCollection services)
    {
        // Includes support for Razor Pages and controllers.
        services.AddMvc();
    }

    public void Configure(IApplicationBuilder app)
    {
        app.UseMvc();
    }
}

```

Consider a basic page:

```

@page

<h1>Hello, world!</h1>
<h2>The time on the server is @DateTime.Now</h2>

```

The preceding code looks a lot like a Razor view file. What makes it different is the `@page` directive. `@page` makes the file into an MVC action - which means that it handles requests directly, without going through a controller.

`@page` must be the first Razor directive on a page. `@page` affects the behavior of other Razor constructs.

A similar page, using a `PageModel` class, is shown in the following two files. The *Pages/Index2.cshtml* file:

```

@page
@using RazorPagesIntro.Pages
@model IndexModel2

<h2>Separate page model</h2>
<p>
    @Model.Message
</p>

```

The *Pages/Index2.cshtml.cs* page model:

```

using Microsoft.AspNetCore.Mvc.RazorPages;
using System;

namespace RazorPagesIntro.Pages
{
    public class IndexModel2 : PageModel
    {
        public string Message { get; private set; } = "PageModel in C#";

        public void OnGet()
        {
            Message += $" Server time is { DateTime.Now }";
        }
    }
}

```

By convention, the `PageModel` class file has the same name as the Razor Page file with `.cs` appended. For example, the previous Razor Page is *Pages/Index2.cshtml*. The file containing the `PageModel` class is named *Pages/Index2.cshtml.cs*.

The associations of URL paths to pages are determined by the page's location in the file system. The following table

shows a Razor Page path and the matching URL:

FILE NAME AND PATH	MATCHING URL
/Pages/Index.cshtml	/ or /Index
/Pages/Contact.cshtml	/Contact
/Pages/Store/Contact.cshtml	/Store/Contact
/Pages/Store/Index.cshtml	/Store or /Store/Index

Notes:

- The runtime looks for Razor Pages files in the *Pages* folder by default.
- `Index` is the default page when a URL doesn't include a page.

## Writing a basic form

Razor Pages is designed to make common patterns used with web browsers easy to implement when building an app. [Model binding](#), [Tag Helpers](#), and HTML helpers all *just work* with the properties defined in a Razor Page class. Consider a page that implements a basic "contact us" form for the `Contact` model:

For the samples in this document, the `DbContext` is initialized in the [Startup.cs](#) file.

```
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using RazorPagesContacts.Data;

namespace RazorPagesContacts
{
    public class Startup
    {
        public IHostingEnvironment HostingEnvironment { get; }

        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<AppDbContext>(options =>
                options.UseInMemoryDatabase("name"));
            services.AddMvc();
        }

        public void Configure(IApplicationBuilder app)
        {
            app.UseMvc();
        }
    }
}
```

The data model:

```

using System.ComponentModel.DataAnnotations;

namespace RazorPagesContacts.Data
{
    public class Customer
    {
        public int Id { get; set; }

        [Required, StringLength(100)]
        public string Name { get; set; }
    }
}

```

The db context:

```

using Microsoft.EntityFrameworkCore;

namespace RazorPagesContacts.Data
{
    public class AppDbContext : DbContext
    {
        public AppDbContext(DbContextOptions options)
            : base(options)
        {
        }

        public DbSet<Customer> Customers { get; set; }
    }
}

```

The *Pages/Create.cshtml* view file:

```

@page
@model RazorPagesContacts.Pages.CreateModel
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers

<html>
<body>
    <p>
        Enter your name.
    </p>
    <div asp-validation-summary="All"></div>
    <form method="POST">
        <div>Name: <input asp-for="Customer.Name" /></div>
        <input type="submit" />
    </form>
</body>
</html>

```

The *Pages/Create.cshtml.cs* page model:

```

using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using RazorPagesContacts.Data;

namespace RazorPagesContacts.Pages
{
    public class CreateModel : PageModel
    {
        private readonly ApplicationDbContext _db;

        public CreateModel(ApplicationDbContext db)
        {
            _db = db;
        }

        [BindProperty]
        public Customer Customer { get; set; }

        public async Task<IActionResult> OnPostAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            _db.Customers.Add(Customer);
            await _db.SaveChangesAsync();
            return RedirectToPage("/Index");
        }
    }
}

```

By convention, the `PageModel` class is called `<PageName>Model` and is in the same namespace as the page.

The `PageModel` class allows separation of the logic of a page from its presentation. It defines page handlers for requests sent to the page and the data used to render the page. This separation allows you to manage page dependencies through [dependency injection](#) and to [unit test](#) the pages.

The page has an `OnPostAsync` *handler method*, which runs on `POST` requests (when a user posts the form). You can add handler methods for any HTTP verb. The most common handlers are:

- `OnGet` to initialize state needed for the page. [OnGet sample](#).
- `OnPost` to handle form submissions.

The `Async` naming suffix is optional but is often used by convention for asynchronous functions. The `OnPostAsync` code in the preceding example looks similar to what you would normally write in a controller. The preceding code is typical for Razor Pages. Most of the MVC primitives like [model binding](#), [validation](#), and action results are shared.

The previous `OnPostAsync` method:

```

public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    _db.Customers.Add(Customer);
    await _db.SaveChangesAsync();
    return RedirectToPage("/Index");
}

```

The basic flow of `OnPostAsync`:

Check for validation errors.

- If there are no errors, save the data and redirect.
- If there are errors, show the page again with validation messages. Client-side validation is identical to traditional ASP.NET Core MVC applications. In many cases, validation errors would be detected on the client, and never submitted to the server.

When the data is entered successfully, the `OnPostAsync` handler method calls the `RedirectToPage` helper method to return an instance of `RedirectToPageResult`. `RedirectToPage` is a new action result, similar to `RedirectToAction` or `RedirectToRoute`, but customized for pages. In the preceding sample, it redirects to the root Index page (`/Index`). `RedirectToPage` is detailed in the [URL generation for Pages](#) section.

When the submitted form has validation errors (that are passed to the server), the `OnPostAsync` handler method calls the `Page` helper method. `Page` returns an instance of `PageResult`. Returning `Page` is similar to how actions in controllers return `View`. `PageResult` is the default return type for a handler method. A handler method that returns `void` renders the page.

The `Customer` property uses `[BindProperty]` attribute to opt in to model binding.

```
public class CreateModel : PageModel
{
    private readonly AppDbContext _db;

    public CreateModel(AppDbContext db)
    {
        _db = db;
    }

    [BindProperty]
    public Customer Customer { get; set; }

    public async Task<IActionResult> OnPostAsync()
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        _db.Customers.Add(Customer);
        await _db.SaveChangesAsync();
        return RedirectToPage("/Index");
    }
}
```

Razor Pages, by default, bind properties only with non-GET verbs. Binding to properties can reduce the amount of code you have to write. Binding reduces code by using the same property to render form fields (

`<input asp-for="Customer.Name" />`) and accept the input.

#### NOTE

For security reasons, you must opt in to binding GET request data to page model properties. Verify user input before mapping it to properties. Opting in to this behavior is useful when addressing scenarios which rely on query string or route values.

To bind a property on GET requests, set the `[BindProperty]` attribute's `SupportsGet` property to `true`:

```
[BindProperty(SupportsGet = true)]
```

The home page (*Index.cshtml*):

```
@page
@model RazorPagesContacts.Pages.IndexModel
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers

<h1>Contacts</h1>
<form method="post">
    <table class="table">
        <thead>
            <tr>
                <th>ID</th>
                <th>Name</th>
            </tr>
        </thead>
        <tbody>
            @foreach (var contact in Model.Customers)
            {
                <tr>
                    <td>@contact.Id</td>
                    <td>@contact.Name</td>
                    <td>
                        <a asp-page=".Edit" asp-route-id="@contact.Id">edit</a>
                        <button type="submit" asp-page-handler="delete"
                                asp-route-id="@contact.Id">delete</button>
                    </td>
                </tr>
            }
        </tbody>
    </table>

    <a asp-page=".Create">Create</a>
</form>
```

The associated `PageModel` class (*Index.cshtml.cs*):

```

using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using RazorPagesContacts.Data;
using System.Collections.Generic;
using Microsoft.EntityFrameworkCore;

namespace RazorPagesContacts.Pages
{
    public class IndexModel : PageModel
    {
        private readonly AppDbContext _db;

        public IndexModel(AppDbContext db)
        {
            _db = db;
        }

        public IList<Customer> Customers { get; private set; }

        public async Task OnGetAsync()
        {
            Customers = await _db.Customers.AsNoTracking().ToListAsync();
        }

        public async Task<IActionResult> OnPostDeleteAsync(int id)
        {
            var contact = await _db.Customers.FindAsync(id);

            if (contact != null)
            {
                _db.Customers.Remove(contact);
                await _db.SaveChangesAsync();
            }

            return RedirectToPage();
        }
    }
}

```

The *Index.cshtml* file contains the following markup to create an edit link for each contact:

```
<a asp-page="./Edit" asp-route-id="@contact.Id">edit</a>
```

The [Anchor Tag Helper](#) used the `asp-route-{value}` attribute to generate a link to the Edit page. The link contains route data with the contact ID. For example, `http://localhost:5000/Edit/1`.

The *Pages/Edit.cshtml* file:

```

@page "{id:int}"
@model RazorPagesContacts.Pages.EditModel
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers

 @{
    ViewData["Title"] = "Edit Customer";
}

<h1>Edit Customer - @Model.Customer.Id</h1>
<form method="post">
    <div asp-validation-summary="All"></div>
    <input asp-for="Customer.Id" type="hidden" />
    <div>
        <label asp-for="Customer.Name"></label>
        <div>
            <input asp-for="Customer.Name" />
            <span asp-validation-for="Customer.Name" ></span>
        </div>
    </div>

    <div>
        <button type="submit">Save</button>
    </div>
</form>

```

The first line contains the `@page "{id:int}"` directive. The routing constraint `"{id:int}"` tells the page to accept requests to the page that contain `int` route data. If a request to the page doesn't contain route data that can be converted to an `int`, the runtime returns an HTTP 404 (not found) error. To make the ID optional, append `?` to the route constraint:

```
@page "{id:int?}"
```

The `Pages/Edit.cshtml.cs` file:

```

using System;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using RazorPagesContacts.Data;

namespace RazorPagesContacts.Pages
{
    public class EditModel : PageModel
    {
        private readonly AppDbContext _db;

        public EditModel(AppDbContext db)
        {
            _db = db;
        }

        [BindProperty]
        public Customer Customer { get; set; }

        public async Task<IActionResult> OnGetAsync(int id)
        {
            Customer = await _db.Customers.FindAsync(id);

            if (Customer == null)
            {
                return RedirectToPage("/Index");
            }

            return Page();
        }

        public async Task<IActionResult> OnPostAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            _db.Attach(Customer).State = EntityState.Modified;

            try
            {
                await _db.SaveChangesAsync();
            }
            catch (DbUpdateConcurrencyException)
            {
                throw new Exception($"Customer {Customer.Id} not found!");
            }

            return RedirectToPage("/Index");
        }
    }
}

```

The *Index.cshtml* file also contains markup to create a delete button for each customer contact:

```

<button type="submit" asp-page-handler="delete"
        asp-route-id="@contact.Id">Delete</button>

```

When the delete button is rendered in HTML, its `formaction` includes parameters for:

- The customer contact ID specified by the `asp-route-id` attribute.

- The `handler` specified by the `asp-page-handler` attribute.

Here is an example of a rendered delete button with a customer contact ID of `1`:

```
<button type="submit" formaction="/?id=1&handler=delete">delete</button>
```

When the button is selected, a form `POST` request is sent to the server. By convention, the name of the handler method is selected based the value of the `handler` parameter according to the scheme `OnPost[handler]Async`.

Because the `handler` is `delete` in this example, the `OnPostDeleteAsync` handler method is used to process the `POST` request. If the `asp-page-handler` is set to a different value, such as `remove`, a page handler method with the name `OnPostRemoveAsync` is selected.

```
public async Task<IActionResult> OnPostDeleteAsync(int id)
{
    var contact = await _db.Customers.FindAsync(id);

    if (contact != null)
    {
        _db.Customers.Remove(contact);
        await _db.SaveChangesAsync();
    }

    return RedirectToPage();
}
```

The `OnPostDeleteAsync` method:

- Accepts the `id` from the query string.
- Queries the database for the customer contact with `FindAsync`.
- If the customer contact is found, they're removed from the list of customer contacts. The database is updated.
- Calls `RedirectToPage` to redirect to the root Index page (`/Index`).

## Mark page properties required

Properties on a `PageModel` can be decorated with the `Required` attribute:

```

using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using System.ComponentModel.DataAnnotations;

namespace RazorPagesMovie.Pages.Movies
{
    public class CreateModel : PageModel
    {
        public IActionResult OnGet()
        {
            return Page();
        }

        [BindProperty]
        [Required(ErrorMessage = "Color is required")]
        public string Color { get; set; }

        public IActionResult OnPostAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            // Process color.

            return RedirectToPage("./Index");
        }
    }
}

```

See [Model validation](#) for more information.

## Manage HEAD requests with the OnGet handler

Ordinarily, a HEAD handler is created and called for HEAD requests:

```

public void OnHead()
{
    HttpContext.Response.Headers.Add("HandledBy", "Handled by OnHead!");
}

```

If no HEAD handler (`OnHead`) is defined, Razor Pages falls back to calling the GET page handler (`OnGet`) in ASP.NET Core 2.1 or later. Opt in to this behavior with the [SetCompatibilityVersion method](#) in `Startup.Configure` for ASP.NET Core 2.1 to 2.x:

```

services.AddMvc()
    .SetCompatibilityVersion(Microsoft.AspNetCore.Mvc.CompatibilityVersion.Version_2_1);

```

`SetCompatibilityVersion` effectively sets the Razor Pages option `AllowMappingHeadRequestsToGetHandler` to `true`.

Rather than opting into all 2.1 behaviors with `SetCompatibilityVersion`, you can explicitly opt-in to specific behaviors. The following code opts into the mapping HEAD requests to the GET handler.

```

services.AddMvc()
    .AddRazorPagesOptions(options =>
    {
        options.AllowMappingHeadRequestsToGetHandler = true;
    });

```

# XSRF/CSRF and Razor Pages

You don't have to write any code for [antiforgery validation](#). Antiforgery token generation and validation are automatically included in Razor Pages.

## Using Layouts, partials, templates, and Tag Helpers with Razor Pages

Pages work with all the capabilities of the Razor view engine. Layouts, partials, templates, Tag Helpers, `_ViewStart.cshtml`, `_ViewImports.cshtml` work in the same way they do for conventional Razor views.

Let's declutter this page by taking advantage of some of those capabilities.

Add a [layout page](#) to `Pages/Shared/_Layout.cshtml`:

Add a [layout page](#) to `Pages/_Layout.cshtml`:

```
<!DOCTYPE html>
<html>
<head>
    <title>Razor Pages Sample</title>
</head>
<body>
    <a asp-page="/Index">Home</a>
    @RenderBody()
    <a asp-page="/Customers/Create">Create</a> <br />
</body>
</html>
```

The [Layout](#):

- Controls the layout of each page (unless the page opts out of layout).
- Imports HTML structures such as JavaScript and stylesheets.

See [layout page](#) for more information.

The [Layout](#) property is set in `Pages/_ViewStart.cshtml`:

```
@{
    Layout = "_Layout";
}
```

The layout is in the `Pages/Shared` folder. Pages look for other views (layouts, templates, partials) hierarchically, starting in the same folder as the current page. A layout in the `Pages/Shared` folder can be used from any Razor page under the `Pages` folder.

The layout file should go in the `Pages/Shared` folder.

The layout is in the `Pages` folder. Pages look for other views (layouts, templates, partials) hierarchically, starting in the same folder as the current page. A layout in the `Pages` folder can be used from any Razor page under the `Pages` folder.

We recommend you **not** put the layout file in the `Views/Shared` folder. `Views/Shared` is an MVC views pattern. Razor Pages are meant to rely on folder hierarchy, not path conventions.

View search from a Razor Page includes the `Pages` folder. The layouts, templates, and partials you're using with MVC controllers and conventional Razor views *just work*.

Add a `Pages/_ViewImports.cshtml` file:

```
@namespace RazorPagesContacts.Pages  
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers
```

`@namespace` is explained later in the tutorial. The `@addTagHelper` directive brings in the [built-in Tag Helpers](#) to all the pages in the *Pages* folder.

When the `@namespace` directive is used explicitly on a page:

```
@page  
@namespace RazorPagesIntro.Pages.Customers  
  
@model NameSpaceModel  
  
<h2>Name space</h2>  
<p>  
    @Model.Message  
</p>
```

The `@page` directive sets the namespace for the page. The `@model` directive doesn't need to include the namespace.

When the `@namespace` directive is contained in `_ViewImports.cshtml`, the specified namespace supplies the prefix for the generated namespace in the Page that imports the `@namespace` directive. The rest of the generated namespace (the suffix portion) is the dot-separated relative path between the folder containing `_ViewImports.cshtml` and the folder containing the page.

For example, the `PageModel` class `Pages/Customers/Edit.cshtml.cs` explicitly sets the namespace:

```
namespace RazorPagesContacts.Pages  
{  
    public class EditModel : PageModel  
    {  
        private readonly AppDbContext _db;  
  
        public EditModel(AppDbContext db)  
        {  
            _db = db;  
        }  
  
        // Code removed for brevity.  
    }  
}
```

The `Pages/_ViewImports.cshtml` file sets the following namespace:

```
@namespace RazorPagesContacts.Pages  
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers
```

The generated namespace for the `Pages/Customers/Edit.cshtml` Razor Page is the same as the `PageModel` class.

`@namespace` also works with conventional Razor views.

The original `Pages/Create.cshtml` view file:

```

@page
@model RazorPagesContacts.Pages.CreateModel
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers

<html>
<body>
    <p>
        Enter your name.
    </p>
    <div asp-validation-summary="All"></div>
    <form method="POST">
        <div>Name: <input asp-for="Customer.Name" /></div>
        <input type="submit" />
    </form>
</body>
</html>

```

The updated *Pages/Create.cshtml* view file:

```

@page
@model CreateModel

<html>
<body>
    <p>
        Enter your name.
    </p>
    <div asp-validation-summary="All"></div>
    <form method="POST">
        <div>Name: <input asp-for="Customer.Name" /></div>
        <input type="submit" />
    </form>
</body>
</html>

```

The [Razor Pages starter project](#) contains the *Pages/\_ValidationScriptsPartial.cshtml*, which hooks up client-side validation.

## URL generation for Pages

The `Create` page, shown previously, uses `RedirectToPage`:

```

public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    _db.Customers.Add(Customer);
    await _db.SaveChangesAsync();
    return RedirectToPage("/Index");
}

```

The app has the following file/folder structure:

- `/Pages`
  - `Index.cshtml`
  - `/Customers`

- *Create.cshtml*
- *Edit.cshtml*
- *Index.cshtml*

The *Pages/Customers/Create.cshtml* and *Pages/Customers/Edit.cshtml* pages redirect to *Pages/Index.cshtml* after success. The string `/Index` is part of the URI to access the preceding page. The string `/Index` can be used to generate URIs to the *Pages/Index.cshtml* page. For example:

- `Url.Page("/Index", ...)`
- `<a asp-page="/Index">My Index Page</a>`
- `RedirectToPage("/Index")`

The page name is the path to the page from the root */Pages* folder including a leading `/` (for example, `/Index`). The preceding URL generation samples offer enhanced options and functional capabilities over hardcoding a URL. URL generation uses [routing](#) and can generate and encode parameters according to how the route is defined in the destination path.

URL generation for pages supports relative names. The following table shows which Index page is selected with different `RedirectToPage` parameters from *Pages/Customers/Create.cshtml*:

REDIRECTTOPAGE(X)	PAGE
<code>RedirectToPage("/Index")</code>	<i>Pages/Index</i>
<code>RedirectToPage("./Index");</code>	<i>Pages/Customers/Index</i>
<code>RedirectToPage("../Index")</code>	<i>Pages/Index</i>
<code>RedirectToPage("Index")</code>	<i>Pages/Customers/Index</i>

`RedirectToPage("Index")`, `RedirectToPage("./Index")`, and `RedirectToPage("../Index")` are *relative names*. The `RedirectToPage` parameter is *combined* with the path of the current page to compute the name of the destination page.

Relative name linking is useful when building sites with a complex structure. If you use relative names to link between pages in a folder, you can rename that folder. All the links still work (because they didn't include the folder name).

## ViewData attribute

Data can be passed to a page with [ViewDataAttribute](#). Properties on controllers or Razor Page models decorated with `[ViewData]` have their values stored and loaded from the [ViewDataDictionary](#).

In the following example, the `AboutModel` contains a `Title` property decorated with `[ViewData]`. The `Title` property is set to the title of the About page:

```
public class AboutModel : PageModel
{
    [ViewData]
    public string Title { get; } = "About";

    public void OnGet()
    {
    }
}
```

In the About page, access the `Title` property as a model property:

```
<h1>@Model.Title</h1>
```

In the layout, the title is read from the ViewData dictionary:

```
<!DOCTYPE html>
<html lang="en">
<head>
<title>@ViewData["Title"] - WebApplication</title>
...

```

## TempData

ASP.NET Core exposes the `TempData` property on a [controller](#). This property stores data until it's read. The `Keep` and `Peek` methods can be used to examine the data without deletion. `TempData` is useful for redirection, when data is needed for more than a single request.

The `[TempData]` attribute is new in ASP.NET Core 2.0 and is supported on controllers and pages.

The following code sets the value of `Message` using `TempData`:

```
public class CreateDotModel : PageModel
{
    private readonly AppDbContext _db;

    public CreateDotModel(AppDbContext db)
    {
        _db = db;
    }

    [TempData]
    public string Message { get; set; }

    [BindProperty]
    public Customer Customer { get; set; }

    public async Task<IActionResult> OnPostAsync()
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        _db.Customers.Add(Customer);
        await _db.SaveChangesAsync();
        Message = $"Customer {Customer.Name} added";
        return RedirectToPage("./Index");
    }
}
```

The following markup in the `Pages/Customers/Index.cshtml` file displays the value of `Message` using `TempData`.

```
<h3>Msg: @Model.Message</h3>
```

The `Pages/Customers/Index.cshtml.cs` page model applies the `[TempData]` attribute to the `Message` property.

```
[TempData]  
public string Message { get; set; }
```

See  [TempData](#) for more information.

## Multiple handlers per page

The following page generates markup for two page handlers using the `asp-page-handler` Tag Helper:

```
@page  
@model CreateFATHModel  
  
<html>  
<body>  
    <p>  
        Enter your name.  
    </p>  
    <div asp-validation-summary="All"></div>  
    <form method="POST">  
        <div>Name: <input asp-for="Customer.Name" /></div>  
        <input type="submit" asp-page-handler="JoinList" value="Join" />  
        <input type="submit" asp-page-handler="JoinListUC" value="JOIN UC" />  
    </form>  
</body>  
</html>
```

The form in the preceding example has two submit buttons, each using the `FormActionTagHelper` to submit to a different URL. The `asp-page-handler` attribute is a companion to `asp-page`. `asp-page-handler` generates URLs that submit to each of the handler methods defined by a page. `asp-page` isn't specified because the sample is linking to the current page.

The page model:

```

using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using RazorPagesContacts.Data;

namespace RazorPagesContacts.Pages.Customers
{
    public class CreateFATHModel : PageModel
    {
        private readonly AppDbContext _db;

        public CreateFATHModel(AppDbContext db)
        {
            _db = db;
        }

        [BindProperty]
        public Customer Customer { get; set; }

        public async Task<IActionResult> OnPostJoinListAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            _db.Customers.Add(Customer);
            await _db.SaveChangesAsync();
            return RedirectToPage("/Index");
        }

        public async Task<IActionResult> OnPostJoinListUCAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }
            Customer.Name = Customer.Name?.ToUpper();
            return await OnPostJoinListAsync();
        }
    }
}

```

The preceding code uses *named handler methods*. Named handler methods are created by taking the text in the name after `On<HTTP Verb>` and before `Async` (if present). In the preceding example, the page methods are `OnPostJoinListAsync` and `OnPostJoinListUCAsync`. With `OnPost` and `Async` removed, the handler names are `JoinList` and `JoinListUC`.

```

<input type="submit" asp-page-handler="JoinList" value="Join" />
<input type="submit" asp-page-handler="JoinListUC" value="JOIN UC" />

```

Using the preceding code, the URL path that submits to `OnPostJoinListAsync` is `http://localhost:5000/Customers/CreateFATH?handler=JoinList`. The URL path that submits to `OnPostJoinListUCAsync` is `http://localhost:5000/Customers/CreateFATH?handler=JoinListUC`.

## Custom routes

Use the `@page` directive to:

- Specify a custom route to a page. For example, the route to the About page can be set to `/Some/Other/Path` with `@page "/Some/Other/Path"`.

- Append segments to a page's default route. For example, an "item" segment can be added to a page's default route with `@page "item"`.
- Append parameters to a page's default route. For example, an ID parameter, `id`, can be required for a page with `@page "{id}"`.

A root-relative path designated by a tilde (`~`) at the beginning of the path is supported. For example, `@page "~/Some/Other/Path"` is the same as `@page "/Some/Other/Path"`.

You can change the query string `?handler=JoinList` in the URL to a route segment `/JoinList` by specifying the route template `@page "{handler?}"`.

If you don't like the query string `?handler=JoinList` in the URL, you can change the route to put the handler name in the path portion of the URL. You can customize the route by adding a route template enclosed in double quotes after the `@page` directive.

```
@page "{handler?}"
@model CreateRouteModel

<html>
<body>
    <p>
        Enter your name.
    </p>
    <div asp-validation-summary="All"></div>
    <form method="POST">
        <div>Name: <input asp-for="Customer.Name" /></div>
        <input type="submit" asp-page-handler="JoinList" value="Join" />
        <input type="submit" asp-page-handler="JoinListUC" value="JOIN UC" />
    </form>
</body>
</html>
```

Using the preceding code, the URL path that submits to `OnPostJoinListAsync` is `http://localhost:5000/Customers/CreateFATH/JoinList`. The URL path that submits to `OnPostJoinListUCAsync` is `http://localhost:5000/Customers/CreateFATH/JoinListUC`.

The `?` following `handler` means the route parameter is optional.

## Configuration and settings

To configure advanced options, use the extension method `AddRazorPagesOptions` on the MVC builder:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc()
        .AddRazorPagesOptions(options =>
    {
        options.RootDirectory = "/MyPages";
        options.Conventions.AuthorizeFolder("/MyPages/Admin");
    });
}
```

Currently you can use the `RazorPagesOptions` to set the root directory for pages, or add application model conventions for pages. We'll enable more extensibility this way in the future.

To precompile views, see [Razor view compilation](#).

[Download or view sample code](#).

See [Get started with Razor Pages](#), which builds on this introduction.

## Specify that Razor Pages are at the content root

By default, Razor Pages are rooted in the `/Pages` directory. Add [WithRazorPagesAtContentRoot](#) to [AddMvc](#) to specify that your Razor Pages are at the content root ([ContentRootPath](#)) of the app:

```
services.AddMvc()
    .AddRazorPagesOptions(options =>
{
    ...
})
.WithRazorPagesAtContentRoot();
```

## Specify that Razor Pages are at a custom root directory

Add [WithRazorPagesRoot](#) to [AddMvc](#) to specify that your Razor Pages are at a custom root directory in the app (provide a relative path):

```
services.AddMvc()
    .AddRazorPagesOptions(options =>
{
    ...
})
.WithRazorPagesRoot("/path/to/razor/pages");
```

## See also

- [Introduction to ASP.NET Core](#)
- [Razor syntax](#)
- [Get started with Razor Pages](#)
- [Razor Pages authorization conventions](#)
- [Razor Pages custom route and page model providers](#)
- [Razor Pages unit tests](#)

# Create a Web API with ASP.NET Core and Visual Studio for Windows

6/21/2018 • 15 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Mike Wasson](#)

This tutorial builds a web API for managing a list of "to-do" items. A user interface (UI) isn't created.

There are three versions of this tutorial:

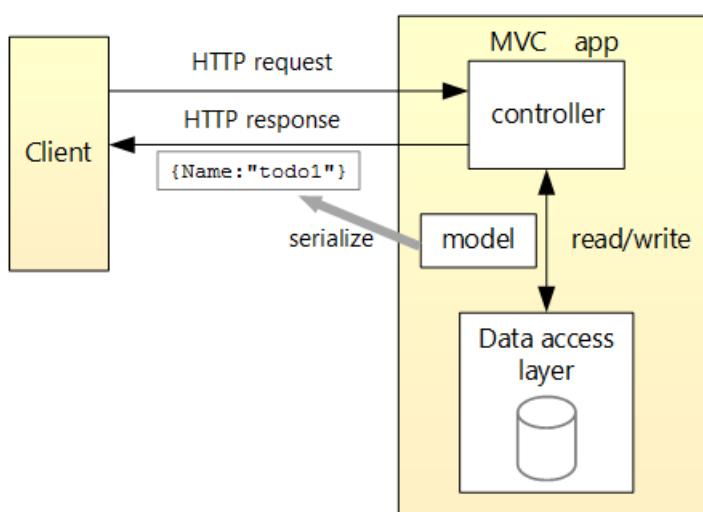
- Windows: Web API with Visual Studio for Windows (This tutorial)
- macOS: [Web API with Visual Studio for Mac](#)
- macOS, Linux, Windows: [Web API with Visual Studio Code](#)

## Overview

This tutorial creates the following API:

API	DESCRIPTION	REQUEST BODY	RESPONSE BODY
GET /api/todo	Get all to-do items	None	Array of to-do items
GET /api/todo/{id}	Get an item by ID	None	To-do item
POST /api/todo	Add a new item	To-do item	To-do item
PUT /api/todo/{id}	Update an existing item	To-do item	None
DELETE /api/todo/{id}	Delete an item	None	None

The following diagram shows the basic design of the app.



- The client is whatever consumes the web API (mobile app, browser, etc.). This tutorial doesn't create a client. [Postman](#) or [curl](#) is used as the client to test the app.
- A *model* is an object that represents the data in the app. In this case, the only model is a to-do item. Models are represented as C# classes, also known as **Plain Old CLR Object** (POCOs).

- A *controller* is an object that handles HTTP requests and creates the HTTP response. This app has a single controller.
- To keep the tutorial simple, the app doesn't use a persistent database. The sample app stores to-do items in an in-memory database.

## Prerequisites

Visual Studio 2017 version 15.7.3 or later with the following workloads:

- **ASP.NET and web development**
- **.NET Core cross-platform development**

.NET Core 2.1 SDK or later

## Create the project

Follow these steps in Visual Studio:

- From the **File** menu, select **New > Project**.
- Select the **ASP.NET Core Web Application** template. Name the project *TodoApi* and click **OK**.
- In the **New ASP.NET Core Web Application - TodoApi** dialog, choose the ASP.NET Core version. Select the **API** template and click **OK**. Do **not** select **Enable Docker Support**.

### Launch the app

In Visual Studio, press CTRL+F5 to launch the app. Visual Studio launches a browser and navigates to `http://localhost:<port>/api/values`, where `<port>` is a randomly chosen port number. Chrome, Microsoft Edge, and Firefox display the following output:

```
["value1","value2"]
```

If using Internet Explorer, you'll be prompted to save a *values.json* file.

### Add a model class

A model is an object representing the data in the app. In this case, the only model is a to-do item.

In Solution Explorer, right-click the project. Select **Add > New Folder**. Name the folder *Models*.

#### NOTE

The model classes can go anywhere in the project. The *Models* folder is used by convention for model classes.

In Solution Explorer, right-click the *Models* folder and select **Add > Class**. Name the class *TodoItem* and click **Add**.

Update the `TodoItem` class with the following code:

```
namespace TodoApi.Models
{
    public class TodoItem
    {
        public long Id { get; set; }
        public string Name { get; set; }
        public bool IsComplete { get; set; }
    }
}
```

The database generates the `Id` when a `TodoItem` is created.

### Create the database context

The *database context* is the main class that coordinates Entity Framework functionality for a given data model. This class is created by deriving from the `Microsoft.EntityFrameworkCore.DbContext` class.

In Solution Explorer, right-click the *Models* folder and select **Add > Class**. Name the class *TodoContext* and click **Add**.

Replace the class with the following code:

```
using Microsoft.EntityFrameworkCore;

namespace TodoApi.Models
{
    public class TodoContext : DbContext
    {
        public TodoContext(DbContextOptions<TodoContext> options)
            : base(options)
        {

        }

        public DbSet<TodoItem> TodoItems { get; set; }
    }
}
```

## Register the database context

In this step, the database context is registered with the [dependency injection](#) container. Services (such as the DB context) that are registered with the dependency injection (DI) container are available to the controllers.

Register the DB context with the service container using the built-in support for [dependency injection](#). Replace the contents of the *Startup.cs* file with the following code:

```
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Mvc;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using TodoApi.Models;

namespace TodoApi
{
    public class Startup
    {
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<TodoContext>(opt =>
                opt.UseInMemoryDatabase("TodoList"));
            services.AddMvc()
                .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
        }

        public void Configure(IApplicationBuilder app)
        {
            app.UseMvc();
        }
    }
}
```

```

using Microsoft.AspNetCore.Builder;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using TodoApi.Models;

namespace TodoApi
{
    public class Startup
    {
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<TodoContext>(opt =>
                opt.UseInMemoryDatabase("TodoList"));
            services.AddMvc();
        }

        public void Configure(IApplicationBuilder app)
        {
            app.UseMvc();
        }
    }
}

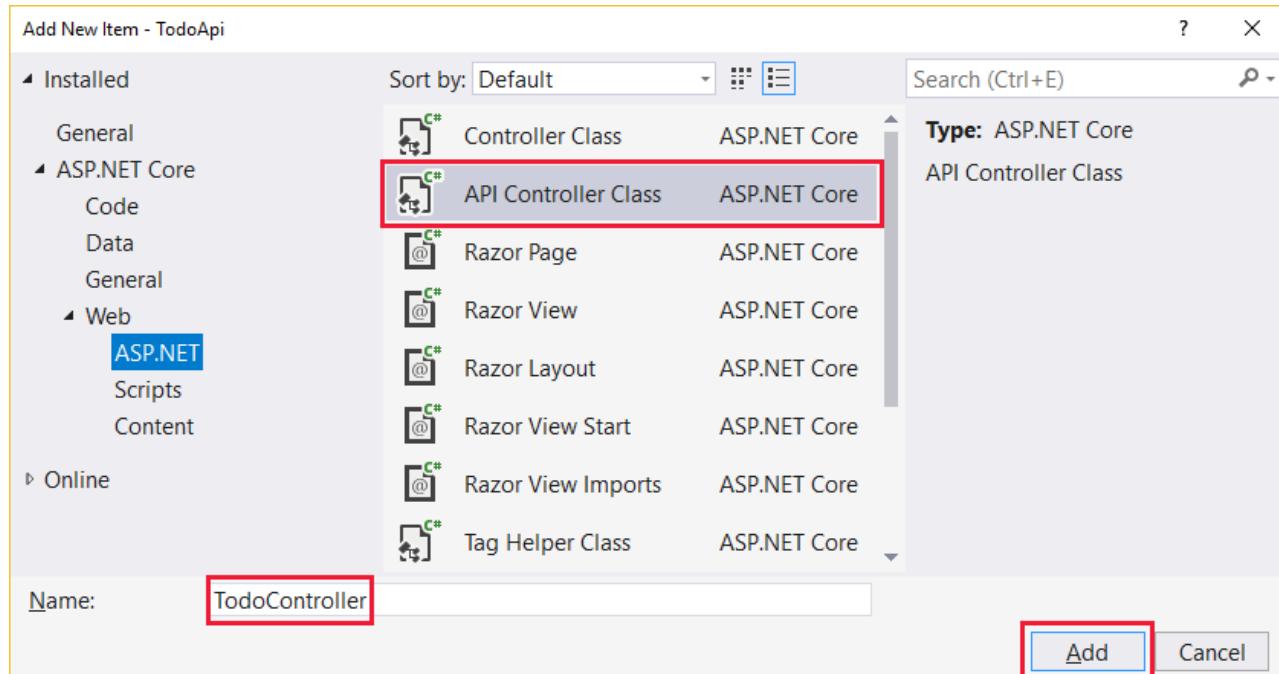
```

The preceding code:

- Removes the unused code.
- Specifies an in-memory database is injected into the service container.

### Add a controller

In Solution Explorer, right-click the *Controllers* folder. Select **Add > New Item**. In the **Add New Item** dialog, select the **API Controller Class** template. Name the class *TodoController*, and click **Add**.



Replace the class with the following code:

```

using Microsoft.AspNetCore.Mvc;
using System.Collections.Generic;
using System.Linq;
using TodoApi.Models;

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

        public TodoController(TodoContext context)
        {
            _context = context;

            if (_context.TodoItems.Count() == 0)
            {
                _context.TodoItems.Add(new TodoItem { Name = "Item1" });
                _context.SaveChanges();
            }
        }
    }
}

```

The preceding code defines an API controller class without methods. In the next sections, methods are added to implement the API.

```

using Microsoft.AspNetCore.Mvc;
using System.Collections.Generic;
using System.Linq;
using TodoApi.Models;

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    [ApiController]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

        public TodoController(TodoContext context)
        {
            _context = context;

            if (_context.TodoItems.Count() == 0)
            {
                _context.TodoItems.Add(new TodoItem { Name = "Item1" });
                _context.SaveChanges();
            }
        }
    }
}

```

The preceding code defines an API controller class without methods. In the next sections, methods are added to implement the API. The class is annotated with an `[ApiController]` attribute to enable some convenient features. For information on features enabled by the attribute, see [Annotate class with ApiControllerAttribute](#).

The controller's constructor uses [Dependency Injection](#) to inject the database context (`TodoContext`) into the controller. The database context is used in each of the [CRUD](#) methods in the controller. The constructor adds an item to the in-memory database if one doesn't exist.

## Get to-do items

To get to-do items, add the following methods to the `TodoController` class:

```
[HttpGet]
public List<TodoItem> GetAll()
{
    return _context.TodoItems.ToList();
}

[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}
```

```
[HttpGet]
public ActionResult<List<TodoItem>> GetAll()
{
    return _context.TodoItems.ToList();
}

[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}
```

These methods implement the two GET methods:

- `GET /api/todo`
- `GET /api/todo/{id}`

Here's a sample HTTP response for the `GetAll` method:

```
[
{
    "id": 1,
    "name": "Item1",
    "isComplete": false
}]
```

Later in the tutorial, I'll show how the HTTP response can be viewed with [Postman](#) or [curl](#).

### Routing and URL paths

The `[HttpGet]` attribute denotes a method that responds to an HTTP GET request. The URL path for each method is constructed as follows:

- Take the template string in the controller's `Route` attribute:

```

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

```

```

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    [ApiController]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

```

- Replace `[controller]` with the name of the controller, which is the controller class name minus the "Controller" suffix. For this sample, the controller class name is **TodoController** and the root name is "todo". ASP.NET Core [routing](#) is case insensitive.
- If the `[HttpGet]` attribute has a route template (such as `[HttpGet("/products")]`), append that to the path. This sample doesn't use a template. For more information, see [Attribute routing with Http\[Verb\] attributes](#).

In the following  `GetById` method, `{id}` is a placeholder variable for the unique identifier of the to-do item. When  `GetById` is invoked, it assigns the value of `{id}` in the URL to the method's `id` parameter.

```

[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}

```

```

[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}

```

`Name = "GetTodo"` creates a named route. Named routes:

- Enable the app to create an HTTP link using the route name.
- Are explained later in the tutorial.

## Return values

The  `GetAll` method returns a collection of `TodoItem` objects. MVC automatically serializes the object to [JSON](#) and writes the JSON into the body of the response message. The response code for this method is 200, assuming there are no unhandled exceptions. Unhandled exceptions are translated into 5xx errors.

In contrast, the  `GetById` method returns the more general [IActionResult type](#), which represents a wide range of

return types.  `GetById` has two different return types:

- If no item matches the requested ID, the method returns a 404 error. Returning `NotFound` returns an HTTP 404 response.
- Otherwise, the method returns 200 with a JSON response body. Returning `Ok` results in an HTTP 200 response.

In contrast, the  `GetById` method returns the `ActionResult<T>` type, which represents a wide range of return types.

`GetById` has two different return types:

- If no item matches the requested ID, the method returns a 404 error. Returning `NotFound` returns an HTTP 404 response.
- Otherwise, the method returns 200 with a JSON response body. Returning `item` results in an HTTP 200 response.

## Launch the app

In Visual Studio, press CTRL+F5 to launch the app. Visual Studio launches a browser and navigates to `http://localhost:<port>/api/values`, where `<port>` is a randomly chosen port number. Navigate to the `Todo` controller at `http://localhost:<port>/api/todo`.

## Implement the other CRUD operations

In the following sections, `Create`, `Update`, and `Delete` methods are added to the controller.

### Create

Add the following `Create` method:

```
[HttpPost]
public IActionResult Create([FromBody] TodoItem item)
{
    if (item == null)
    {
        return BadRequest();
    }

    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}
```

The preceding code is an HTTP POST method, as indicated by the `[HttpPost]` attribute. The `[FromBody]` attribute tells MVC to get the value of the to-do item from the body of the HTTP request.

```
[HttpPost]
public IActionResult Create(TodoItem item)
{
    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}
```

The preceding code is an HTTP POST method, as indicated by the `[HttpPost]` attribute. MVC gets the value of the to-do item from the body of the HTTP request.

The `CreatedAtRoute` method:

- Returns a 201 response. HTTP 201 is the standard response for an HTTP POST method that creates a new

resource on the server.

- Adds a Location header to the response. The Location header specifies the URI of the newly created to-do item. See [10.2.2 201 Created](#).
- Uses the "GetTodo" named route to create the URL. The "GetTodo" named route is defined in  `GetById` :

```
[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}
```

```
[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}
```

### Use Postman to send a Create request

- Start the app.
- Open Postman.

The screenshot shows the Postman application interface. At the top, there's a navigation bar with File, Edit, View, Help, and workspace-related items like My Workspace, IN SYNC, and notifications. Below the header is a toolbar with New, Import, Runner, and other icons. The main area shows a request configuration for a POST method to the URL <https://localhost:44375/api/todo>. The 'Body' tab is selected, indicated by a red box. Under 'Body' type, 'raw' is selected (also highlighted with a red box), and the content type is set to 'JSON (application/json)' (also highlighted with a red box). The request body contains the following JSON:

```
1 [{}  
2   "name": "walk dog",  
3   "isComplete": true  
4 ]
```

Below the request configuration, the Response pane is visible. It shows the status as '201 Created' and the time taken as '148 ms'. The 'Body' tab is selected, and the response body is displayed in JSON format:

```
1 {  
2   "id": 6,  
3   "name": "walk dog",  
4   "isComplete": true  
5 }
```

- Update the port number in the localhost URL.
- Set the HTTP method to *POST*.
- Click the **Body** tab.
- Select the **raw** radio button.
- Set the type to *JSON (application/json)*.
- Enter a request body with a to-do item resembling the following JSON:

```
{  
  "name": "walk dog",  
  "isComplete": true  
}
```

- Click the **Send** button.

#### TIP

If no response displays after clicking **Send**, disable the **SSL certification verification** option. This is found under **File > Settings**. Click the **Send** button again after disabling the setting.

Click the **Headers** tab in the **Response** pane and copy the **Location** header value:

The screenshot shows the Postman application interface. At the top, there's a navigation bar with File, Edit, View, Help, and a workspace dropdown labeled "My Workspace". Below the header are buttons for New, Import, Runner, and a plus sign. To the right of the workspace are icons for sync status ("IN SYNC") and notifications.

The main area shows a request configuration for a POST method to the URL <https://localhost:44375/api/todo>. The "Body" tab is selected, showing a JSON payload:

```
1 [{}  
2   "name": "walk dog",  
3   "isComplete": true  
4 }]
```

Below the body, the "Headers" tab is highlighted with a red box, showing seven headers: Content-Type → application/json; charset=utf-8, Date → Fri, 27 Apr 2018 18:32:32 GMT, and Location → <https://localhost/api/Todo/6>.

The status bar at the bottom indicates Status: 201 Created and Time: 148 ms.

The Location header URI can be used to access the new item.

## Update

Add the following `Update` method:

```
[HttpPut("{id}")]  
public IActionResult Update(long id, [FromBody] TodoItem item)  
{  
    if (item == null || item.Id != id)  
    {  
        return BadRequest();  
    }  
  
    var todo = _context.TodoItems.Find(id);  
    if (todo == null)  
    {  
        return NotFound();  
    }  
  
    todo.IsComplete = item.IsComplete;  
    todo.Name = item.Name;  
  
    _context.TodoItems.Update(todo);  
    _context.SaveChanges();  
    return NoContent();  
}
```

```
[HttpPut("{id}")]
public IActionResult Update(long id, TodoItem item)
{
    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    todo.IsComplete = item.IsComplete;
    todo.Name = item.Name;

    _context.TodoItems.Update(todo);
    _context.SaveChanges();
    return NoContent();
}
```

`Update` is similar to `Create`, except it uses HTTP PUT. The response is [204 \(No Content\)](#). According to the HTTP specification, a PUT request requires the client to send the entire updated entity, not just the deltas. To support partial updates, use HTTP PATCH.

Use Postman to update the to-do item's name to "walk cat":

The screenshot shows the Postman application interface. The request URL is `https://localhost:44375/api/todo/1`. The method is set to `PUT`. The `Body` tab is selected, and the `raw` option is chosen. The JSON payload is:

```
1 {  
2     "name": "walk cat",  
3     "isComplete": true  
4 }
```

The response status is `204 No Content` and the time taken is `70 ms`.

## Delete

Add the following `Delete` method:

```
[HttpDelete("{id}")]
public IActionResult Delete(long id)
{
    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    _context.TodoItems.Remove(todo);
    _context.SaveChanges();
    return NoContent();
}
```

The `Delete` response is [204 \(No Content\)](#).

Use Postman to delete the to-do item:

The screenshot shows the Postman application window. At the top, there are tabs for File, Edit, View, and Help. Below the tabs are buttons for New, Import, Runner, and a workspace dropdown labeled "My Workspace". To the right of the workspace dropdown are icons for IN SYNC, environment management, and notifications. The main toolbar has three tabs: "DELETE" (highlighted with a red box), "https://localhost:44375/api/todo/1" (the URL being tested), and "Params". On the far right of the toolbar is a "Send" button. Below the toolbar, there are tabs for Authorization, Headers, Body, Pre-request Script, and Tests. The Authorization tab is selected and shows "No Auth" selected from a dropdown. A note states: "The authorization header will be automatically generated when you send the request. [Learn more about authorization](#)". To the right of this note, it says: "This request does not use any authorization. [Learn more about authorization](#)". The Body tab is selected at the bottom, showing a "Pretty" button, "Raw" button, "Preview" button, and a "Text" dropdown set to "Text". Below these buttons is a text area containing the number "1". At the very bottom of the interface are several small icons: a file icon, a search icon, a refresh icon, a "BUILD" dropdown, and a lightbulb icon.

## Call the Web API with jQuery

In this section, an HTML page is added that uses jQuery to call the Web API. jQuery initiates the request and updates the page with the details from the API's response.

Configure the project to serve static files and to enable default file mapping. This is accomplished by invoking the `UseStaticFiles` and `UseDefaultFiles` extension methods in `Startup.Configure`. For more information, see [Static files](#).

```

public void Configure(IApplicationBuilder app)
{
    app.UseDefaultFiles();
    app.UseStaticFiles();
    app.UseMvc();
}

```

Add an HTML file, named *index.html*, to the project's *wwwroot* directory. Replace its contents with the following markup:

```

<!DOCTYPE html>
<html>
<head>
    <meta charset="UTF-8">
    <title>To-do CRUD</title>
    <style>
        input[type='submit'], button, [aria-label] {
            cursor: pointer;
        }

        #spoiler {
            display: none;
        }

        table {
            font-family: Arial, sans-serif;
            border: 1px solid;
            border-collapse: collapse;
        }

        th {
            background-color: #0066CC;
            color: white;
        }

        td {
            border: 1px solid;
            padding: 5px;
        }
    </style>
</head>
<body>
    <h1>To-do CRUD</h1>
    <h3>Add</h3>
    <form action="javascript:void(0);" method="POST" onsubmit="addItem()">
        <input type="text" id="add-name" placeholder="New to-do">
        <input type="submit" value="Add">
    </form>

    <div id="spoiler">
        <h3>Edit</h3>
        <form class="my-form">
            <input type="hidden" id="edit-id">
            <input type="checkbox" id="edit-isComplete">
            <input type="text" id="edit-name">
            <input type="submit" value="Edit">
            <a onclick="closeInput()" aria-label="Close">✖</a>
        </form>
    </div>

    <p id="counter"></p>

    <table>
        <tr>
            <th>Is Complete</th>
            <th>Name</th>

```

```

        <th></th>
        <th></th>
    </tr>
    <tbody id="todos"></tbody>
</table>

<script src="https://code.jquery.com/jquery-3.3.1.min.js"
        integrity="sha256-FgpCb/KJQ1LNfOu91ta32o/NMZxltwRo8QtmkMRdAu8="
        crossorigin="anonymous"></script>
<script src="site.js"></script>
</body>
</html>

```

Add a JavaScript file, named *site.js*, to the project's *wwwroot* directory. Replace its contents with the following code:

```

const uri = 'api/todo';
let todos = null;
function getCount(data) {
    const el = $('#counter');
    let name = 'to-do';
    if (data) {
        if (data > 1) {
            name = 'to-dos';
        }
        el.text(data + ' ' + name);
    } else {
        el.html('No ' + name);
    }
}

$(document).ready(function () {
    getData();
});

function getData() {
    $.ajax({
        type: 'GET',
        url: uri,
        success: function (data) {
            $('#todos').empty();
            getCount(data.length);
            $.each(data, function (key, item) {
                const checked = item.isComplete ? 'checked' : '';

                $('<tr><td><input disabled="true" type="checkbox" ' + checked + '></td>' +
                    '<td>' + item.name + '</td>' +
                    '<td><button onclick="editItem(' + item.id + ')">Edit</button></td>' +
                    '<td><button onclick="deleteItem(' + item.id + ')">Delete</button></td>' +
                    '</tr>').appendTo($('#todos'));
            });
            todos = data;
        }
    });
}

function addItem() {
    const item = {
        'name': $('#add-name').val(),
        'isComplete': false
    };

    $.ajax({
        type: 'POST',
        accepts: 'application/json',
        url: uri,
        contentType: 'application/json',

```

```

        },
        data: JSON.stringify(item),
        error: function (jqXHR, textStatus, errorThrown) {
            alert('here');
        },
        success: function (result) {
            getData();
            $('#add-name').val('');
        }
    });
}

function deleteItem(id) {
    $.ajax({
        url: uri + '/' + id,
        type: 'DELETE',
        success: function (result) {
            getData();
        }
    });
}

function editItem(id) {
    $.each(todos, function (key, item) {
        if (item.id === id) {
            $('#edit-name').val(item.name);
            $('#edit-id').val(item.id);
            $('#edit-isComplete').val(item.isComplete);
        }
    });
    $('#spoiler').css({ 'display': 'block' });
}

$('.my-form').on('submit', function () {
    const item = {
        'name': $('#edit-name').val(),
        'isComplete': $('#edit-isComplete').is(':checked'),
        'id': $('#edit-id').val()
    };

    $.ajax({
        url: uri + '/' + $('#edit-id').val(),
        type: 'PUT',
        accepts: 'application/json',
        contentType: 'application/json',
        data: JSON.stringify(item),
        success: function (result) {
            getData();
        }
    });

    closeInput();
    return false;
});

function closeInput() {
    $('#spoiler').css({ 'display': 'none' });
}

```

A change to the ASP.NET Core project's launch settings may be required to test the HTML page locally. Open `launchSettings.json` in the `Properties` directory of the project. Remove the `launchUrl` property to force the app to open at `index.html`—the project's default file.

There are several ways to get jQuery. In the preceding snippet, the library is loaded from a CDN. This sample is a complete CRUD example of calling the API with jQuery. There are additional features in this sample to make the experience richer. Below are explanations around the calls to the API.

## Get a list of to-do items

To get a list of to-do items, send an HTTP GET request to `/api/todo`.

The jQuery `ajax` function sends an AJAX request to the API, which returns JSON representing an object or array. This function can handle all forms of HTTP interaction, sending an HTTP request to the specified `url`. `GET` is used as the `type`. The `success` callback function is invoked if the request succeeds. In the callback, the DOM is updated with the to-do information.

```
$(document).ready(function () {
    getData();
});

function getData() {
    $.ajax({
        type: 'GET',
        url: uri,
        success: function (data) {
            $('#todos').empty();
            getCount(data.length);
            $.each(data, function (key, item) {
                const checked = item.isComplete ? 'checked' : '';

                $('<tr><td><input disabled="true" type="checkbox" ' + checked + '></td>' +
                    '<td>' + item.name + '</td>' +
                    '<td><button onclick="editItem(' + item.id + ')">Edit</button></td>' +
                    '<td><button onclick="deleteItem(' + item.id + ')">Delete</button></td>' +
                    '</tr>').appendTo($('#todos'));
            });
            todos = data;
        }
    });
}
```

## Add a to-do item

To add a to-do item, send an HTTP POST request to `/api/todo/`. The request body should contain a to-do object. The `ajax` function is using `POST` to call the API. For `POST` and `PUT` requests, the request body represents the data sent to the API. The API is expecting a JSON request body. The `accepts` and `contentType` options are set to `application/json` to classify the media type being received and sent, respectively. The data is converted to a JSON object using `JSON.stringify`. When the API returns a successful status code, the `getData` function is invoked to update the HTML table.

```

function addItem() {
    const item = {
        'name': $('#add-name').val(),
        'isComplete': false
    };

    $.ajax({
        type: 'POST',
        accepts: 'application/json',
        url: uri,
        contentType: 'application/json',
        data: JSON.stringify(item),
        error: function (jqXHR, textStatus, errorThrown) {
            alert('here');
        },
        success: function (result) {
            getData();
            $('#add-name').val('');
        }
    });
}

```

## Update a to-do item

Updating a to-do item is very similar to adding one, since both rely on a request body. The only real difference between the two in this case is that the `url` changes to add the unique identifier of the item, and the `type` is `PUT`.

```

$.ajax({
    url: uri + '/' + $('#edit-id').val(),
    type: 'PUT',
    accepts: 'application/json',
    contentType: 'application/json',
    data: JSON.stringify(item),
    success: function (result) {
        getData();
    }
});

```

## Delete a to-do item

Deleting a to-do item is accomplished by setting the `type` on the AJAX call to `DELETE` and specifying the item's unique identifier in the URL.

```

$.ajax({
    url: uri + '/' + id,
    type: 'DELETE',
    success: function (result) {
        getData();
    }
});

```

## Next steps

- For information on using a persistent database, see:
  - [Create a Razor Pages web app with ASP.NET Core](#)
  - [Work with data in ASP.NET Core](#)
- [ASP.NET Core Web API help pages using Swagger](#)
- [Routing to controller actions](#)

- [Build web APIs with ASP.NET Core](#)
- [Controller action return types](#)
- For information about deploying an API, including to Azure App Service, see [Host and deploy](#).
- [View or download sample code](#). See [how to download](#).

# ASP.NET Core tutorials

7/2/2018 • 2 minutes to read • [Edit Online](#)

The following step-by-step guides for developing ASP.NET Core applications are available:

## Build web apps

[Razor Pages](#) is the recommended approach to create a new Web UI app with ASP.NET Core 2.0.

- [Introduction to Razor Pages in ASP.NET Core](#)
- Create a Razor Pages web app with ASP.NET Core
  - [Razor Pages on Windows](#)
  - [Razor Pages on macOS](#)
  - [Razor Pages with VS Code](#)
- [Create a real-time SignalR web app](#)
- [Create a SignalR web app with TypeScript](#)
- Create an ASP.NET Core MVC web app
  - [Web app with Visual Studio for Windows](#)
  - [Web app with Visual Studio for Mac](#)
  - [Web app with Visual Studio Code on macOS or Linux](#)
- [Get started with ASP.NET Core and Entity Framework Core using Visual Studio](#)
- [Create Tag Helpers](#)
- [Create a simple view component](#)
- [Develop apps using a file watcher](#)

## Build Web APIs

- Create a Web API with ASP.NET Core
  - [Web API with Visual Studio for Windows](#)
  - [Web API with Visual Studio for Mac](#)
  - [Web API with Visual Studio Code](#)
- [ASP.NET Core Web API help pages using Swagger](#)
  - [Get started with NSwag](#)
  - [Get started with Swashbuckle](#)
- [Create backend web services for native mobile apps](#)

## Data access and storage

- [Get started with Razor Pages and EF Core using Visual Studio](#)
- [Get started with ASP.NET Core MVC and EF Core using Visual Studio](#)
- [ASP.NET Core MVC with EF Core - new database](#)
- [ASP.NET Core MVC with EF Core - existing database](#)

## Authentication and authorization

- [Enable authentication using Facebook, Google, and other external providers](#)
- [Account confirmation and password recovery](#)
- [Two-factor authentication with SMS](#)

## Client-side development

- [Use Gulp](#)
- [Use Grunt](#)
- [Manage client-side packages with Bower](#)
- [Build responsive sites with Bootstrap](#)

## Test

- [Unit testing in .NET Core using dotnet test](#)

## Host and deploy

- [Deploy an ASP.NET Core web app to Azure using Visual Studio](#)
- [Deploy an ASP.NET Core web app to Azure using the command line](#)
- [Publish to an Azure Web App with continuous deployment](#)
- [Deploy an ASP.NET container to a remote Docker host](#)
- [ASP.NET Core and Azure Service Fabric](#)

## How to download a sample

1. [Download the ASP.NET repository zip file.](#)
2. Unzip the *Docs-master.zip* file.
3. Use the URL in the sample link to help you navigate to the sample directory.

# Create a Razor Pages web app with ASP.NET Core

7/11/2018 • 2 minutes to read • [Edit Online](#)

This series explains the basics of building a Razor Pages web app with ASP.NET Core using Visual Studio. Other versions of this series include a [macOS version](#) and a [Visual Studio Code version](#).

1. [Get started with Razor Pages](#)
2. [Add a model to a Razor Pages app](#)
3. [Scaffolded Razor Pages](#)
4. [Work with SQL Server LocalDB](#)
5. [Updating the pages](#)
6. [Add search](#)
7. [Add a new field](#)
8. [Add validation](#)

After the tutorial to add a file upload capability to the sample app, see [Upload files to a Razor Page in ASP.NET Core](#).

# Get started with Razor Pages in ASP.NET Core

7/3/2018 • 6 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

We recommend you follow the ASP.NET Core 2.1 version of this tutorial. It's **much** easier to follow and covers more features. Select **ASP.NET Core 2.1** in the version selector.

The screenshot shows a dropdown menu with a red border around the title 'ASP.NET Core 2.0'. Below it is a search bar labeled 'Filter by title'. The menu items are:

- Introduction
- Get started
- Tutorials
  - Create a Razor Pages web app
- [Get started with Razor Pages](#) (This item is highlighted with a blue background)
- Add a model
- Scaffolded Razor Pages

This tutorial teaches the basics of building an ASP.NET Core Razor Pages web app. Razor Pages is the recommended way to build UI for web apps in ASP.NET Core.

There are three versions of this tutorial:

- Windows: This tutorial
- MacOS: [Get started with Razor Pages with Visual Studio for Mac](#)
- macOS, Linux, and Windows: [Get started with ASP.NET Core Razor Pages in Visual Studio Code](#)

[View or download sample code \(how to download\)](#)

## Prerequisites

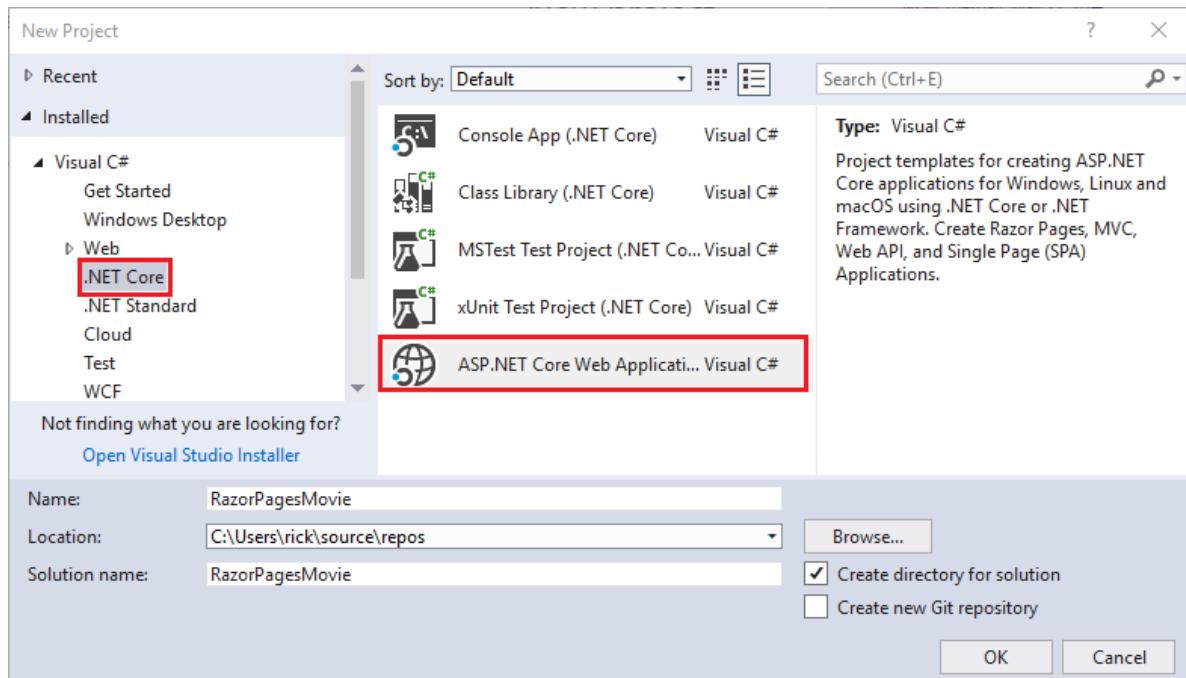
[Visual Studio 2017 version 15.7.3 or later](#) with the following workloads:

- **ASP.NET and web development**
- **.NET Core cross-platform development**

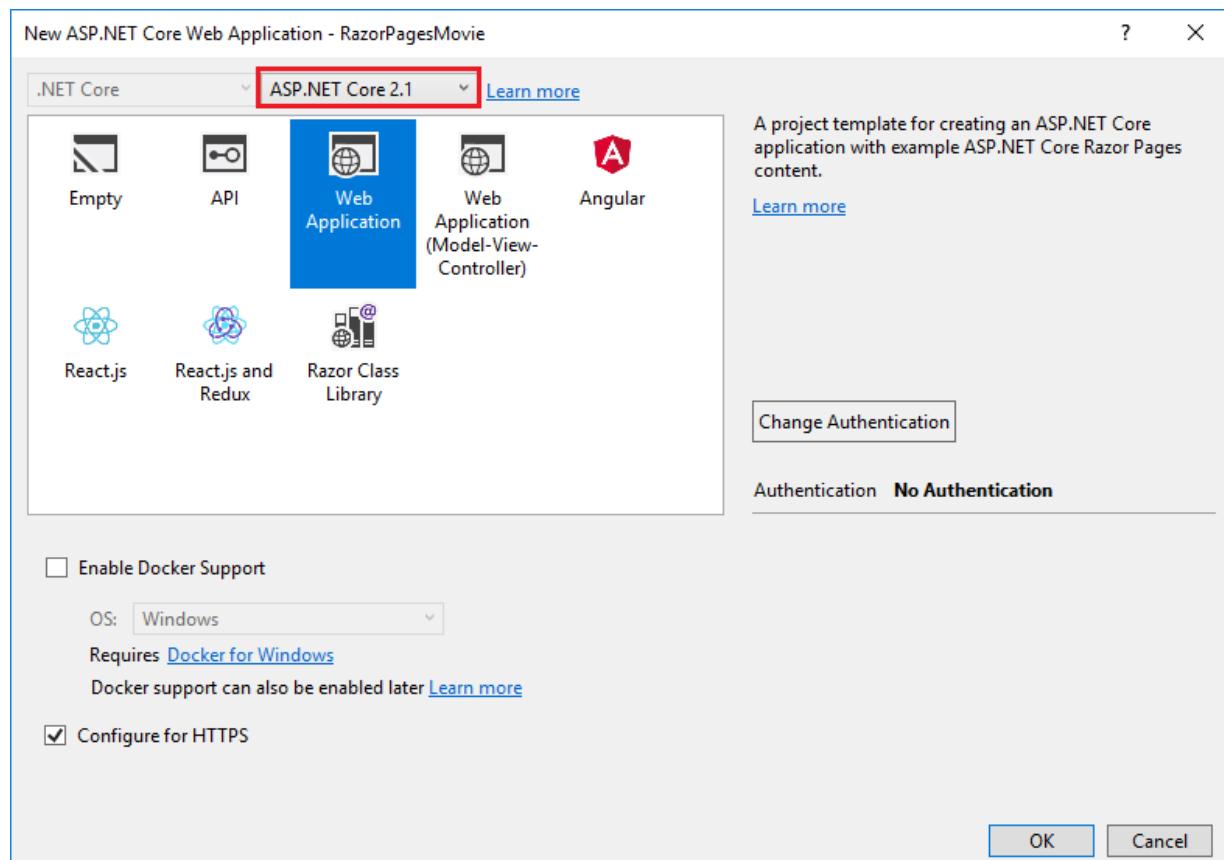
[.NET Core 2.1 SDK or later](#)

## Create a Razor web app

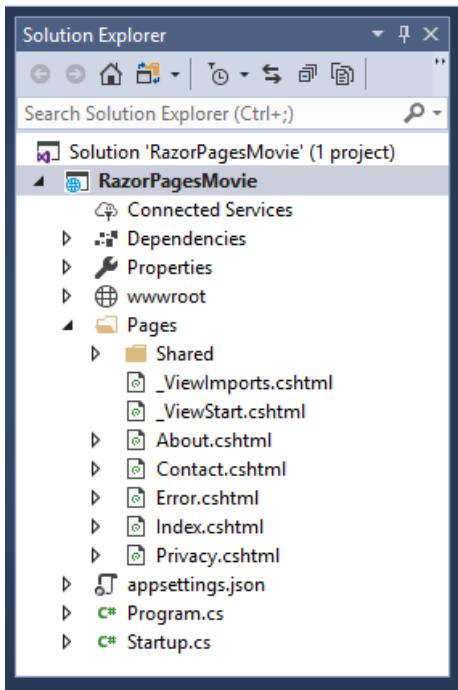
- From the Visual Studio **File** menu, select **New > Project**.
- Create a new ASP.NET Core Web Application. Name the project **RazorPagesMovie**. It's important to name the project *RazorPagesMovie* so the namespaces will match when you copy/paste code.



- Select **ASP.NET Core 2.1** in the dropdown, and then select **Web Application**.



The Visual Studio template creates a starter project:



Press **F5** to run the app in debug mode or **Ctrl-F5** to run without attaching the debugger. Select **Accept** to consent to tracking. This app doesn't track personal information. The template generated code includes assets to help meet [General Data Protection Regulation \(GDPR\)](#).

The screenshot shows a web browser window displaying the 'Home page - RazorPages' page. The URL is https://localhost:44353. A tracking consent dialog is present at the top right of the page, containing the text 'Use this space to summarize your privacy and cookie use policy.' with a 'Learn More' link, and a red box highlights the 'Accept' button.

ASP.NET Core | Windows Linux OSX

Learn how to build ASP.NET apps that can run anywhere. [Learn More](#)

● ○ ○

## Application uses

- Sample pages using ASP.NET Core Razor Pages
- Theming using [Bootstrap](#)

## How to

The following image shows the app after accepting tracking:

RazorPagesMovie Home About Contact

ASP.NET Core | Windows | Linux | OSX

Learn how to build ASP.NET apps that can run anywhere. [Learn More](#)

● ○ ○

## Application uses

- Sample pages using ASP.NET Core Razor Pages
- Theming using Bootstrap

## How to

- Working with Razor Pages.
- Manage User Secrets using Secret Manager.

- Visual Studio starts **IIS Express** and runs the app. The address bar shows `localhost:port#` and not something like `example.com`. That's because `localhost` is the standard hostname for your local computer. Localhost only serves web requests from the local computer. When Visual Studio creates a web project, a random port is used for the web server. In the preceding image, the port number is 5000. When you run the app, you'll see a different port number.
- Launching the app with **Ctrl+F5** (non-debug mode) allows you to make code changes, save the file, refresh the browser, and see the code changes. Many developers prefer to use non-debug mode to quickly launch the app and view changes.

The default template creates **RazorPagesMovie**, **Home**, **About** and **Contact** links and pages. Depending on the size of your browser window, you might need to click the navigation icon to show the links.

## Application uses

- Sample pages using ASP.NET Core Razor Pages
- [Bower](#) for managing client-side libraries
- Theming using [Bootstrap](#)

## How to

- [Working with Razor Pages](#).
- [Manage User Secrets using Secret Manager](#).
- [Use logging to log a message](#).
- [Add packages using NuGet](#).

Test the links. The **RazorPagesMovie** and **Home** links go to the Index page. The **About** and **Contact** links go to the [About](#) and [Contact](#) pages, respectively.

## Project files and folders

The following table lists the files and folders in the project. For this tutorial, the *Startup.cs* file is the most important to understand. You don't need to review each link provided below. The links are provided as a reference when you need more information on a file or folder in the project.

FILE OR FOLDER	PURPOSE
<code>wwwroot</code>	Contains static assets. See <a href="#">Static files</a> .
<code>Pages</code>	Folder for <a href="#">Razor Pages</a> .
<code>appsettings.json</code>	<a href="#">Configuration</a>
<code>Program.cs</code>	Configures the <a href="#">host</a> of the ASP.NET Core app.
<code>Startup.cs</code>	Configures services and the request pipeline. See <a href="#">Startup</a> .

### The Pages/Shared folder

The `_Layout.cshtml` file contains common HTML elements (script and stylesheet links) and sets the layout for the app. For example when you select **RazorPagesMovie**, **Home**, **About** or **Contact**, a common set of elements appears in the webpage. The common elements include the navigation menu at the top and the header at the bottom of the window. For more information, see [Layout](#).

The `_ValidationScriptsPartial.cshtml` file provides a reference to [jQuery](#) validation scripts. When the [Create](#)

and [Edit](#) pages are added later in the tutorial, the `_ValidationScriptsPartial.cshtml` file is used.

The `_CookieConsentPartial.cshtml` file provides a navigation bar and content to summarize the privacy and cookie use policy. For more information on the GDPR assets included in the project, see [EU General Data Protection Regulation \(GDPR\) support in ASP.NET Core](#).

## The Pages folder

The `_ViewStart.cshtml` sets the Razor Pages `Layout` property to use the `_Layout.cshtml` file. See [Layout](#) for more information.

The `_ViewImports.cshtml` file contains Razor directives that are imported into each Razor Page. See [Importing Shared Directives](#) for more information.

The `About`, `Contact` and `Index` pages are basic pages you can use to start an app. The `Error` page is used to display error information.

## Prerequisites

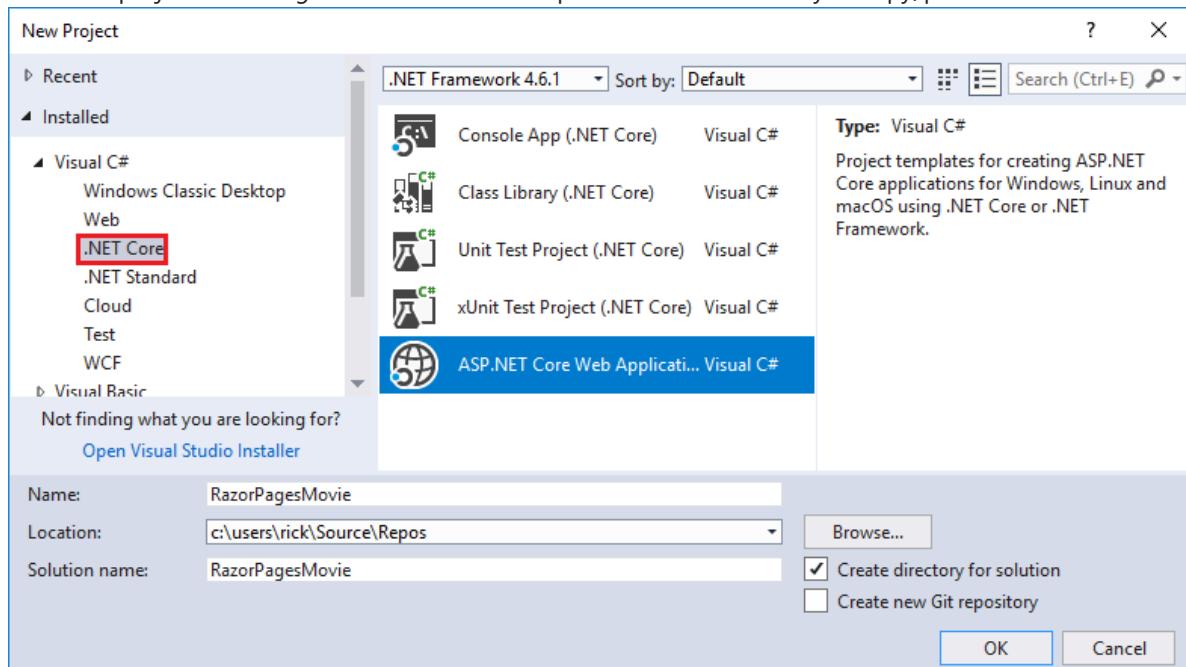
Visual Studio 2017 version 15.7.3 or later with the following workloads:

- **ASP.NET and web development**
- **.NET Core cross-platform development**

.NET Core 2.1 SDK or later

## Create a Razor web app

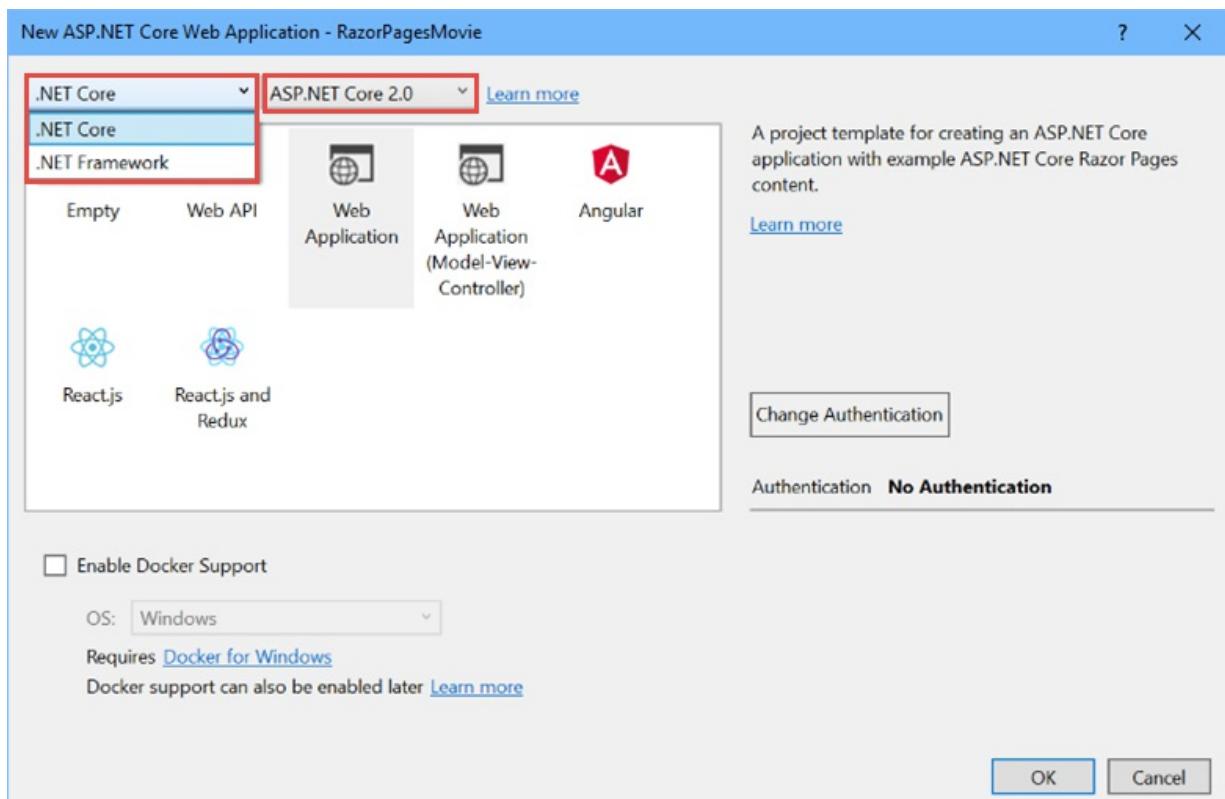
- From the Visual Studio **File** menu, select **New > Project**.
- Create a new ASP.NET Core Web Application. Name the project **RazorPagesMovie**. It's important to name the project *RazorPagesMovie* so the namespaces will match when you copy/paste code.



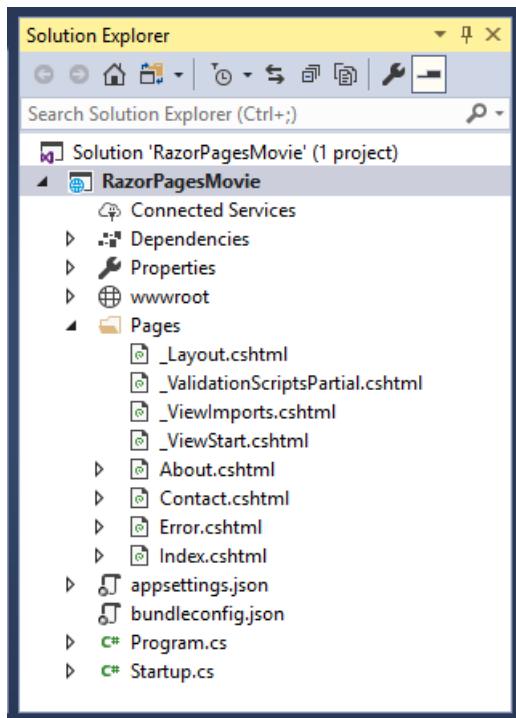
- Select **ASP.NET Core 2.0** in the dropdown, and then select **Web Application**.

### NOTE

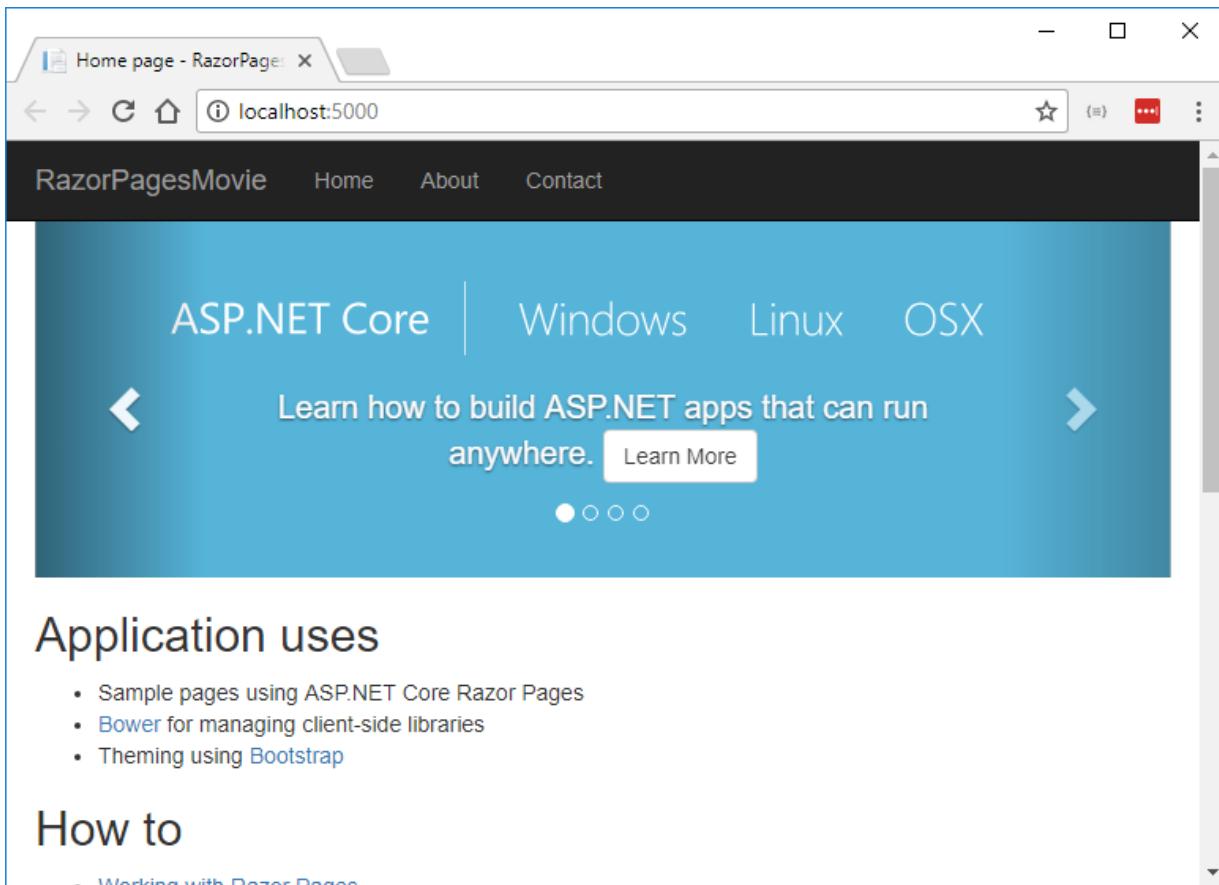
To use ASP.NET Core with .NET Framework, you must first select **.NET Framework** from the leftmost drop-down in the dialog, then you can select the desired ASP.NET Core version.



The Visual Studio template creates a starter project:



Press **F5** to run the app in debug mode or **Ctrl-F5** to run without attaching the debugger



## Application uses

- Sample pages using ASP.NET Core Razor Pages
- Bower for managing client-side libraries
- Theming using Bootstrap

## How to

Working with Razor Pages

- Visual Studio starts IIS Express and runs your app. The address bar shows `localhost:port#` and not something like `example.com`. That's because `localhost` is the standard hostname for your local computer. Localhost only serves web requests from the local computer. When Visual Studio creates a web project, a random port is used for the web server. In the preceding image, the port number is 5000. When you run the app, you'll see a different port number.
- Launching the app with **Ctrl+F5** (non-debug mode) allows you to make code changes, save the file, refresh the browser, and see the code changes. Many developers prefer to use non-debug mode to quickly launch the app and view changes.

The default template creates **RazorPagesMovie**, **Home**, **About** and **Contact** links and pages. Depending on the size of your browser window, you might need to click the navigation icon to show the links.

## Application uses

- Sample pages using ASP.NET Core Razor Pages
- [Bower](#) for managing client-side libraries
- Theming using [Bootstrap](#)

## How to

- [Working with Razor Pages](#).
- [Manage User Secrets using Secret Manager](#).
- [Use logging to log a message](#).
- [Add packages using NuGet](#).

Test the links. The **RazorPagesMovie** and **Home** links go to the Index page. The **About** and **Contact** links go to the [About](#) and [Contact](#) pages, respectively.

## Project files and folders

The following table lists the files and folders in the project. For this tutorial, the *Startup.cs* file is the most important to understand. You don't need to review each link provided below. The links are provided as a reference when you need more information on a file or folder in the project.

FILE OR FOLDER	PURPOSE
wwwroot	Contains static files. See <a href="#">Static files</a> .
Pages	Folder for <a href="#">Razor Pages</a> .
<i>appsettings.json</i>	<a href="#">Configuration</a>
<i>Program.cs</i>	<a href="#">Hosts</a> the ASP.NET Core app.
<i>Startup.cs</i>	Configures services and the request pipeline. See <a href="#">Startup</a> .

### The Pages folder

The *\_Layout.cshtml* file contains common HTML elements (scripts and stylesheets) and sets the layout for the application. For example, when you click on **RazorPagesMovie**, **Home**, **About** or **Contact**, you see the same elements. The common elements include the navigation menu on the top and the header on the bottom of the window. See [Layout](#) for more information.

The *\_ViewStart.cshtml* sets the Razor Pages [Layout](#) property to use the *\_Layout.cshtml* file. See [Layout](#) for

more information.

The `_ViewImports.cshtml` file contains Razor directives that are imported into each Razor Page. See [Importing Shared Directives](#) for more information.

The `_ValidationScriptsPartial.cshtml` file provides a reference to [jQuery](#) validation scripts. When we add `Create` and `Edit` pages later in the tutorial, the `_ValidationScriptsPartial.cshtml` file will be used.

The `About`, `Contact` and `Index` pages are basic pages you can use to start an app. The `Error` page is used to display error information.

NEXT: ADDING A  
MODEL

# Add a model to a Razor Pages app in ASP.NET Core

7/10/2018 • 8 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section, you add classes for managing movies in a database. You use these classes with [Entity Framework Core](#) (EF Core) to work with a database. EF Core is an object-relational mapping (ORM) framework that simplifies the data access code that you have to write.

The model classes you create are known as POCO classes (from "plain-old CLR objects") because they don't have any dependency on EF Core. They define the properties of the data that are stored in the database.

In this tutorial, you write the model classes first, and EF Core creates the database. An alternate approach not covered here is to [generate model classes from an existing database](#).

[View or download](#) sample.

## Add a data model

In Solution Explorer, right-click the **RazorPagesMovie** project > **Add > New Folder**. Name the folder *Models*.

Right click the *Models* folder. Select **Add > Class**. Name the class **Movie** and add the following properties:

Replace the contents of the `Movie` class with the following code:

```
using System;
using System.ComponentModel.DataAnnotations.Schema;

namespace RazorPagesMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}
```

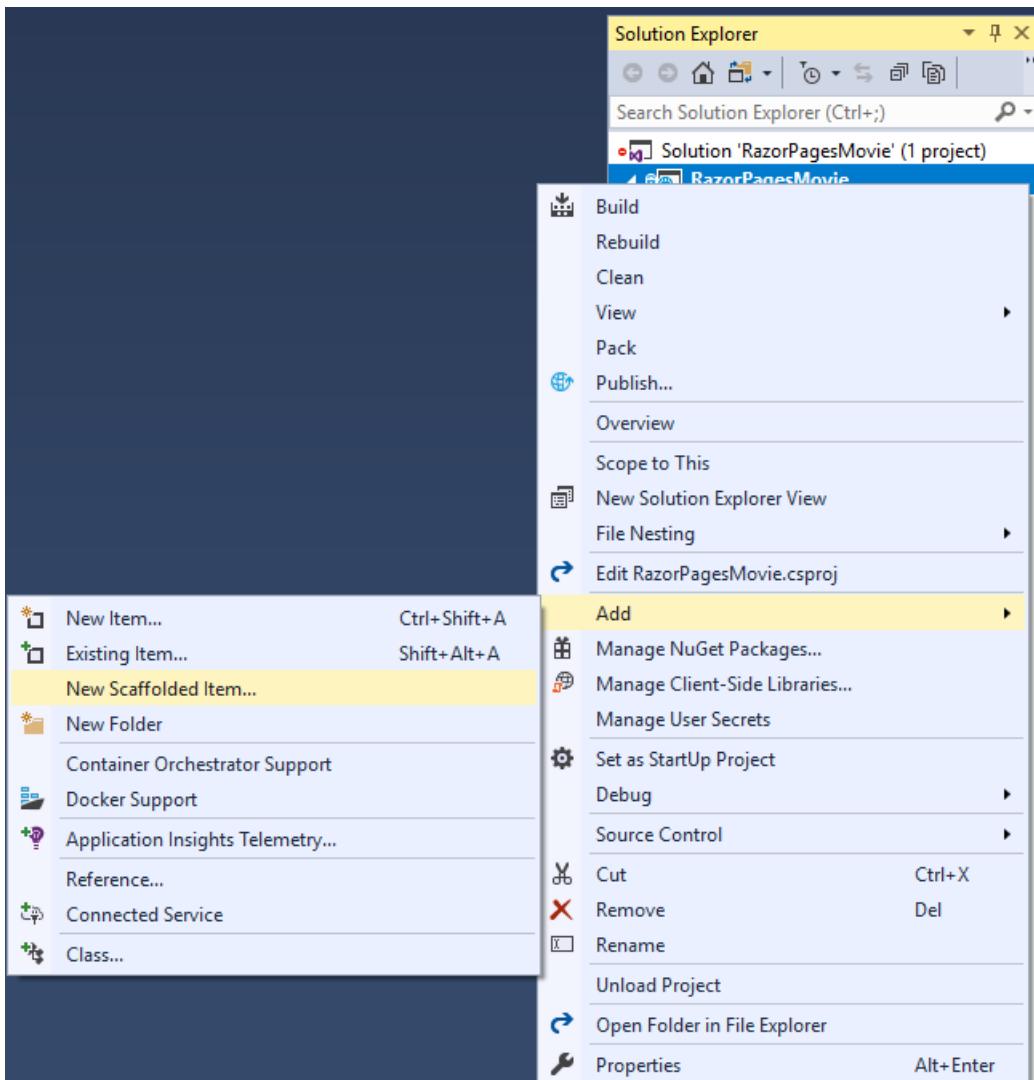
## Scaffold the movie model

In this section, the movie model is scaffolded. That is, the scaffolding tool produces pages for Create, Read, Update, and Delete (CRUD) operations for the movie model.

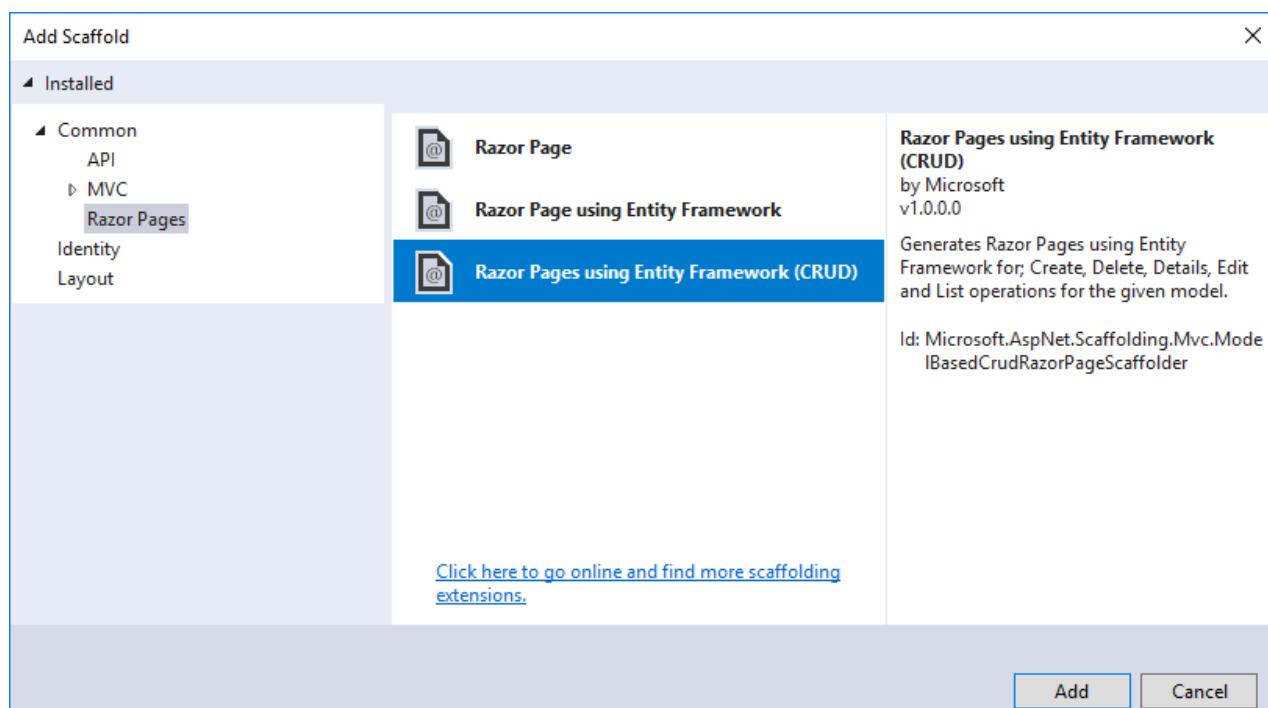
Create a *Pages/Movies* folder:

- In **Solution Explorer**, right click on the *Pages* folder > **Add > New Folder**.
- Name the folder *Movies*

In **Solution Explorer**, right click on the *Pages/Movies* folder > **Add > New Scaffolded Item**.



In the **Add Scaffold** dialog, select **Razor Pages using Entity Framework (CRUD) > ADD**.

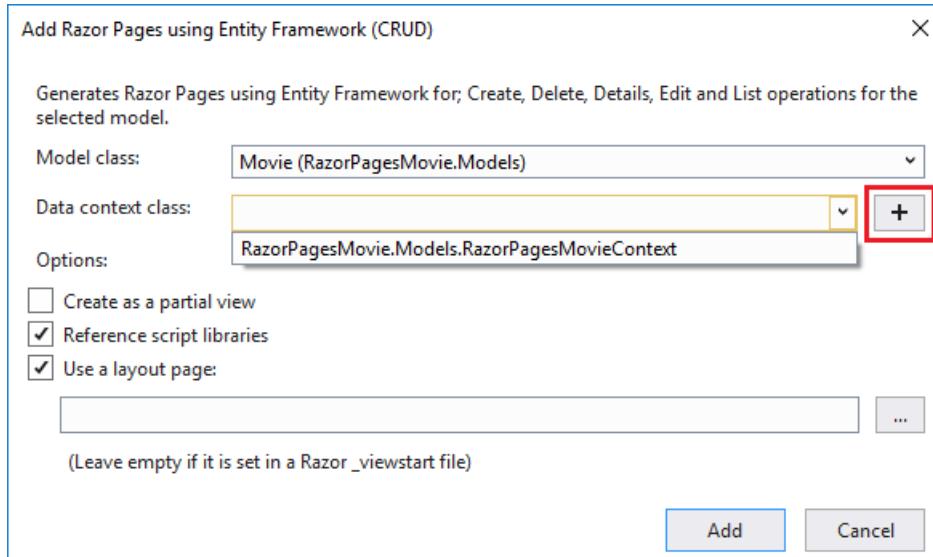


Complete the **Add Razor Pages using Entity Framework (CRUD)** dialog:

- In the **Model class** drop down, select **Movie (RazorPagesMovie.Models)**.
- In the **Data context class** row, select the + (plus) sign and accept the generated name

## RazorPagesMovie.Models.RazorPagesMovieContext.

- In the **Data context class** drop down, select **RazorPagesMovie.Models.RazorPagesMovieContext**
- Select **Add**.



The scaffold process created and changed the following files:

### Files created

- *Pages/Movies* Create, Delete, Details, Edit, Index. These pages are detailed in the next tutorial.
- *Data/RazorPagesMovieContext.cs*

### Files updates

- *Startup.cs*: Changes to this file are detailed in the next section.
- *appsettings.json*: The connection string used to connect to a local database is added.

## Examine the context registered with dependency injection

ASP.NET Core is built with [dependency injection](#). Services (such as the EF Core DB context) are registered with dependency injection during application startup. Components that require these services (such as Razor Pages) are provided these services via constructor parameters. The constructor code that gets a DB context instance is shown later in the tutorial.

The scaffolding tool automatically created a DB context and registered it with the dependency injection container.

Examine the `Startup.ConfigureServices` method. The highlighted line was added by the scaffolder:

```
public void ConfigureServices(IServiceCollection services)
{
    services.Configure<CookiePolicyOptions>(options =>
    {
        options.CheckConsentNeeded = context => true;
        options.MinimumSameSitePolicy = SameSiteMode.None;
    });

    services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1);

    services.AddDbContext<RazorPagesMovieContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("RazorPagesMovieContext")));
}
```

The main class that coordinates EF Core functionality for a given data model is the DB context class. The data

context is derived from [Microsoft.EntityFrameworkCore.DbContext](#). The data context specifies which entities are included in the data model. In this project, the class is named `RazorPagesMovieContext`.

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.EntityFrameworkCore;

namespace RazorPagesMovie.Models
{
    public class RazorPagesMovieContext : DbContext
    {
        public RazorPagesMovieContext (DbContextOptions<RazorPagesMovieContext> options)
            : base(options)
        {

        }

        public DbSet<RazorPagesMovie.Models.Movie> Movie { get; set; }
    }
}
```

The preceding code creates a `DbSet<Movie>` property for the entity set. In Entity Framework terminology, an entity set typically corresponds to a database table. An entity corresponds to a row in the table.

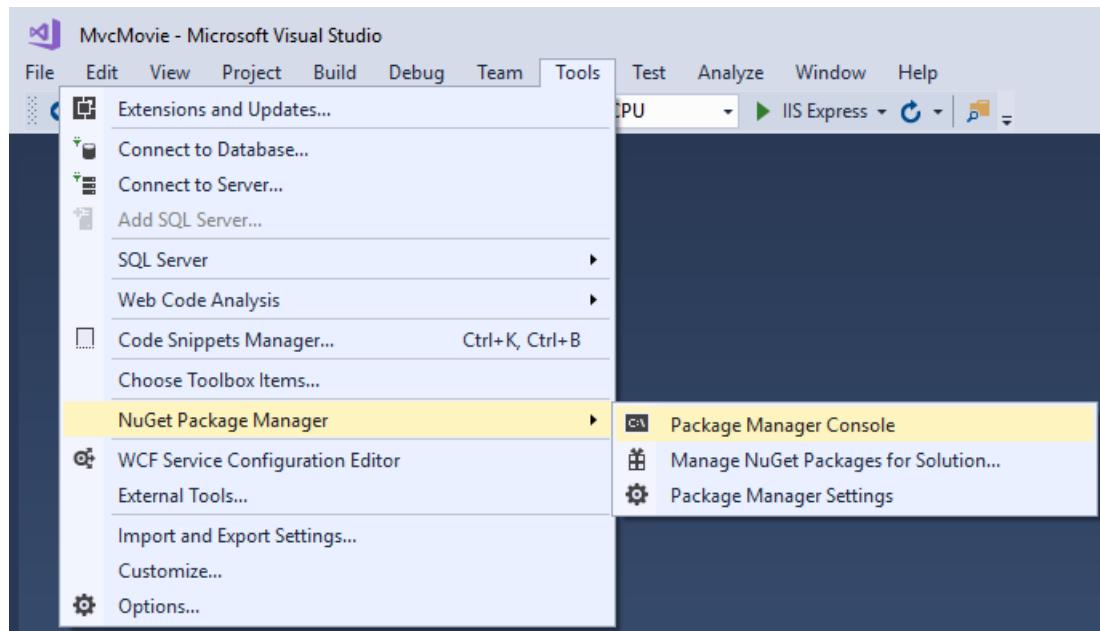
The name of the connection string is passed in to the context by calling a method on a `DbContextOptions` object. For local development, the [ASP.NET Core configuration system](#) reads the connection string from the `appsettings.json` file.

## Perform initial migration

In this section, you use the Package Manager Console (PMC) to:

- Add an initial migration.
- Update the database with the initial migration.

From the **Tools** menu, select **NuGet Package Manager > Package Manager Console**.



In the PMC, enter the following commands:

```
Add-Migration Initial  
Update-Database
```

Alternatively, the following .NET Core CLI commands can be used:

```
dotnet ef migrations add Initial  
dotnet ef database update
```

Ignore the following warning message, you fix that in the next tutorial:

```
Microsoft.EntityFrameworkCore.Model.Validation[30000]
```

*No type was specified for the decimal column 'Price' on entity type 'Movie'. This will cause values to be silently truncated if they do not fit in the default precision and scale. Explicitly specify the SQL server column type that can accommodate all the values using 'ForHasColumnType()'.*

The `Add-Migration` command generates code to create the initial database schema. The schema is based on the model specified in the `RazorPagesMovieContext` (In the `Data/RazorPagesMovieContext.cs` file). The `Initial` argument is used to name the migrations. You can use any name, but by convention you choose a name that describes the migration. See [Introduction to migrations](#) for more information.

The `Update-Database` command runs the `Up` method in the `Migrations/{time-stamp}_InitialCreate.cs` file, which creates the database.

If you get the error:

```
SqlException: Cannot open database "RazorPagesMovieContext-GUID" requested by the login. The login failed.  
Login failed for user 'User-name'.
```

You missed the [migrations step](#).

By [Rick Anderson](#)

In this section, you add classes for managing movies in a database. You use these classes with [Entity Framework Core](#) (EF Core) to work with a database. EF Core is an object-relational mapping (ORM) framework that simplifies the data access code that you have to write.

The model classes you create are known as POCO classes (from "plain-old CLR objects") because they don't have any dependency on EF Core. They define the properties of the data that are stored in the database.

In this tutorial, you write the model classes first, and EF Core creates the database. An alternate approach not covered here is to [generate model classes from an existing database](#).

[View or download](#) sample.

## Add a data model

In Solution Explorer, right-click the **RazorPagesMovie** project > **Add > New Folder**. Name the folder **Models**.

Right click the **Models** folder. Select **Add > Class**. Name the class **Movie** and add the following properties:

Add the following properties to the `Movie` class:

```

using System;

namespace RazorPagesMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}

```

The `ID` field is required by the database for the primary key.

## Add a database context class

Add the following `MovieContext.cs` class to the `Models` folder:

```

using Microsoft.EntityFrameworkCore;

namespace RazorPagesMovie.Models
{
    public class MovieContext : DbContext
    {
        public MovieContext(DbContextOptions<MovieContext> options)
            : base(options)
        {

        }

        public DbSet<Movie> Movie { get; set; }
    }
}

```

The preceding code creates a `DbSet` property for the entity set. In Entity Framework terminology, an entity set typically corresponds to a database table, and an entity corresponds to a row in the table.

## Add a database connection string

Add a connection string to the `appsettings.json` file.

```

{
    "Logging": {
        "IncludeScopes": false,
        "LogLevel": {
            "Default": "Warning"
        }
    },
    "ConnectionStrings": {
        "MovieContext": "Server=(localdb)\\mssqllocaldb;Database=Movie-1;Trusted_Connection=True;MultipleActiveResultSets=true"
    }
}

```

## Register the database context

Register the database context with the [dependency injection](#) container in the [ConfigureServices method of the Startup class \(Startup.cs\)](#):

```

public void ConfigureServices(IServiceCollection services)
{
    // requires
    // using RazorPagesMovie.Models;
    // using Microsoft.EntityFrameworkCore;

    services.AddDbContext<MovieContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("MovieContext")));
    services.AddMvc();
}

```

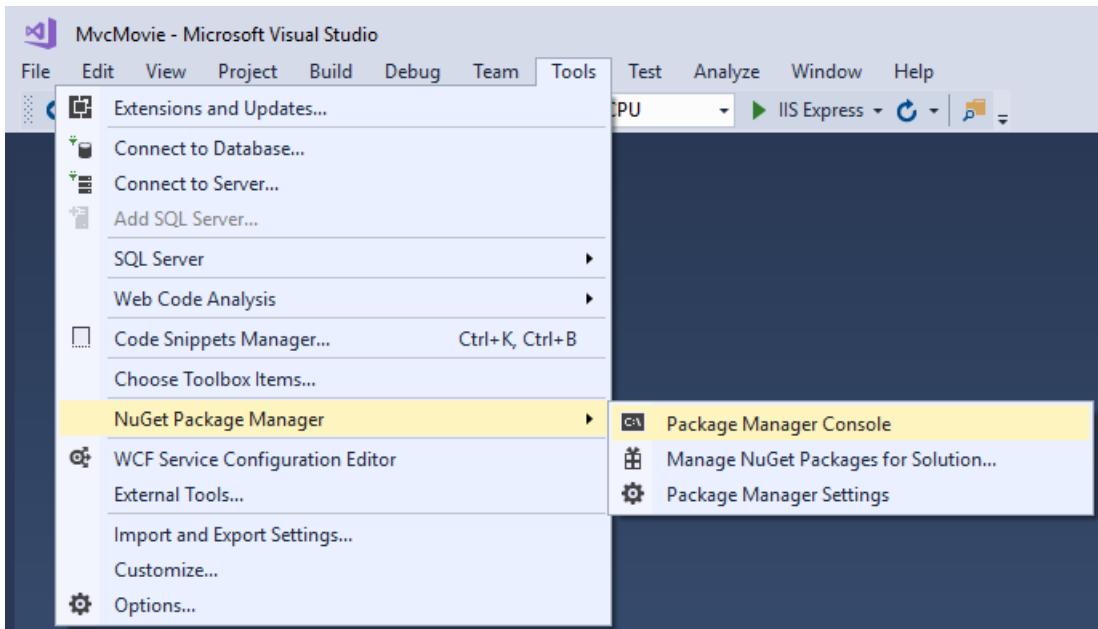
Build the project to verify you don't have any errors.

## Add scaffold tooling and perform initial migration

In this section, you use the Package Manager Console (PMC) to:

- Add the Visual Studio web code generation package. This package is required to run the scaffolding engine.
- Add an initial migration.
- Update the database with the initial migration.

From the **Tools** menu, select **NuGet Package Manager > Package Manager Console**.



In the PMC, enter the following commands:

```

Install-Package Microsoft.VisualStudio.Web.CodeGeneration.Design -Version 2.0.3
Add-Migration Initial
Update-Database

```

Alternatively, the following .NET Core CLI commands can be used:

```

dotnet add package Microsoft.VisualStudio.Web.CodeGeneration.Design
dotnet ef migrations add Initial
dotnet ef database update

```

Ignore the following message:

```
Microsoft.EntityFrameworkCore.Model.Validation[30000]
```

*No type was specified for the decimal column 'Price' on entity type 'Movie'. This will cause values to be silently truncated if they do not fit in the default precision and scale. Explicitly specify the SQL server column type that can accommodate all the values using 'ForHasColumnType()'*

You fix that in the next tutorial.

The `Install-Package` command installs the tooling required to run the scaffolding engine.

The `Add-Migration` command generates code to create the initial database schema. The schema is based on the model specified in the `DbContext` (In the `Models/MovieContext.cs` file). The `Initial` argument is used to name the migrations. You can use any name, but by convention you choose a name that describes the migration. See [Introduction to migrations](#) for more information.

The `Update-Database` command runs the `Up` method in the `Migrations/{time-stamp}_InitialCreate.cs` file, which creates the database.

### Scaffold the Movie model

- Run the following from the command line (in the project directory that contains the `Program.cs`, `Startup.cs`, and `.csproj` files):

```
dotnet restore  
dotnet aspnet-codegenerator razorpage -m Movie -dc MovieContext -udl -outDir Pages\Movies --  
referenceScriptLibraries
```

If you get the error:

```
No executable found matching command "dotnet-aspnet-codegenerator"
```

The preceding error happens when you are in the wrong directory. Open a command shell to the project directory (The directory that contains the `Program.cs`, `Startup.cs`, and `.csproj` files), and then run the preceding command.

If you get the error:

```
The process cannot access the file  
'RazorPagesMovie/bin/Debug/netcoreapp2.0/RazorPagesMovie.dll'  
because it is being used by another process.
```

Exit Visual Studio and run the command again.

The following table details the ASP.NET Core code generators` parameters:

PARAMETER	DESCRIPTION
<code>-m</code>	The name of the model.
<code>-dc</code>	The data context.
<code>-udl</code>	Use the default layout.
<code>-outDir</code>	The relative output folder path to create the views.
<code>--referenceScriptLibraries</code>	Adds <code>_ValidationScriptsPartial</code> to Edit and Create pages

Use the `-h` switch to get help on the `aspnet-codegenerator razorpage` command:

```
dotnet aspnet-codegenerator razorpage -h
```

## Test the app

- Run the app and append `/Movies` to the URL in the browser (`http://localhost:port/movies`).
- Test the **Create** link.

The screenshot shows a browser window titled "Create - Movie". The address bar indicates a secure connection to `https://localhost:44348/Movies/Create`. The page itself is titled "Create" and has a sub-section "Movie". It contains four input fields: "Title" (value: "The Good, the bad, and the ugly"), "Release Date" (value: "05/30/2018"), "Genre" (value: "Western"), and "Price" (value: "1.19"). Below these fields is a "Create" button. At the bottom of the page is a link "Back to List" and a copyright notice "© 2018 - RazorPagesMovie".

- Test the **Edit**, **Details**, and **Delete** links.

If you get a SQL exception, verify you have run migrations and updated the database.

The next tutorial explains the files created by scaffolding.

PREVIOUS: GET  
STARTED

NEXT: SCAFFOLDED RAZOR  
PAGES

# Scaffolded Razor Pages in ASP.NET Core

6/21/2018 • 8 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

This tutorial examines the Razor Pages created by scaffolding in the previous tutorial.

[View or download sample.](#)

## The Create, Delete, Details, and Edit pages.

Examine the *Pages/Movies/Index.cshtml.cs* Page Model:

```
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using System.Collections.Generic;
using System.Threading.Tasks;
using RazorPagesMovie.Models;

namespace RazorPagesMovie.Pages.Movies
{
    public class IndexModel : PageModel
    {
        private readonly RazorPagesMovie.Models.MovieContext _context;

        public IndexModel(RazorPagesMovie.Models.MovieContext context)
        {
            _context = context;
        }

        public IList<Movie> Movie { get; set; }

        public async Task OnGetAsync()
        {
            Movie = await _context.Movie.ToListAsync();
        }
    }
}
```

```

using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using RazorPagesMovie.Models;
using System.Collections.Generic;
using System.Threading.Tasks;

namespace RazorPagesMovie.Pages.Movies
{
    public class IndexModel : PageModel
    {
        private readonly RazorPagesMovie.Models.RazorPagesMovieContext _context;

        public IndexModel(RazorPagesMovie.Models.RazorPagesMovieContext context)
        {
            _context = context;
        }

        public IList<Movie> Movie { get; set; }

        public async Task OnGetAsync()
        {
            Movie = await _context.Movie.ToListAsync();
        }
    }
}

```

Razor Pages are derived from `PageModel`. By convention, the `PageModel`-derived class is called `<PageName>Model`. The constructor uses [dependency injection](#) to add the `MovieContext` to the page. All the scaffolded pages follow this pattern. See [Asynchronous code](#) for more information on asynchronous programming with Entity Framework.

When a request is made for the page, the `OnGetAsync` method returns a list of movies to the Razor Page. `OnGetAsync` or `OnGet` is called on a Razor Page to initialize the state for the page. In this case, `OnGetAsync` gets a list of movies and displays them.

When `OnGet` returns `void` or `OnGetAsync` returns `Task`, no return method is used. When the return type is `IActionResult` or `Task<IActionResult>`, a return statement must be provided. For example, the `Pages/Movies/Create.cshtml.cs` `OnPostAsync` method:

```

public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    _context.Movie.Add(Movie);
    await _context.SaveChangesAsync();

    return RedirectToPage("./Index");
}

```

Examine the `Pages/Movies/Index.cshtml` Razor Page:

```

@page
@model RazorPagesMovie.Pages.Movies.IndexModel

 @{
    ViewData["Title"] = "Index";
}

<h2>Index</h2>

<p>
    <a asp-page="Create">Create New</a>
</p>
<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].ReleaseDate)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].Genre)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].Price)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
@foreach (var item in Model.Movie) {
        <tr>
            <td>
                @Html.DisplayFor(modelItem => item.Title)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.ReleaseDate)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.Genre)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.Price)
            </td>
            <td>
                <a asp-page=".Edit" asp-route-id="@item.ID">Edit</a> |
                <a asp-page=".Details" asp-route-id="@item.ID">Details</a> |
                <a asp-page=".Delete" asp-route-id="@item.ID">Delete</a>
            </td>
        </tr>
}
    </tbody>
</table>

```

Razor can transition from HTML into C# or into Razor-specific markup. When an `@` symbol is followed by a [Razor reserved keyword](#), it transitions into Razor-specific markup, otherwise it transitions into C#.

The `@page` Razor directive makes the file into an MVC action — which means that it can handle requests. `@page` must be the first Razor directive on a page. `@page` is an example of transitioning into Razor-specific markup. See [Razor syntax](#) for more information.

Examine the lambda expression used in the following HTML Helper:

```
@Html.DisplayNameFor(model => model.Movie[0].Title)
```

The `DisplayNameFor` HTML Helper inspects the `Title` property referenced in the lambda expression to determine the display name. The lambda expression is inspected rather than evaluated. That means there is no access violation when `model`, `model.Movie`, or `model.Movie[0]` are `null` or empty. When the lambda expression is evaluated (for example, with `@Html.DisplayFor(modelItem => item.Title)`), the model's property values are evaluated.

### The `@model` directive

```
@page  
@model RazorPagesMovie.Pages.Movies.IndexModel
```

The `@model` directive specifies the type of the model passed to the Razor Page. In the preceding example, the `@model` line makes the `PageModel`-derived class available to the Razor Page. The model is used in the `@Html.DisplayNameFor` and `@Html.DisplayName` [HTML Helpers](#) on the page.

### ViewData and layout

Consider the following code:

```
@page  
@model RazorPagesMovie.Pages.Movies.IndexModel  
  
{@  
    ViewData["Title"] = "Index";  
}
```

The preceding highlighted code is an example of Razor transitioning into C#. The `{` and `}` characters enclose a block of C# code.

The `PageModel` base class has a `ViewData` dictionary property that can be used to add data that you want to pass to a View. You add objects into the `ViewData` dictionary using a key/value pattern. In the preceding sample, the "Title" property is added to the `ViewData` dictionary.

The "Title" property is used in the `Pages/_Layout.cshtml` file. The following markup shows the first few lines of the `Pages/_Layout.cshtml` file.

The "Title" property is used in the `Pages/Shared/_Layout.cshtml` file. The following markup shows the first few lines of the `_Layout.cshtml` file.

```
<!DOCTYPE html>  
<html>  
<head>  
    <meta charset="utf-8" />  
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />  
    <title>@ViewData["Title"] - RazorPagesMovie</title>  
  
    /*Markup removed for brevity.*@
```

The line `/*Markup removed for brevity.*@` is a Razor comment. Unlike HTML comments (`<!-- -->`), Razor comments are not sent to the client.

Run the app and test the links in the project (**Home**, **About**, **Contact**, **Create**, **Edit**, and **Delete**). Each page sets the title, which you can see in the browser tab. When you bookmark a page, the title is used for the bookmark. `Pages/Index.cshtml` and `Pages/Movies/Index.cshtml` currently have the same title, but you can modify them to

have different values.

#### NOTE

You may not be able to enter decimal commas in the `Price` field. To support [jQuery validation](#) for non-English locales that use a comma (",") for a decimal point, and non US-English date formats, you must take steps to globalize your app. This [GitHub issue 4076](#) for instructions on adding decimal comma.

The `Layout` property is set in the *Pages/\_ViewStart.cshtml* file:

```
@{  
    Layout = "_Layout";  
}
```

The preceding markup sets the layout file to *Pages/\_Layout.cshtml* for all Razor files under the *Pages* folder. See [Layout](#) for more information.

#### Update the layout

Change the `<title>` element in the *Pages/\_Layout.cshtml* file to use a shorter string.

```
<!DOCTYPE html>  
<html>  
<head>  
    <meta charset="utf-8" />  
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />  
    <title>@ ViewData["Title"] - Movie</title>
```

Find the following anchor element in the *Pages/\_Layout.cshtml* file.

```
<a asp-page="/Index" class="navbar-brand">RazorPagesMovie</a>
```

Replace the preceding element with the following markup.

```
<a asp-page="/Movies/Index" class="navbar-brand">RpMovie</a>
```

The preceding anchor element is a [Tag Helper](#). In this case, it's the [Anchor Tag Helper](#). The `asp-page="/Movies/Index"` Tag Helper attribute and value creates a link to the `/Movies/Index` Razor Page.

Save your changes, and test the app by clicking on the **RpMovie** link. See the *\_Layout.cshtml* file in GitHub.

#### The Create page model

Examine the *Pages/Movies/Create.cshtml.cs* page model:

```
// Unused usings removed.
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using RazorPagesMovie.Models;
using System.Threading.Tasks;

namespace RazorPagesMovie.Pages.Movies
{
    public class CreateModel : PageModel
    {
        private readonly RazorPagesMovie.Models.MovieContext _context;

        public CreateModel(RazorPagesMovie.Models.MovieContext context)
        {
            _context = context;
        }

        public IActionResult OnGet()
        {
            return Page();
        }

        [BindProperty]
        public Movie Movie { get; set; }

        public async Task<IActionResult> OnPostAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            _context.Movie.Add(Movie);
            await _context.SaveChangesAsync();

            return RedirectToPage("./Index");
        }
    }
}
```

```

// Unused usings removed.
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using RazorPagesMovie.Models;
using System.Threading.Tasks;

namespace RazorPagesMovie.Pages.Movies
{
    public class CreateModel : PageModel
    {
        private readonly RazorPagesMovie.Models.RazorPagesMovieContext _context;

        public CreateModel(RazorPagesMovie.Models.RazorPagesMovieContext context)
        {
            _context = context;
        }

        public IActionResult OnGet()
        {
            return Page();
        }

        [BindProperty]
        public Movie Movie { get; set; }

        public async Task<IActionResult> OnPostAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            _context.Movie.Add(Movie);
            await _context.SaveChangesAsync();

            return RedirectToPage("./Index");
        }
    }
}

```

The `OnGet` method initializes any state needed for the page. The Create page doesn't have any state to initialize, so `Page` is returned. Later in the tutorial you see `OnGet` method initialize state. The `Page` method creates a `PageResult` object that renders the *Create.cshtml* page.

The `Movie` property uses the `[BindProperty]` attribute to opt-in to [model binding](#). When the Create form posts the form values, the ASP.NET Core runtime binds the posted values to the `Movie` model.

The `OnPostAsync` method is run when the page posts form data:

```

public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    _context.Movie.Add(Movie);
    await _context.SaveChangesAsync();

    return RedirectToPage("./Index");
}

```

If there are any model errors, the form is redisplayed, along with any form data posted. Most model errors can be

caught on the client-side before the form is posted. An example of a model error is posting a value for the date field that cannot be converted to a date. We'll talk more about client-side validation and model validation later in the tutorial.

If there are no model errors, the data is saved, and the browser is redirected to the Index page.

## The Create Razor Page

Examine the *Pages/Movies/Create.cshtml* Razor Page file:

```
@page
@model RazorPagesMovie.Pages.Movies.CreateModel

 @{
    ViewData["Title"] = "Create";
}

<h2>Create</h2>

<h4>Movie</h4>
<hr />
<div class="row">
    <div class="col-md-4">
        <form method="post">
            <div asp-validation-summary="ModelOnly" class="text-danger"></div>
            <div class="form-group">
                <label asp-for="Movie.Title" class="control-label"></label>
                <input asp-for="Movie.Title" class="form-control" />
                <span asp-validation-for="Movie.Title" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Movie.ReleaseDate" class="control-label"></label>
                <input asp-for="Movie.ReleaseDate" class="form-control" />
                <span asp-validation-for="Movie.ReleaseDate" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Movie.Genre" class="control-label"></label>
                <input asp-for="Movie.Genre" class="form-control" />
                <span asp-validation-for="Movie.Genre" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Movie.Price" class="control-label"></label>
                <input asp-for="Movie.Price" class="form-control" />
                <span asp-validation-for="Movie.Price" class="text-danger"></span>
            </div>
            <div class="form-group">
                <input type="submit" value="Create" class="btn btn-default" />
            </div>
        </form>
    </div>
</div>

<div>
    <a asp-page="Index">Back to List</a>
</div>

@section Scripts {
    @{await Html.RenderPartialAsync("_ValidationScriptsPartial");}
}
```

Visual Studio displays the `<form method="post">` tag in a distinctive font used for Tag Helpers:

```
1  @page
2  @model RazorPagesMovie.Pages_Movie.CreateModel
3
4  @{
5      ViewData["Title"] = "Create";
6  }
7
8  <h2>Create</h2>
9
10 <h4>Movie</h4>
11 <hr />
12 <div class="row">
13     <div class="col-md-4">
14         <form method="post">
15
16             The form element represents a collection of form-associated elements, some of which can represent editable values that can be submitted to a server for processing.
17
18             Learn more \(F1\)
19
20
21             Microsoft.AspNetCore.Mvc.TagHelpers.FormTagHelper
22             Microsoft.AspNetCore.Razor.TagHelpers.TagHelper implementation targeting <form> elements.
23
24                 <span asp-validation-for="Movie.ReleaseDate" class="text-danger">
25                     </div>
26                     <div class="form-group">
27                         <label asp-for="Movie.Genre" class="control-label"></label>
28                         <input asp-for="Movie.Genre" class="form-control" />
29                         <span asp-validation-for="Movie.Genre" class="text-danger"></span>
30                     </div>
31                     <div class="form-group">
32                         <label asp-for="Movie.Price" class="control-label"></label>
33                         <input asp-for="Movie.Price" class="form-control" />
34                         <span asp-validation-for="Movie.Price" class="text-danger"></span>
35                     </div>
36                     <div class="form-group">
37                         <input type="submit" value="Create" class="btn btn-default" />
38                     </div>
39                 </form>
40             </div>

```

The `<form method="post">` element is a [Form Tag Helper](#). The Form Tag Helper automatically includes an [antiforgery token](#).

The scaffolding engine creates Razor markup for each field in the model (except the ID) similar to the following:

```
<div asp-validation-summary="ModelOnly" class="text-danger"></div>
<div class="form-group">
    <label asp-for="Movie.Title" class="control-label"></label>
    <input asp-for="Movie.Title" class="form-control" />
    <span asp-validation-for="Movie.Title" class="text-danger"></span>
</div>
```

The [Validation Tag Helpers](#) (`<div asp-validation-summary` and `<span asp-validation-for`) display validation errors. Validation is covered in more detail later in this series.

The [Label Tag Helper](#) (`<label asp-for="Movie.Title" class="control-label"></label>`) generates the label caption and `for` attribute for the `Title` property.

The [Input Tag Helper](#) (`<input asp-for="Movie.Title" class="form-control" />`) uses the [DataAnnotations](#) attributes and produces HTML attributes needed for jQuery Validation on the client-side.

The next tutorial explains SQL Server LocalDB and seeding the database.



# Work with SQL Server LocalDB and ASP.NET Core

7/6/2018 • 4 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Joe Audette](#)

The `MovieContext` object handles the task of connecting to the database and mapping `Movie` objects to database records. The database context is registered with the [Dependency Injection](#) container in the `ConfigureServices` method in the `Startup.cs` file:

```
public void ConfigureServices(IServiceCollection services)
{
    // requires
    // using RazorPagesMovie.Models;
    // using Microsoft.EntityFrameworkCore;

    services.AddDbContext<MovieContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("MovieContext")));
    services.AddMvc();
}
```

```
public void ConfigureServices(IServiceCollection services)
{
    services.Configure<CookiePolicyOptions>(options =>
    {
        options.CheckConsentNeeded = context => true;
        options.MinimumSameSitePolicy = SameSiteMode.None;
    });

    services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1);

    services.AddDbContext<RazorPagesMovieContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("RazorPagesMovieContext")));
}
```

For more information on the methods used in `ConfigureServices`, see:

- [EU General Data Protection Regulation \(GDPR\) support in ASP.NET Core for `CookiePolicyOptions`](#).
- [SetCompatibilityVersion](#)

The ASP.NET Core [Configuration](#) system reads the `ConnectionString`. For local development, it gets the connection string from the `appsettings.json` file. The name value for the database (`Database={Database name}`) will be different for your generated code. The name value is arbitrary.

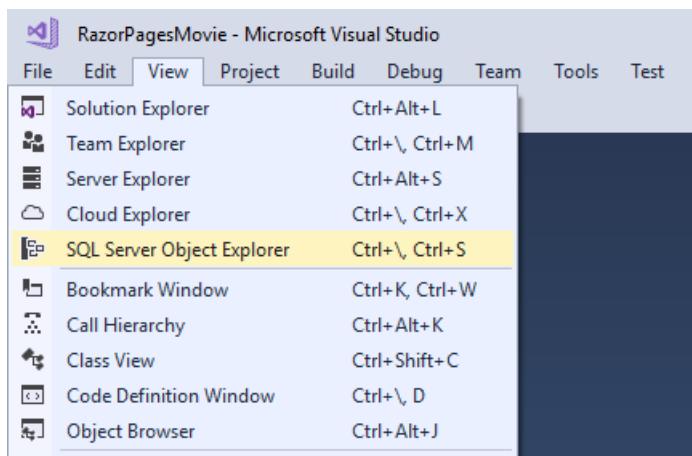
```
"ConnectionStrings": {
    "MovieContext": "Server=(localdb)\\mssqllocaldb;Database=Movie-
    1;Trusted_Connection=True;MultipleActiveResultSets=true"
}
```

When you deploy the app to a test or production server, you can use an environment variable or another approach to set the connection string to a real SQL Server. See [Configuration](#) for more information.

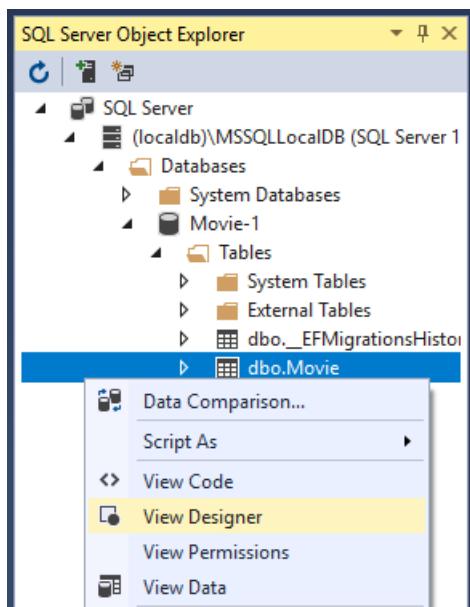
## SQL Server Express LocalDB

LocalDB is a lightweight version of the SQL Server Express Database Engine that's targeted for program development. LocalDB starts on demand and runs in user mode, so there's no complex configuration. By default, LocalDB database creates "\*.mdf" files in the C:/Users/<user> directory.

- From the **View** menu, open **SQL Server Object Explorer** (SSOX).



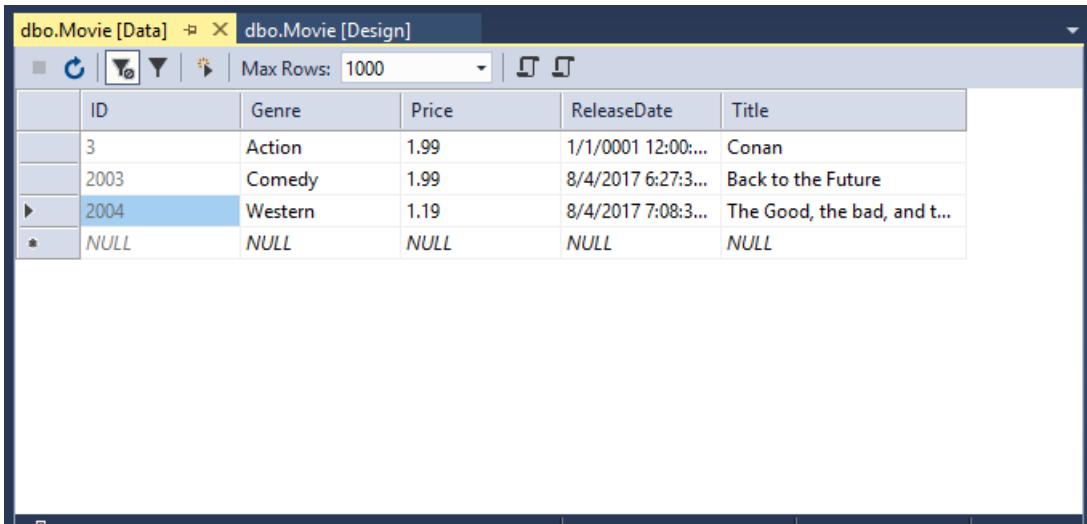
- Right click on the **Movie** table and select **View Designer**:



A screenshot of the SQL Server Object Explorer showing the 'Design' tab for the 'dbo.Movie' table. The table structure is displayed in a grid with columns: Name, Data Type, Allow Nulls, and Default. The rows represent the columns: ID, Genre, Price, ReleaseDate, and Title. To the right of the table, there is a sidebar with sections for Keys (1), Check Constraints (0), Indexes (0), Foreign Keys (0), and Triggers (0). Below the table, there is a T-SQL script window containing the CREATE TABLE statement for the 'Movie' table. The script includes columns for ID, Genre, Price, ReleaseDate, and Title, with ID being the primary key.

Note the key icon next to `ID`. By default, EF creates a property named `ID` for the primary key.

- Right click on the `Movie` table and select **View Data**:



The screenshot shows a database interface with two tabs at the top: "dbo.Movie [Data]" and "dbo.Movie [Design]". The "dbo.Movie [Data]" tab is selected, indicated by a yellow background. Below the tabs is a toolbar with icons for refresh, search, and other database operations. A dropdown menu "Max Rows: 1000" is open. The main area displays a table with five columns: ID, Genre, Price, ReleaseDate, and Title. There are four data rows and one empty row marked with an asterisk (\*). The first row has an ID of 3, Action genre, and a price of 1.99. The second row has an ID of 2003, Comedy genre, and a price of 1.99. The third row has an ID of 2004, Western genre, and a price of 1.19. The fourth row is empty, with all columns showing "NULL".

	ID	Genre	Price	ReleaseDate	Title
	3	Action	1.99	1/1/0001 12:00:...	Conan
	2003	Comedy	1.99	8/4/2017 6:27:3...	Back to the Future
▶	2004	Western	1.19	8/4/2017 7:08:3...	The Good, the bad, and t...
*	NULL	NULL	NULL	NULL	NULL

## Seed the database

Create a new class named `SeedData` in the *Models* folder. Replace the generated code with the following:

```
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using System;
using System.Linq;

namespace RazorPagesMovie.Models
{
    public static class SeedData
    {
        public static void Initialize(IServiceProvider serviceProvider)
        {
            using (var context = new MovieContext(
                serviceProvider.GetRequiredService<DbContextOptions<MovieContext>>()))
            {
                // Look for any movies.
                if (context.Movie.Any())
                {
                    return; // DB has been seeded
                }

                context.Movie.AddRange(
                    new Movie
                    {
                        Title = "When Harry Met Sally",
                        ReleaseDate = DateTime.Parse("1989-2-12"),
                        Genre = "Romantic Comedy",
                        Price = 7.99M
                    },
                    new Movie
                    {
                        Title = "Ghostbusters",
                        ReleaseDate = DateTime.Parse("1984-3-13"),
                        Genre = "Comedy",
                        Price = 8.99M
                    },
                    new Movie
                    {
                        Title = "Ghostbusters 2",
                        ReleaseDate = DateTime.Parse("1986-2-23"),
                        Genre = "Comedy",
                        Price = 9.99M
                    },
                    new Movie
                    {
                        Title = "Rio Bravo",
                        ReleaseDate = DateTime.Parse("1959-4-15"),
                        Genre = "Western",
                        Price = 3.99M
                    }
                );
                context.SaveChanges();
            }
        }
    }
}
```

```

using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using System;
using System.Linq;

namespace RazorPagesMovie.Models
{
    public static class SeedData
    {
        public static void Initialize(IServiceProvider serviceProvider)
        {
            using (var context = new RazorPagesMovieContext(
                serviceProvider.GetRequiredService<DbContextOptions<RazorPagesMovieContext>>()))
            {
                // Look for any movies.
                if (context.Movie.Any())
                {
                    return; // DB has been seeded
                }

                context.Movie.AddRange(
                    new Movie
                    {
                        Title = "When Harry Met Sally",
                        ReleaseDate = DateTime.Parse("1989-2-12"),
                        Genre = "Romantic Comedy",
                        Price = 7.99M
                    },
                    new Movie
                    {
                        Title = "Ghostbusters ",
                        ReleaseDate = DateTime.Parse("1984-3-13"),
                        Genre = "Comedy",
                        Price = 8.99M
                    },
                    new Movie
                    {
                        Title = "Ghostbusters 2",
                        ReleaseDate = DateTime.Parse("1986-2-23"),
                        Genre = "Comedy",
                        Price = 9.99M
                    },
                    new Movie
                    {
                        Title = "Rio Bravo",
                        ReleaseDate = DateTime.Parse("1959-4-15"),
                        Genre = "Western",
                        Price = 3.99M
                    }
                );
                context.SaveChanges();
            }
        }
    }
}

```

If there are any movies in the DB, the seed initializer returns and no movies are added.

```
if (context.Movie.Any())
{
    return; // DB has been seeded.
}
```

## Add the seed initializer

In *Program.cs*, modify the `Main` method to do the following:

- Get a DB context instance from the dependency injection container.
- Call the seed method, passing to it the context.
- Dispose the context when the seed method completes.

The following code shows the updated *Program.cs* file.

```
// Unused usings removed.
using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;
using RazorPagesMovie.Models;
using System;
using Microsoft.EntityFrameworkCore;

namespace RazorPagesMovie
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = BuildWebHost(args);

            using (var scope = host.Services.CreateScope())
            {
                var services = scope.ServiceProvider;

                try
                {
                    var context = services.GetRequiredService<MovieContext>();
                    // requires using Microsoft.EntityFrameworkCore;
                    context.Database.Migrate();
                    // Requires using RazorPagesMovie.Models;
                    SeedData.Initialize(services);
                }
                catch (Exception ex)
                {
                    var logger = services.GetRequiredService<ILogger<Program>>();
                    logger.LogError(ex, "An error occurred seeding the DB.");
                }
            }

            host.Run();
        }

        public static IWebHost BuildWebHost(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>()
                .Build();
    }
}
```

```

using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;
using RazorPagesMovie.Models;
using System;
using Microsoft.EntityFrameworkCore;

namespace RazorPagesMovie
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = CreateWebHostBuilder(args).Build();

            using (var scope = host.Services.CreateScope())
            {
                var services = scope.ServiceProvider;

                try
                {
                    var context = services.GetRequiredService<RazorPagesMovieContext>();
                    context.Database.Migrate();
                    SeedData.Initialize(services);
                }
                catch (Exception ex)
                {
                    var logger = services.GetRequiredService<ILogger<Program>>();
                    logger.LogError(ex, "An error occurred seeding the DB.");
                }
            }

            host.Run();
        }

        public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>();
    }
}

```

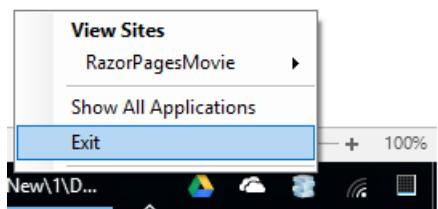
A production app would not call `Database.Migrate`. It's added to the preceding code to prevent the following exception when `Update-Database` has not been run:

`SqlException: Cannot open database "RazorPagesMovieContext-21" requested by the login. The login failed. Login failed for user 'user name'.`

## Test the app

- Delete all the records in the DB. You can do this with the delete links in the browser or from [SSOX](#)
- Force the app to initialize (call the methods in the `Startup` class) so the seed method runs. To force initialization, IIS Express must be stopped and restarted. You can do this with any of the following approaches:
  - Right click the IIS Express system tray icon in the notification area and tap **Exit** or **Stop Site**:





- o If you were running VS in non-debug mode, press F5 to run in debug mode.
- o If you were running VS in debug mode, stop the debugger and press F5.

The app shows the seeded data:

A screenshot of a Microsoft Edge browser window. The title bar says 'Index - Movie'. The address bar shows the URL 'localhost:5000/Movies'. The main content area displays a table titled 'Index' with the following data:

Title	ReleaseDate	Genre	Price	
When Harry Met Sally	2/12/1989 12:00:00 AM	Romantic Comedy	7.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Ghostbusters	3/13/1984 12:00:00 AM	Comedy	8.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Ghostbusters 2	2/23/1986 12:00:00 AM	Comedy	9.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Rio Bravo	4/15/1959 12:00:00 AM	Western	3.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

At the bottom left, it says '© 2017 - RazorPagesMovie'. A watermark 'Window Snip' is visible in the bottom right corner of the browser window.

The next tutorial will clean up the presentation of the data.

[PREVIOUS: SCAFFOLDED RAZOR  
PAGES](#)

[NEXT: UPDATING THE  
PAGES](#)

# Update the generated pages in an ASP.NET Core app

6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

We have a good start to the movie app, but the presentation isn't ideal. We don't want to see the time (12:00:00 AM in the image below) and **ReleaseDate** should be **Release Date** (two words).

Title	ReleaseDate	Genre	Price	
When Harry Met Sally	2/12/1989 12:00:00 AM	Romantic Comedy	7.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Ghostbusters	3/13/1984 12:00:00 AM	Comedy	8.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Ghostbusters 2	2/23/1986 12:00:00 AM	Comedy	9.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Rio Bravo	4/15/1959 12:00:00 AM	Western	3.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

© 2017 - RazorPagesMovie

Window Snip

## Update the generated code

Open the *Models/Movie.cs* file and add the highlighted lines shown in the following code:

```
using System;

namespace RazorPagesMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }

        [Display(Name = "Release Date")]
        [DataType(DataType.Date)]
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}
```

```

using System;

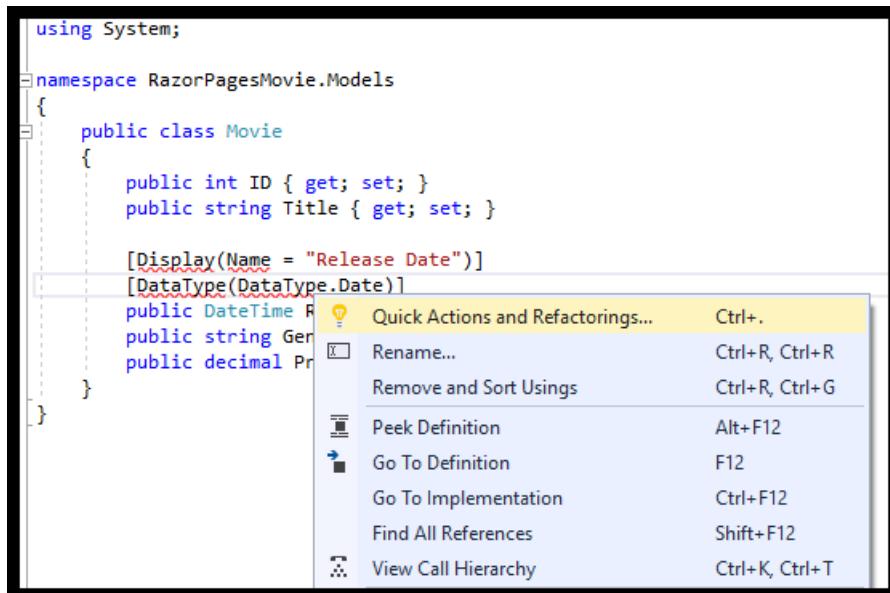
namespace RazorPagesMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }

        [Display(Name = "Release Date")]
        [DataType(DataType.Date)]
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }

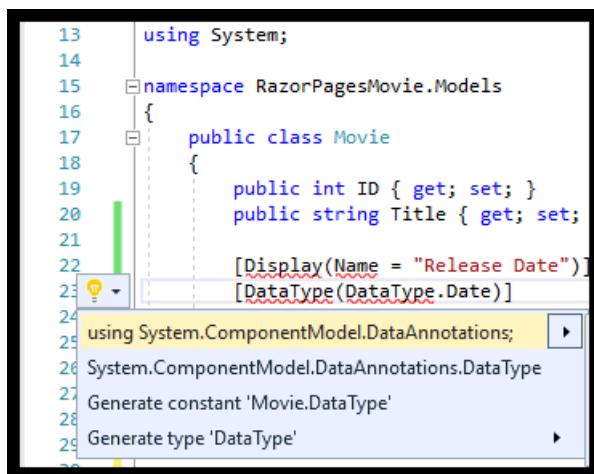
        [Column(TypeName = "decimal(18, 2)")]
        public decimal Price { get; set; }
    }
}

```

Right click on a red squiggly line > **Quick Actions and Refactorings**.



Select `using System.ComponentModel.DataAnnotations;`



Visual studio adds `using System.ComponentModel.DataAnnotations;`.

Right click on a red squiggly line > **Quick Actions and Refactorings** on the `[Column]` attribute and select

`using System.ComponentModel.DataAnnotations.Schema;`

The `[Column(TypeName = "decimal(18, 2)")]` data annotation is required so Entity Framework Core can correctly map `Price` to currency in the database. For more information, see [Data Types](#).

The completed model:

```
using System;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace RazorPagesMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }

        [Display(Name = "Release Date")]
        [DataType(DataType.Date)]
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }

        [Column(TypeName = "decimal(18, 2)")]
        public decimal Price { get; set; }
    }
}
```

We'll cover [DataAnnotations](#) in the next tutorial. The [Display](#) attribute specifies what to display for the name of a field (in this case "Release Date" instead of "ReleaseDate"). The [DataType](#) attribute specifies the type of the data (Date), so the time information stored in the field isn't displayed.

Browse to Pages/Movies and hover over an **Edit** link to see the target URL.

Title	Release Date	Genre	Price	
When Harry Met Sally	2/12/1989	Romantic Comedy	7.99	<a href="#">Edit</a> <a href="#">Details</a> <a href="#">Delete</a>
Ghostbusters	3/13/1984	Comedy	8.99	<a href="#">Edit</a> <a href="#">Details</a> <a href="#">Delete</a>
Ghostbusters 2	2/23/1986	Comedy	9.99	<a href="#">Edit</a> <a href="#">Details</a> <a href="#">Delete</a>
Rio Bravo	4/15/1959	Western	3.99	<a href="#">Edit</a> <a href="#">Details</a> <a href="#">Delete</a>

The **Edit**, **Details**, and **Delete** links are generated by the [Anchor Tag Helper](#) in the *Pages/Movies/Index.cshtml* file.

```

@foreach (var item in Model.Movie) {
    <tr>
        <td>
            @Html.DisplayFor(modelItem => item.Title)
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.ReleaseDate)
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.Genre)
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.Price)
        </td>
        <td>
            <a asp-page="./Edit" asp-route-id="@item.ID">Edit</a> | 
            <a asp-page="./Details" asp-route-id="@item.ID">Details</a> | 
            <a asp-page="./Delete" asp-route-id="@item.ID">Delete</a>
        </td>
    </tr>
}
</tbody>
</table>

```

Tag Helpers enable server-side code to participate in creating and rendering HTML elements in Razor files. In the preceding code, the `AnchorTagHelper` dynamically generates the HTML `href` attribute value from the Razor Page (the route is relative), the `asp-page`, and the route id (`asp-route-id`). See [URL generation for Pages](#) for more information.

Use **View Source** from your favorite browser to examine the generated markup. A portion of the generated HTML is shown below:

```

<td>
    <a href="/Movies/Edit?id=1">Edit</a> | 
    <a href="/Movies/Details?id=1">Details</a> | 
    <a href="/Movies/Delete?id=1">Delete</a>
</td>

```

The dynamically-generated links pass the movie ID with a query string (for example,

`http://localhost:5000/Movies/Details?id=2`).

Update the Edit, Details, and Delete Razor Pages to use the "`{id:int}`" route template. Change the page directive for each of these pages from `@page` to `@page "{id:int}"`. Run the app and then view source. The generated HTML adds the ID to the path portion of the URL:

```

<td>
    <a href="/Movies/Edit/1">Edit</a> | 
    <a href="/Movies/Details/1">Details</a> | 
    <a href="/Movies/Delete/1">Delete</a>
</td>

```

A request to the page with the "`{id:int}`" route template that does **not** include the integer will return an HTTP 404 (not found) error. For example, `http://localhost:5000/Movies/Details` will return a 404 error. To make the ID optional, append `?` to the route constraint:

```

@page "{id:int?}"

```

## Update concurrency exception handling

Update the `OnPostAsync` method in the `Pages/Movies/Edit.cshtml.cs` file. The following highlighted code shows the changes:

```
public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    _context.Attach(Movie).State = EntityState.Modified;

    try
    {
        await _context.SaveChangesAsync();
    }
    catch (DbUpdateConcurrencyException)
    {
        if (!_context.Movie.Any(e => e.ID == Movie.ID))
        {
            return NotFound();
        }
        else
        {
            throw;
        }
    }

    return RedirectToPage("./Index");
}
```

The previous code only detects concurrency exceptions when the first concurrent client deletes the movie, and the second concurrent client posts changes to the movie.

To test the `catch` block:

- Set a breakpoint on `catch (DbUpdateConcurrencyException)`
- Edit a movie.
- In another browser window, select the **Delete** link for the same movie, and then delete the movie.
- In the previous browser window, post changes to the movie.

Production code would generally detect concurrency conflicts when two or more clients concurrently updated a record. See [Handle concurrency conflicts](#) for more information.

### Posting and binding review

Examine the `Pages/Movies/Edit.cshtml.cs` file:

```
public class EditModel : PageModel
{
    private readonly RazorPagesMovie.Models.MovieContext _context;

    public EditModel(RazorPagesMovie.Models.MovieContext context)
    {
        _context = context;
    }

    [BindProperty]
    public Movie Movie { get; set; }

    public async Task<IActionResult> OnGetAsync(int? id)
    {
        if (id == null)
        {
            return NotFound();
        }

        Movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);

        if (Movie == null)
        {
            return NotFound();
        }
        return Page();
    }

    public async Task<IActionResult> OnPostAsync()
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        _context.Attach(Movie).State = EntityState.Modified;

        try
        {
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!_context.Movie.Any(e => e.ID == Movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }

        return RedirectToPage("./Index");
    }
}
```

```

public class EditModel : PageModel
{
    private readonly RazorPagesMovie.Models.RazorPagesMovieContext _context;

    public EditModel(RazorPagesMovie.Models.RazorPagesMovieContext context)
    {
        _context = context;
    }

    [BindProperty]
    public Movie Movie { get; set; }

    public async Task<IActionResult> OnGetAsync(int? id)
    {
        if (id == null)
        {
            return NotFound();
        }

        Movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);

        if (Movie == null)
        {
            return NotFound();
        }
        return Page();
    }

    public async Task<IActionResult> OnPostAsync()
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        _context.Attach(Movie).State = EntityState.Modified;

        try
        {
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!_context.Movie.Any(e => e.ID == Movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
    }

    return RedirectToPage("./Index");
}
}

```

When an HTTP GET request is made to the Movies/Edit page (for example, `http://localhost:5000/Movies/Edit/2`):

- The `OnGetAsync` method fetches the movie from the database and returns the `Page` method.
- The `Page` method renders the `Pages/Movies/Edit.cshtml` Razor Page. The `Pages/Movies/Edit.cshtml` file contains the model directive (`@model RazorPagesMovie.Pages.Movies.EditModel`), which makes the movie model available on the page.
- The Edit form is displayed with the values from the movie.

When the Movies/Edit page is posted:

- The form values on the page are bound to the `Movie` property. The `[BindProperty]` attribute enables [Model binding](#).

```
[BindProperty]  
public Movie Movie { get; set; }
```

- If there are errors in the model state (for example, `ReleaseDate` cannot be converted to a date), the form is posted again with the submitted values.
- If there are no model errors, the movie is saved.

The HTTP GET methods in the Index, Create, and Delete Razor pages follow a similar pattern. The HTTP POST `OnPostAsync` method in the Create Razor Page follows a similar pattern to the `OnPostAsync` method in the Edit Razor Page.

Search is added in the next tutorial.

[PREVIOUS: WORKING WITH SQL SERVER](#)

[LOCALDB](#)

[ADD](#)

[SEARCH](#)

# Add search to ASP.NET Core Razor Pages

6/21/2018 • 3 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this document, search capability is added to the Index page that enables searching movies by *genre* or *name*.

Update the Index page's `OnGetAsync` method with the following code:

```
public async Task OnGetAsync(string searchString)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    Movie = await movies.ToListAsync();
}
```

The first line of the `OnGetAsync` method creates a [LINQ](#) query to select the movies:

```
var movies = from m in _context.Movie
             select m;
```

The query is *only* defined at this point, it has **not** been run against the database.

If the `searchString` parameter contains a string, the movies query is modified to filter on the search string:

```
if (!String.IsNullOrEmpty(searchString))
{
    movies = movies.Where(s => s.Title.Contains(searchString));
}
```

The `s => s.Title.Contains()` code is a [Lambda Expression](#). Lambdas are used in method-based [LINQ](#) queries as arguments to standard query operator methods such as the `Where` method or `Contains` (used in the preceding code). LINQ queries are not executed when they're defined or when they're modified by calling a method (such as `Where`, `Contains` or `OrderBy`). Rather, query execution is deferred. That means the evaluation of an expression is delayed until its realized value is iterated over or the `ToListAsync` method is called. See [Query Execution](#) for more information.

**Note:** The `Contains` method is run on the database, not in the C# code. The case sensitivity on the query depends on the database and the collation. On SQL Server, `Contains` maps to [SQL LIKE](#), which is case insensitive. In SQLite, with the default collation, it's case sensitive.

Navigate to the Movies page and append a query string such as `?searchString=Ghost` to the URL (for example, `http://localhost:5000/Movies?searchString=Ghost`). The filtered movies are displayed.

The screenshot shows a browser window with the title "Index - Movie". The address bar contains "localhost:5000/Movies?searchString=Ghost". The main content area is titled "RpMovie" and has a "Index" heading. Below it is a "Create New" link. A table lists two movies: "Ghostbusters" (3/13/1984, Comedy, 8.99) and "Ghostbusters 2" (2/23/1986, Comedy, 9.99). Each movie row has "Edit | Details | Delete" links. At the bottom, there is a copyright notice: "© 2017 - RazorPagesMovie".

If the following route template is added to the Index page, the search string can be passed as a URL segment (for example, `http://localhost:5000/Movies/Ghost`).

```
@page "{searchString?}"
```

The preceding route constraint allows searching the title as route data (a URL segment) instead of as a query string value. The `?` in `"{searchString?}"` means this is an optional route parameter.

The screenshot shows a browser window with the title "Index - Movie". The address bar contains "localhost:5000/Movies/Ghost". The main content area is titled "RpMovie" and has a "Index" heading. Below it is a "Create New" link. A table lists two movies: "Ghostbusters" (3/13/1984, Comedy, 8.99) and "Ghostbusters 2" (2/23/1986, Comedy, 9.99). Each movie row has "Edit | Details | Delete" links. At the bottom, there is a copyright notice: "© 2017 - RazorPagesMovie".

However, you can't expect users to modify the URL to search for a movie. In this step, UI is added to filter movies. If you added the route constraint `"{searchString?}"`, remove it.

Open the `Pages/Movies/Index.cshtml` file, and add the `<form>` markup highlighted in the following code:

```

@page
@model RazorPagesMovie.Pages.Movies.IndexModel

 @{
     ViewData["Title"] = "Index";
 }

<h2>Index</h2>

<p>
    <a href="#" asp-page="Create">Create New</a>
</p>

<form>
    <p>
        Title: <input type="text" name="SearchString">
        <input type="submit" value="Filter" />
    </p>
</form>

<table class="table">
    @*Markup removed for brevity.*@

```

The HTML `<form>` tag uses the [Form Tag Helper](#). When the form is submitted, the filter string is sent to the `Pages/Movies/Index` page. Save the changes and test the filter.

Title	Release Date	Genre	Price	
Ghostbusters	3/13/1984	Comedy	8.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Ghostbusters 2	2/23/1986	Comedy	9.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

© 2017 - RazorPagesMovie

## Search by genre

Add the following highlighted properties to `Pages/Movies/Index.cshtml.cs`:

```
public class IndexModel : PageModel
{
    private readonly RazorPagesMovie.Models.MovieContext _context;

    public IndexModel(RazorPagesMovie.Models.MovieContext context)
    {
        _context = context;
    }

    public IList<Movie> Movie { get; set; }
    public SelectList Genres { get; set; }
    public string MovieGenre { get; set; }
```

```
public class IndexModel : PageModel
{
    private readonly RazorPagesMovie.Models.RazorPagesMovieContext _context;

    public IndexModel(RazorPagesMovie.Models.RazorPagesMovieContext context)
    {
        _context = context;
    }

    public IList<Movie> Movie { get; set; }
    public SelectList Genres { get; set; }
    public string MovieGenre { get; set; }
```

The `SelectList Genres` contains the list of genres. This allows the user to select a genre from the list.

The `MovieGenre` property contains the specific genre the user selects (for example, "Western").

Update the `OnGetAsync` method with the following code:

```
// Requires using Microsoft.AspNetCore.Mvc.Rendering;
public async Task OnGetAsync(string movieGenre, string searchString)
{
    // Use LINQ to get list of genres.
    IQueryable<string> genreQuery = from m in _context.Movie
                                         orderby m.Genre
                                         select m.Genre;

    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    if (!String.IsNullOrEmpty(movieGenre))
    {
        movies = movies.Where(x => x.Genre == movieGenre);
    }
    Genres = new SelectList(await genreQuery.Distinct().ToListAsync());
    Movie = await movies.ToListAsync();
}
```

The following code is a LINQ query that retrieves all the genres from the database.

```
// Use LINQ to get list of genres.  
IQueryable<string> genreQuery = from m in _context.Movie  
                                orderby m.Genre  
                                select m.Genre;
```

The `SelectList` of genres is created by projecting the distinct genres.

```
Genres = new SelectList(await genreQuery.Distinct().ToListAsync());
```

## Adding search by genre

Update `Index.cshtml` as follows:

```
@page  
@model RazorPagesMovie.Pages.Movies.IndexModel  
  
{@  
    ViewData["Title"] = "Index";  
}  
  
<h2>Index</h2>  
  
<p>  
    <a asp-page="Create">Create New</a>  
</p>  
  
<form>  
    <p>  
        <select asp-for="MovieGenre" asp-items="Model.Genres">  
            <option value="">All</option>  
        </select>  
  
        Title: <input type="text" name="SearchString">  
        <input type="submit" value="Filter" />  
    </p>  
</form>  
  
<table class="table">  
    <thead>
```

Test the app by searching by genre, by movie title, and by both.

PREVIOUS: UPDATING THE  
PAGES

NEXT: ADDING A NEW  
FIELD

# Add a new field to a Razor Page in ASP.NET Core

6/21/2018 • 4 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section you use [Entity Framework](#) Code First Migrations to add a new field to the model and migrate that change to the database.

When using EF Code First to automatically create a database, Code First:

- Adds a table to the database to track whether the schema of the database is in sync with the model classes it was generated from.
- If the model classes aren't in sync with the DB, EF throws an exception.

Automatic verification of schema/model in sync makes it easier to find inconsistent database/code issues.

## Adding a Rating Property to the Movie Model

Open the `Models/Movie.cs` file and add a `Rating` property:

```
public class Movie
{
    public int ID { get; set; }
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }
    public string Genre { get; set; }
    public decimal Price { get; set; }
    public string Rating { get; set; }
}
```

```
public class Movie
{
    public int ID { get; set; }
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }
    public string Genre { get; set; }

    [Column(TypeName = "decimal(18, 2)")]
    public decimal Price { get; set; }
    public string Rating { get; set; }
}
```

Build the app (Ctrl+Shift+B).

Edit `Pages/Movies/Index.cshtml`, and add a `Rating` field:

```
@page
@model RazorPagesMovie.Pages.Movies.IndexModel

{@{
```

```

    ViewData["Title"] = "Index";
}

<h2>Index</h2>

<p>
    <a asp-page="Create">Create New</a>
</p>

<form>
    <p>
        <select asp-for="MovieGenre" asp-items="Model.Genres">
            <option value="">All</option>
        </select>

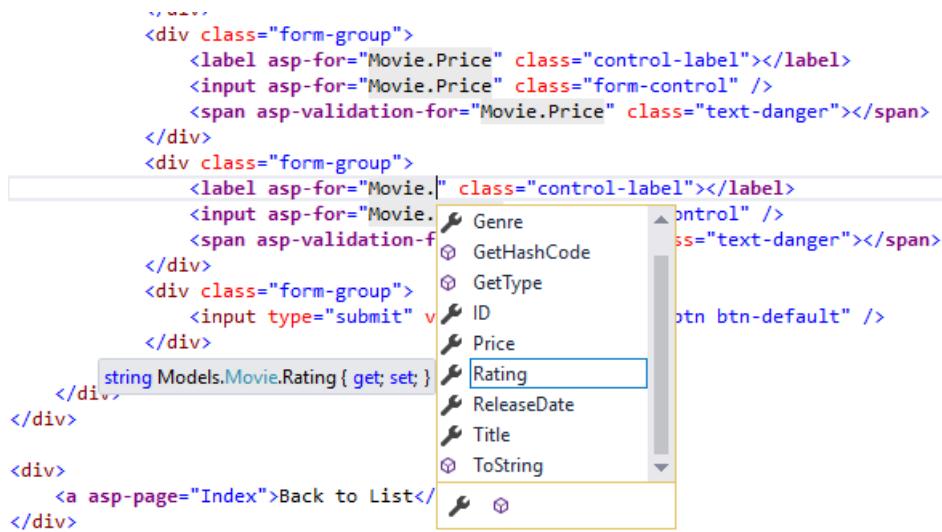
        Title: <input type="text" name="SearchString">
        <input type="submit" value="Filter" />
    </p>
</form>

<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].ReleaseDate)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].Genre)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].Price)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].Rating)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model.Movie) {
            <tr>
                <td>
                    @Html.DisplayFor(modelItem => item.Title)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.ReleaseDate)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Genre)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Price)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Rating)
                </td>
                <td>
                    <a asp-page=".Edit" asp-route-id="@item.ID">Edit</a> |
                    <a asp-page=".Details" asp-route-id="@item.ID">Details</a> |
                    <a asp-page=".Delete" asp-route-id="@item.ID">Delete</a>
                </td>
            </tr>
        }
    </tbody>
</table>

```

Add the `Rating` field to the Delete and Details pages.

Update `Create.cshtml` with a `Rating` field. You can copy/paste the previous `<div>` element and let intelliSense help you update the fields. IntelliSense works with [Tag Helpers](#).



```
    <div class="form-group">
        <label asp-for="Movie.Price" class="control-label"></label>
        <input asp-for="Movie.Price" class="form-control" />
        <span asp-validation-for="Movie.Price" class="text-danger"></span>
    </div>
    <div class="form-group">
        <label asp-for="Movie." class="control-label"></label>
        <input asp-for="Movie." class="form-control" />
        <span asp-validation-for="Movie." class="text-danger"></span>
    </div>
    <div class="form-group">
        <input type="submit" value="Create" class="btn btn-default" />
    </div>
    string Models.Movie.Rating { get; set; }
</div>
<div>
    <a asp-page="Index">Back to List</a>
</div>
```

The screenshot shows a portion of the `Create.cshtml` file. A tooltip from the `asp-for` attribute is open, displaying a list of properties for the `Movie` model. The `Rating` property is highlighted in blue, indicating it is the current selection. Other properties listed include `Genre`, `GetHashCode`, `GetType`, `ID`, `Price`, `ReleaseDate`, `Title`, and `ToString`. The `Rating` entry is preceded by a key icon, while the others have a gear icon.

The following code shows `Create.cshtml` with a `Rating` field:

```

@page
@model RazorPagesMovie.Pages.Movies.CreateModel

 @{
     ViewData["Title"] = "Create";
 }

<h2>Create</h2>

<h4>Movie</h4>
<hr />
<div class="row">
    <div class="col-md-4">
        <form method="post">
            <div asp-validation-summary="ModelOnly" class="text-danger"></div>
            <div class="form-group">
                <label asp-for="Movie.Title" class="control-label"></label>
                <input asp-for="Movie.Title" class="form-control" />
                <span asp-validation-for="Movie.Title" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Movie.ReleaseDate" class="control-label"></label>
                <input asp-for="Movie.ReleaseDate" class="form-control" />
                <span asp-validation-for="Movie.ReleaseDate" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Movie.Genre" class="control-label"></label>
                <input asp-for="Movie.Genre" class="form-control" />
                <span asp-validation-for="Movie.Genre" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Movie.Price" class="control-label"></label>
                <input asp-for="Movie.Price" class="form-control" />
                <span asp-validation-for="Movie.Price" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Movie.Rating" class="control-label"></label>
                <input asp-for="Movie.Rating" class="form-control" />
                <span asp-validation-for="Movie.Rating" class="text-danger"></span>
            </div>
            <div class="form-group">
                <input type="submit" value="Create" class="btn btn-default" />
            </div>
        </form>
    </div>
</div>

<div>
    <a asp-page="Index">Back to List</a>
</div>

@section Scripts {
    @await Html.RenderPartialAsync("_ValidationScriptsPartial");
}

```

Add the `Rating` field to the Edit Page.

The app won't work until the DB is updated to include the new field. If run now, the app throws a `SqlException`:

```
SqlException: Invalid column name 'Rating'.
```

This error is caused by the updated Movie model class being different than the schema of the Movie table of the database. (There's no `Rating` column in the database table.)

There are a few approaches to resolving the error:

1. Have the Entity Framework automatically drop and re-create the database using the new model class schema. This approach is convenient early in the development cycle; it allows you to quickly evolve the model and database schema together. The downside is that you lose existing data in the database. You don't want to use this approach on a production database! Dropping the DB on schema changes and using an initializer to automatically seed the database with test data is often a productive way to develop an app.
2. Explicitly modify the schema of the existing database so that it matches the model classes. The advantage of this approach is that you keep your data. You can make this change either manually or by creating a database change script.
3. Use Code First Migrations to update the database schema.

For this tutorial, use Code First Migrations.

Update the `SeedData` class so that it provides a value for the new column. A sample change is shown below, but you'll want to make this change for each `new Movie` block.

```
context.Movie.AddRange(  
    new Movie  
    {  
        Title = "When Harry Met Sally",  
        ReleaseDate = DateTime.Parse("1989-2-12"),  
        Genre = "Romantic Comedy",  
        Price = 7.99M,  
        Rating = "R"  
    },
```

See the [completed SeedData.cs file](#).

See the [completed SeedData.cs file](#).

Build the solution.

From the **Tools** menu, select **NuGet Package Manager > Package Manager Console**. In the PMC, enter the following commands:

```
Add-Migration Rating  
Update-Database
```

The `Add-Migration` command tells the framework to:

- Compare the `Movie` model with the `Movie` DB schema.
- Create code to migrate the DB schema to the new model.

The name "Rating" is arbitrary and is used to name the migration file. It's helpful to use a meaningful name for the migration file.

If you delete all the records in the DB, the initializer will seed the DB and include the `Rating` field. You can do this with the delete links in the browser or from [Sql Server Object Explorer](#) (SSOX). To delete the database from SSOX:

- Select the database in SSOX.
- Right click on the database, and select *Delete*.
- Check **Close existing connections**.

- Select **OK**.
- In the [PMC](#), update the database:

```
Update-Database
```

Run the app and verify you can create/edit/display movies with a [Rating](#) field. If the database isn't seeded, stop IIS Express, and then run the app.

[PREVIOUS: ADDING  
SEARCH](#)

[NEXT: ADDING  
VALIDATION](#)

# Add validation to an ASP.NET Core Razor Page

7/11/2018 • 8 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section, validation logic is added to the `Movie` model. The validation rules are enforced any time a user creates or edits a movie.

## Validation

A key tenet of software development is called **DRY** ("Don't Repeat Yourself"). Razor Pages encourages development where functionality is specified once, and it's reflected throughout the app. DRY can help reduce the amount of code in an app. DRY makes the code less error prone, and easier to test and maintain.

The validation support provided by Razor Pages and Entity Framework is a good example of the DRY principle. Validation rules are declaratively specified in one place (in the model class), and the rules are enforced everywhere in the app.

### Adding validation rules to the movie model

Open the `Movie.cs` file. [DataAnnotations](#) provides a built-in set of validation attributes that are applied declaratively to a class or property. DataAnnotations also contains formatting attributes like `DataType` that help with formatting and don't provide validation.

Update the `Movie` class to take advantage of the `Required`, `StringLength`, `RegularExpression`, and `Range` validation attributes.

```
public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3)]
    [Required]
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [Range(1, 100)]
    [DataType(DataType.Currency)]
    public decimal Price { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z''"\s-]*$")]
    [Required]
    [StringLength(30)]
    public string Genre { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z0-9'''\s-]*$")]
    [StringLength(5)]
    [Required]
    public string Rating { get; set; }
}
```

```

//#define MovieDateRatingDA
#if MovieDateRatingDA
using System;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace RazorPagesMovie.Models
{
    #region snippet1
    public class Movie
    {
        public int ID { get; set; }

        [StringLength(60, MinimumLength = 3)]
        [Required]
        public string Title { get; set; }

        #region snippet2
        [Display(Name = "Release Date")]
        [DataType(DataType.Date)]
        public DateTime ReleaseDate { get; set; }

        [Range(1, 100)]
        [DataType(DataType.Currency)]
        [Column(TypeName = "decimal(18, 2)")]
        public decimal Price { get; set; }
        #endregion

        [RegularExpression(@"^[A-Z]+[a-zA-Z'''\s-]*$")]
        [Required]
        [StringLength(30)]
        public string Genre { get; set; }

        [RegularExpression(@"^[A-Z]+[a-zA-Z0-9'''\s-]*$")]
        [StringLength(5)]
        [Required]
        public string Rating { get; set; }
    }
    #endregion
}
#endif

```

Validation attributes specify behavior that's enforced on model properties:

- The `Required` and `MinimumLength` attributes indicate that a property must have a value. However, nothing prevents a user from entering whitespace to satisfy the validation constraint for a nullable type. Non-nullable `value types` (such as `decimal`, `int`, `float`, and `DateTime`) are inherently required and don't need the `Required` attribute.
- The `RegularExpression` attribute limits the characters that the user can enter. In the preceding code, `Genre` must start with one or more capital letters and follow with zero or more letters, single or double quotes, whitespace characters, or dashes. `Rating` must start with one or more capital letters and follow with zero or more letters, numbers, single or double quotes, whitespace characters, or dashes.
- The `Range` attribute constrains a value to a specified range.
- The `StringLength` attribute sets the maximum length of a string, and optionally the minimum length.

Having validation rules automatically enforced by ASP.NET Core helps make an app more robust. Automatic validation on models helps protect the app because you don't have to remember to apply them when new code is added.

## Validation Error UI in Razor Pages

Run the app and navigate to Pages/Movies.

Select the **Create New** link. Complete the form with some invalid values. When jQuery client-side validation detects the error, it displays an error message.

The screenshot shows a browser window titled "Create - Movie" with the URL "localhost:5000/Movies/Create". The page is titled "RpMovie" and has a "Create" heading. The form contains five fields: "Title" (value "a"), "Release Date" (value "00/01/0001"), "Genre" (value "a"), "Price" (value "Dog"), and "Rating" (value "z"). Below each field is a red validation message: "The field Title must be a string with a minimum length of 3 and a maximum length of 60.", "The Release Date field is required.", "The field Genre must match the regular expression '^([A-Z]+[a-zA-Z"-\'s]\*\$'.", "The field Price must be a number.", and "The field Rating must match the regular expression '^([A-Z]+[a-zA-Z"-\'s]\*\$'. At the bottom are "Create" and "Back to List" buttons.

#### NOTE

You may not be able to enter decimal points or commas in the `Price` field. To support [jQuery validation](#) in non-English locales that use a comma (",") for a decimal point, and non US-English date formats, you must take steps to globalize your app. See [Additional resources](#) for more information. For now, just enter whole numbers like 10.

Notice how the form has automatically rendered a validation error message in each field containing an invalid value. The errors are enforced both client-side (using JavaScript and jQuery) and server-side (when a user has JavaScript disabled).

A significant benefit is that **no** code changes were necessary in the Create or Edit pages. Once DataAnnotations were applied to the model, the validation UI was enabled. The Razor Pages created in this tutorial automatically picked up the validation rules (using validation attributes on the properties of the `Movie` model class). Test validation using the Edit page, the same validation is applied.

The form data isn't posted to the server until there are no client-side validation errors. Verify form data isn't posted by one or more of the following approaches:

- Put a break point in the `OnPostAsync` method. Submit the form (select **Create** or **Save**). The break point is never hit.
- Use the [Fiddler tool](#).
- Use the browser developer tools to monitor network traffic.

## Server-side validation

When JavaScript is disabled in the browser, submitting the form with errors will post to the server.

Optional, test server-side validation:

- Disable JavaScript in the browser. If you can't disable JavaScript in the browser, try another browser.
- Set a break point in the `OnPostAsync` method of the Create or Edit page.
- Submit a form with validation errors.
- Verify the model state is invalid:

```
if (!ModelState.IsValid)
{
    return Page();
}
```

The following code shows a portion of the *Create.cshtml* page that you scaffolded earlier in the tutorial. It's used by the Create and Edit pages to display the initial form and to redisplay the form in the event of an error.

```
<form method="post">
    <div asp-validation-summary="ModelOnly" class="text-danger"></div>
    <div class="form-group">
        <label asp-for="Movie.Title" class="control-label"></label>
        <input asp-for="Movie.Title" class="form-control" />
        <span asp-validation-for="Movie.Title" class="text-danger"></span>
    </div>
```

The [Input Tag Helper](#) uses the [DataAnnotations](#) attributes and produces HTML attributes needed for jQuery Validation on the client-side. The [Validation Tag Helper](#) displays validation errors. See [Validation](#) for more information.

The Create and Edit pages have no validation rules in them. The validation rules and the error strings are specified only in the `Movie` class. These validation rules are automatically applied to Razor Pages that edit the `Movie` model.

When validation logic needs to change, it's done only in the model. Validation is applied consistently throughout the application (validation logic is defined in one place). Validation in one place helps keep the code clean, and makes it easier to maintain and update.

## Using DataType Attributes

Examine the `Movie` class. The `System.ComponentModel.DataAnnotations` namespace provides formatting attributes in addition to the built-in set of validation attributes. The `DataType` attribute is applied to the `ReleaseDate` and `Price` properties.

```
[Display(Name = "Release Date")]
[DataType(DataType.Date)]
public DateTime ReleaseDate { get; set; }

[Range(1, 100)]
[DataType(DataType.Currency)]
public decimal Price { get; set; }
```

The `DataType` attributes only provide hints for the view engine to format the data (and supplies attributes such as `<a>` for URL's and `<a href="mailto:EmailAddress.com">` for email). Use the `RegularExpression` attribute to validate the format of the data. The `DataType` attribute is used to specify a data type that's more specific than the database intrinsic type. `DataType` attributes are not validation attributes. In the sample application, only the date is displayed, without time.

The `DataType` Enumeration provides for many data types, such as Date, Time, PhoneNumber, Currency, EmailAddress, and more. The `DataType` attribute can also enable the application to automatically provide type-specific features. For example, a `mailto:` link can be created for `DataType.EmailAddress`. A date selector can be provided for `DataType.Date` in browsers that support HTML5. The `DataType` attributes emits HTML 5 `data-` (pronounced data dash) attributes that HTML 5 browsers consume. The `DataType` attributes do **not** provide any validation.

`DataType.Date` doesn't specify the format of the date that's displayed. By default, the data field is displayed according to the default formats based on the server's `CultureInfo`.

The `[Column(TypeName = "decimal(18, 2)")]` data annotation is required so Entity Framework Core can correctly map `Price` to currency in the database. For more information, see [Data Types](#).

The `DisplayFormat` attribute is used to explicitly specify the date format:

```
[DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
public DateTime ReleaseDate { get; set; }
```

The `ApplyFormatInEditMode` setting specifies that the formatting should be applied when the value is displayed for editing. You might not want that behavior for some fields. For example, in currency values, you probably don't want the currency symbol in the edit UI.

The `DisplayFormat` attribute can be used by itself, but it's generally a good idea to use the `DataType` attribute. The `DataType` attribute conveys the semantics of the data as opposed to how to render it on a screen, and provides the following benefits that you don't get with `DisplayFormat`:

- The browser can enable HTML5 features (for example to show a calendar control, the locale-appropriate currency symbol, email links, etc.)
- By default, the browser will render data using the correct format based on your locale.
- The `DataType` attribute can enable the ASP.NET Core framework to choose the right field template to render the data. The `DisplayFormat` if used by itself uses the string template.

Note: jQuery validation doesn't work with the `Range` attribute and `DateTime`. For example, the following code will always display a client-side validation error, even when the date is in the specified range:

```
[Range(typeof(DateTime), "1/1/1966", "1/1/2020")]
```

It's generally not a good practice to compile hard dates in your models, so using the `Range` attribute and `DateTime` is discouraged.

The following code shows combining attributes on one line:

```
public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3)]
    public string Title { get; set; }

    [Display(Name = "Release Date"), DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z\s-]*$"), Required, StringLength(30)]
    public string Genre { get; set; }

    [Range(1, 100), DataType(DataType.Currency)]
    public decimal Price { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z0-9\s-]*$"), StringLength(5)]
    public string Rating { get; set; }
}
```

```
public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3)]
    public string Title { get; set; }

    [Display(Name = "Release Date"), DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z\s-]*$"), Required, StringLength(30)]
    public string Genre { get; set; }

    [Range(1, 100), DataType(DataType.Currency)]
    [Column(TypeName = "decimal(18, 2)")]
    public decimal Price { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z0-9\s-]*$"), StringLength(5)]
    public string Rating { get; set; }
}
```

[Get started with Razor Pages and EF Core](#) shows advanced EF Core operations with Razor Pages.

## Publish to Azure

See [Publish an ASP.NET Core web app to Azure App Service using Visual Studio](#) for instructions on how to publish this app to Azure.

Thanks for completing this introduction to Razor Pages. We appreciate feedback. [Get started with MVC and EF Core](#) is an excellent follow up to this tutorial.

## Additional resources

- [Working with Forms](#)
- [Globalization and localization](#)
- [Introduction to Tag Helpers](#)
- [Author Tag Helpers](#)

[PREVIOUS: ADDING A NEW](#)

[FIELD](#)

# Get started with SignalR on ASP.NET Core

7/5/2018 • 5 minutes to read • [Edit Online](#)

By [Rachel Appel](#)

This tutorial teaches the basics of building a real-time app using SignalR for ASP.NET Core.

The image contains two side-by-side screenshots of a web browser displaying a SignalR-based chat application. Both screenshots show the same interface with a dark header bar containing the text "SignalRChat". Below the header is a form with two input fields: "Name" and "Message", and a "Send" button. The "Name" field is populated with "Bill Gates" in the top screenshot and "Satya Nadella" in the bottom screenshot. The "Message" field contains the text "Hello, computers!" in both cases. The "Send" button is grayed out in both screenshots. Below the form, a list of messages is displayed in a scrollable area. In the top screenshot, the messages are:

- 3/15/2018 11:12:10 PM **Bill Gates**: Hello, computers!
- 3/15/2018 11:12:29 PM **Satya Nadella**: Hello, cloud computers!

In the bottom screenshot, the messages are:

- 3/15/2018 11:12:10 PM **Bill Gates**: Hello, computers!
- 3/15/2018 11:12:29 PM **Satya Nadella**: Hello, cloud computers!

At the bottom of each screenshot, there is a copyright notice: "© 2018 - SignalRChat".

This tutorial demonstrates the following SignalR development tasks:

- Create a SignalR on ASP.NET Core web app.
- Create a SignalR hub to push content to clients.
- Modify the `Startup` class and configure the app.

[View or download sample code](#) ([how to download](#))

## Prerequisites

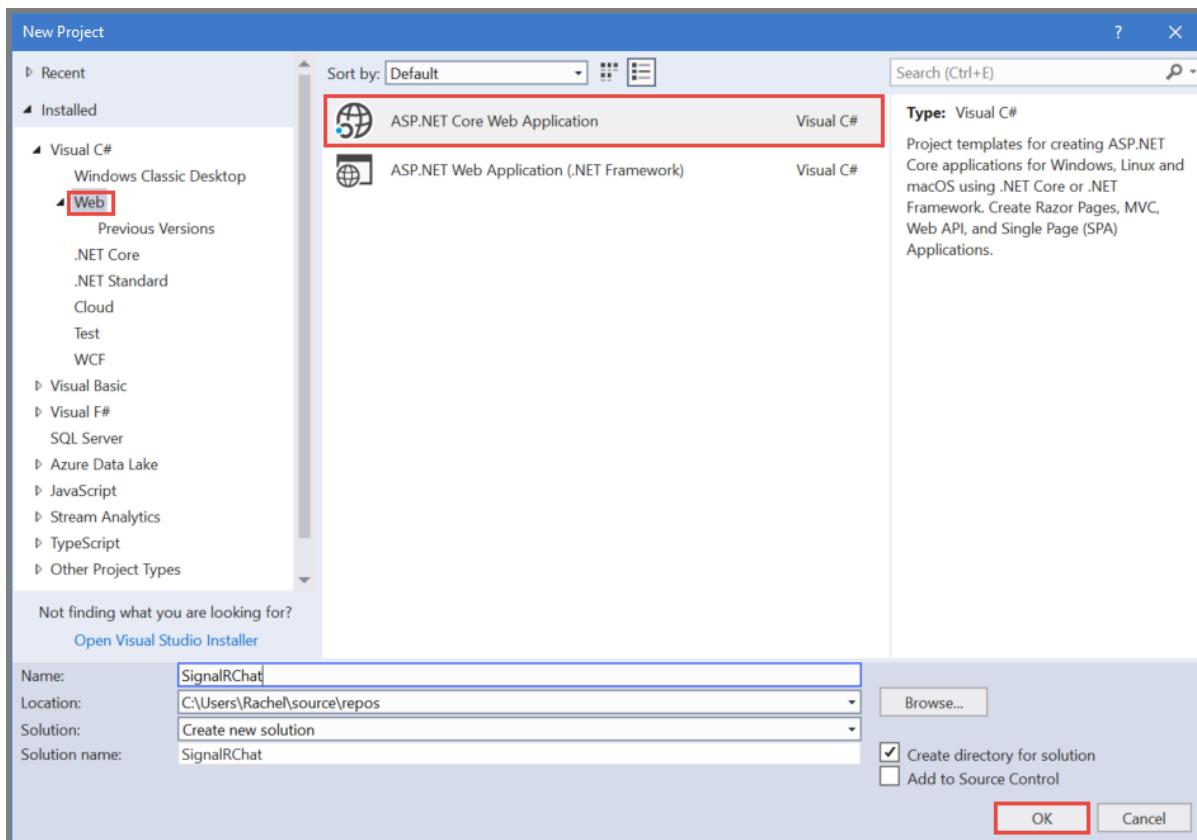
Install the following software:

- [Visual Studio](#)
- [Visual Studio Code](#)
- [.NET Core SDK 2.1 or later](#)
- [Visual Studio 2017](#) version 15.7.3 or later with the **ASP.NET and web development** workload
- [npm](#)

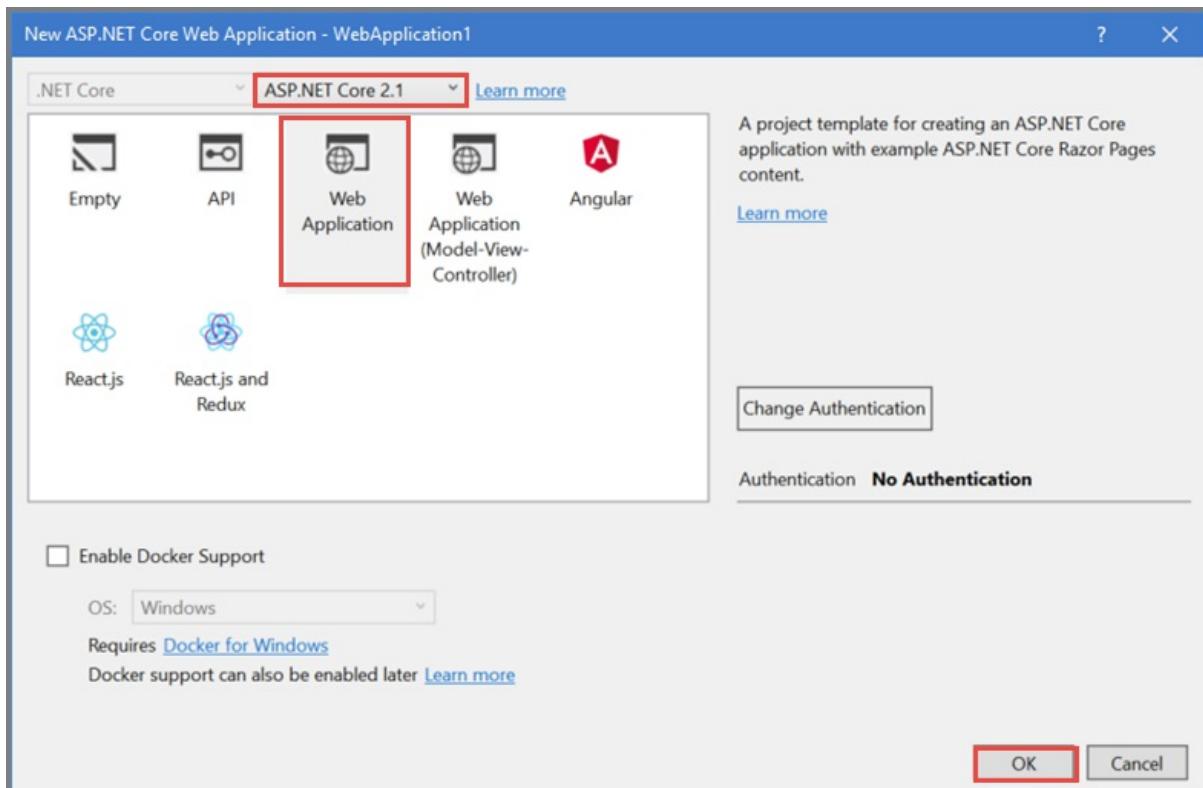
## Create an ASP.NET Core project that hosts SignalR client and server

- [Visual Studio](#)
- [Visual Studio Code](#)

1. Use the **File > New Project** menu option and choose **ASP.NET Core Web Application**. Name the project *SignalRChat*.



2. Select **Web Application** to create a project using Razor Pages. Then select **OK**. Be sure that **ASP.NET Core 2.1** is selected from the framework selector, though SignalR runs on older versions of .NET.



Visual Studio includes the `Microsoft.AspNetCore.SignalR` package containing its server libraries as part of its **ASP.NET Core Web Application** template. However, the JavaScript client library for SignalR must be installed using *npm*.

3. Run the following commands in the **Package Manager Console** window, from the project root:

```
npm init -y
npm install @aspnet/signalr
```

4. Create a new folder named "signalr" inside the *lib* folder in your project. Copy the *signalrjs* file from *node\_modules\@aspnet\signalr\dist\browser* to this folder.

## Create the SignalR Hub

A hub is a class that serves as a high-level pipeline that allows the client and server to call methods on each other.

- [Visual Studio](#)
- [Visual Studio Code](#)

1. Add a class to the project by choosing **File > New > File** and selecting **Visual C# Class**. Name the class `ChatHub` and the file `ChatHub.cs`.
2. Inherit from `Microsoft.AspNetCore.SignalR.Hub`. The `Hub` class contains properties and events for managing connections and groups, as well as sending and receiving data.
3. Create the `SendMessage` method that sends a message to all connected chat clients. Notice it returns a `Task`, because SignalR is asynchronous. Asynchronous code scales better.

```
using Microsoft.AspNetCore.SignalR;
using System.Threading.Tasks;

namespace SignalRChat.Hubs
{
    public class ChatHub : Hub
    {
        public async Task SendMessage(string user, string message)
        {
            await Clients.All.SendAsync("ReceiveMessage", user, message);
        }
    }
}
```

## Configure the project to use SignalR

The SignalR server must be configured so that it knows to pass requests to SignalR.

1. To configure a SignalR project, modify the project's `Startup.ConfigureServices` method.

`services.AddSignalR` makes the SignalR services available to the [dependency injection](#) system.

2. Configure routes to your hubs with `UseSignalR` in the `Configure` method. `app.UseSignalR` adds SignalR to the [middleware](#) pipeline.

```
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.AspNetCore.Http;
using Microsoft.Extensions.Configuration;
using Microsoft.Extensions.DependencyInjection;
using SignalRChat.Hubs;

namespace SignalRChat
{
    public class Startup
    {
        public Startup(IConfiguration configuration)
        {
            Configuration = configuration;
        }

        public IConfiguration Configuration { get; }

        public void ConfigureServices(IServiceCollection services)
        {
            services.Configure<CookiePolicyOptions>(options =>
            {
                options.CheckConsentNeeded = context => true;
                options.MinimumSameSitePolicy = SameSiteMode.None;
            });

            services.AddMvc();

            services.AddCors(options => options.AddPolicy("CorsPolicy",
                builder =>
                {
                    builder.AllowAnyMethod().AllowAnyHeader()
                        .WithOrigins("http://localhost:55830")
                        .AllowCredentials();
                }));
            services.AddSignalR();
        }

        public void Configure(IApplicationBuilder app, IHostingEnvironment env)
        {
            if (env.IsDevelopment())
            {

                app.UseDeveloperExceptionPage();
            }
            else
            {
                app.UseExceptionHandler("/Error");
                app.UseHsts();
            }

            app.UseHttpsRedirection();
            app.UseStaticFiles();
            app.UseCookiePolicy();
            app.UseCors("CorsPolicy");
            app.UseSignalR(routes =>
            {
                routes.MapHub<ChatHub>("/chatHub");
            });
            app.UseMvc();
        }
    }
}
```

## Create the SignalR client code

1. Add a JavaScript file, named *chat.js*, to the *wwwroot\js* folder. Add the following code to it:

```
// The following sample code uses modern ECMAScript 6 features
// that aren't supported in Internet Explorer 11.
// To convert the sample for environments that do not support ECMAScript 6,
// such as Internet Explorer 11, use a transpiler such as
// Babel at http://babeljs.io/.
//
// See Es5-chat.js for a Babel transpiled version of the following code:

const connection = new signalR.HubConnectionBuilder()
    .withUrl("/chatHub")
    .build();

connection.on("ReceiveMessage", (user, message) => {
    const msg = message.replace(/&/g, "&").replace(/</g, "<").replace(/>/g, ">");
    const encodedMsg = user + " says " + msg;
    const li = document.createElement("li");
    li.textContent = encodedMsg;
    document.getElementById("messagesList").appendChild(li);
});

connection.start().catch(err => console.error(err.toString()));

document.getElementById("sendButton").addEventListener("click", event => {
    const user = document.getElementById("userInput").value;
    const message = document.getElementById("messageInput").value;
    connection.invoke("SendMessage", user, message).catch(err => console.error(err.toString()));
    event.preventDefault();
});
```

2. Replace the content in *Pages\Index.cshtml* with the following code:

```
@page


<div class="row">&nbsp;</div>
    <div class="row">
        <div class="col-6">&nbsp;</div>
        <div class="col-6">
            User.....<input type="text" id="userInput" />
            <br />
            Message...<input type="text" id="messageInput" />
            <input type="button" id="sendButton" value="Send Message" />
        </div>
    </div>
    <div class="row">
        <div class="col-12">
            <hr />
        </div>
    </div>
    <div class="row">
        <div class="col-6">&nbsp;</div>
        <div class="col-6">
            <ul id="messagesList"></ul>
        </div>
    </div>
</div>
<script src="~/lib/signalr/signalr.js"></script>
<script src="~/js/chat.js"></script>
@*<script src="~/js/es5-chat.js"></script>*@

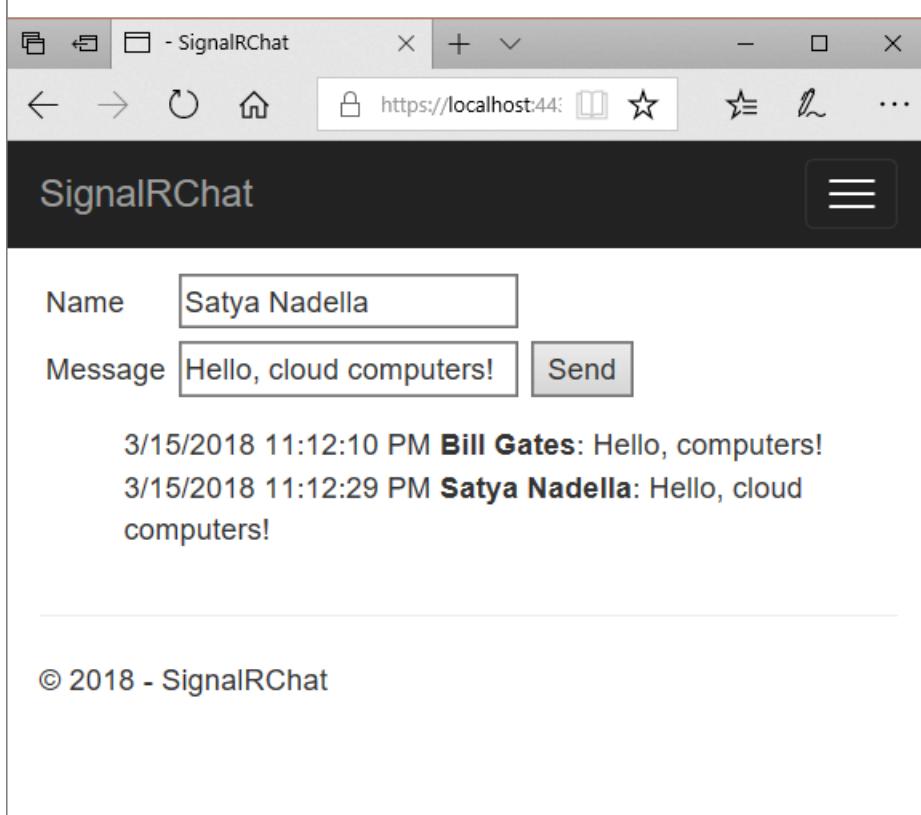
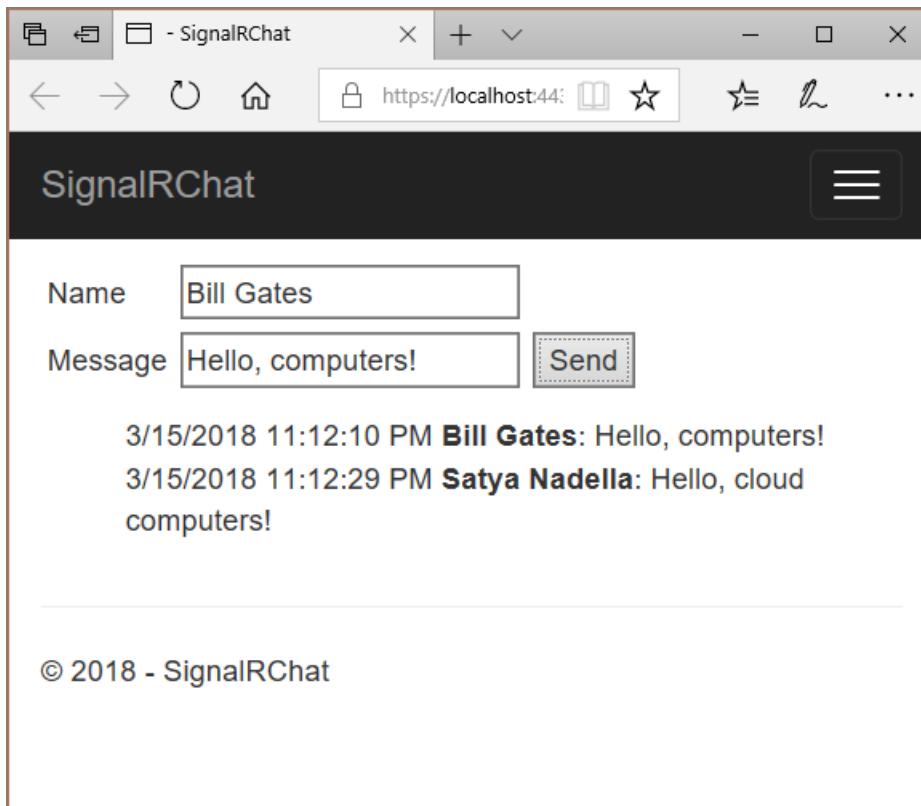

```

The preceding HTML displays name and message fields, and a submit button. Notice the script references at the bottom: a reference to SignalR and *chat.js*.

## Run the app

- [Visual Studio](#)
- [Visual Studio Code](#)

1. Select **Debug > Start without debugging** to launch a browser and load the website locally. Copy the URL from the address bar.
2. Open another browser instance (any browser) and paste the URL in the address bar.
3. Choose either browser, enter a name and message, and click the **Send** button. The name and message are displayed on both pages instantly.



## Related resources

[Introduction to ASP.NET Core SignalR](#)

# Use ASP.NET Core SignalR with TypeScript and Webpack

7/10/2018 • 10 minutes to read • [Edit Online](#)

By Sébastien Sougnez and Scott Addie

Webpack enables developers to bundle and build the client-side resources of a web app. This tutorial demonstrates using Webpack in an ASP.NET Core SignalR web app whose client is written in [TypeScript](#).

In this tutorial, you learn how to:

- Scaffold a starter ASP.NET Core SignalR app
- Configure the SignalR TypeScript client
- Configure a build pipeline using Webpack
- Configure the SignalR server
- Enable communication between client and server

[View or download sample code \(how to download\)](#)

## Prerequisites

Install the following software:

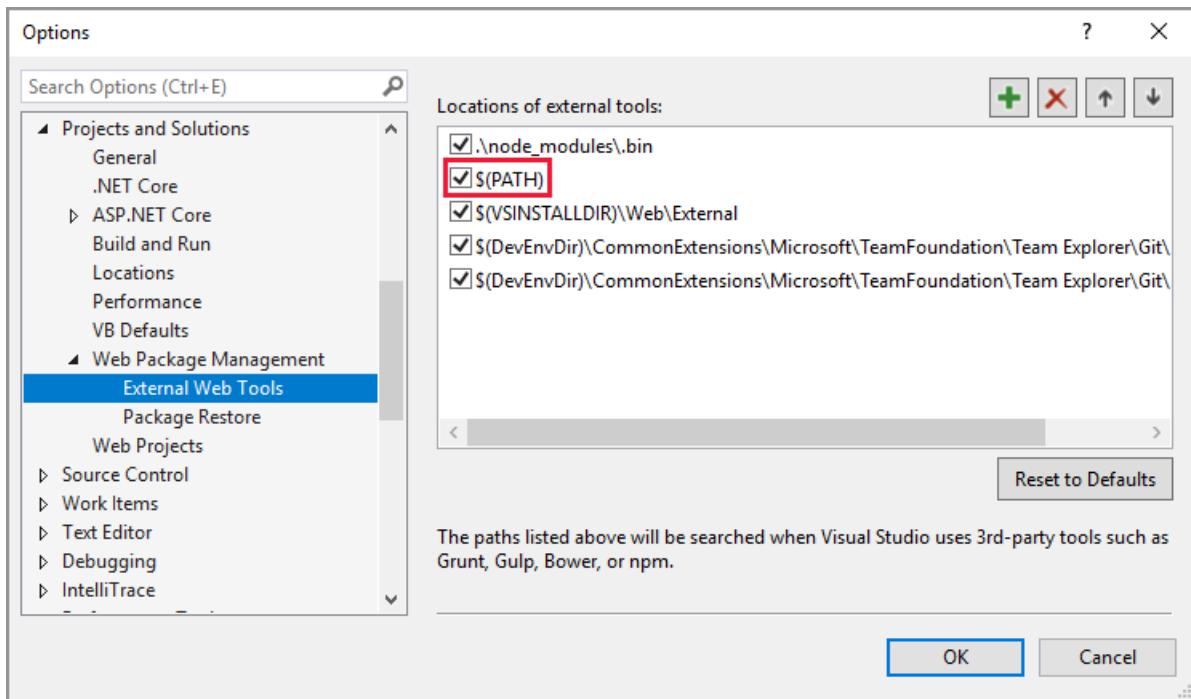
- [Visual Studio](#)
- [.NET Core CLI](#)
- [.NET Core SDK 2.1 or later](#)
- [Node.js](#) with [npm](#)
- [Visual Studio 2017](#) version 15.7.3 or later with the **ASP.NET and web development** workload

## Create the ASP.NET Core web app

- [Visual Studio](#)
- [.NET Core CLI](#)

Configure Visual Studio to look for npm in the *PATH* environment variable. By default, Visual Studio uses the version of npm found in its installation directory. Follow these instructions in Visual Studio:

1. Navigate to **Tools > Options > Projects and solutions > Web Package Management > External Web Tools**.
2. Select the `$(PATH)` entry from the list. Click the up arrow to move the entry to the second position in the list.  
As an aside, the first entry refers to the project's local packages.



Visual Studio configuration is completed. It's time to create the project.

1. Use the **File > New > Project** menu option and choose the **ASP.NET Core Web Application** template.
2. Name the project *SignalRWebPack*, and click the **OK** button.
3. Select *.NET Core* from the target framework drop-down, and select *ASP.NET Core 2.1* from the framework selector drop-down. Select the **Empty** template, and click the **OK** button.

## Configure Webpack and TypeScript

The following steps configure the conversion of TypeScript to JavaScript and the bundling of client-side resources.

1. Execute the following command in the project root to create a *package.json* file:

```
npm init -y
```

2. Add the highlighted property to the *package.json* file:

```
{
  "name": "SignalRWebPack",
  "version": "1.0.0",
  "private": true,
  "description": "",
  "main": "index.js",
  "scripts": {
    "test": "echo \"Error: no test specified\" && exit 1"
  },
  "keywords": [],
  "author": "",
  "license": "ISC"
}
```

Setting the `private` property to `true` prevents package installation warnings in the next step.

3. Install the required npm packages. Execute the following command from the project root:

```
npm install -D -E clean-webpack-plugin@0.1.19 css-loader@0.28.11 html-webpack-plugin@3.2.0 mini-css-extract-plugin@0.4.0 ts-loader@4.4.1 typescript@2.9.2 webpack@4.12.0 webpack-cli@3.0.6
```

Some command details to note:

- A version number follows the `@` sign for each package name. npm installs those specific package versions.
- The `-E` option disables npm's default behavior of writing [semantic versioning](#) range operators to `package.json`. For example, `"webpack": "4.12.0"` is used instead of `"webpack": "^4.12.0"`. This option prevents unintended upgrades to newer package versions.

See the official [npm-install](#) docs for more detail.

#### 4. Replace the `scripts` property of the `package.json` file with the following snippet:

```
"scripts": {  
  "build": "webpack --mode=development --watch",  
  "release": "webpack --mode=production",  
  "publish": "npm run release && dotnet publish -c Release"  
},
```

Some explanation of the scripts:

- `build` : Bundles your client-side resources in development mode and watches for file changes. The file watcher causes the bundle to regenerate each time a project file changes. The `mode` option disables production optimizations, such as tree shaking and minification. Only use `build` in development.
- `release` : Bundles your client-side resources in production mode.
- `publish` : Runs the `release` script to bundle the client-side resources in production mode. It calls the .NET Core CLI's `publish` command to publish the app.

#### 5. Create a file named `webpack.config.js`, in the project root, with the following content:

```

const path = require("path");
const HtmlWebpackPlugin = require("html-webpack-plugin");
const CleanWebpackPlugin = require("clean-webpack-plugin");
const MiniCssExtractPlugin = require("mini-css-extract-plugin");

module.exports = {
  entry: "./src/index.ts",
  output: {
    path: path.resolve(__dirname, "wwwroot"),
    filename: "[name].[chunkhash].js",
    publicPath: "/"
  },
  resolve: {
    extensions: [".js", ".ts"]
  },
  module: {
    rules: [
      {
        test: /\.ts$/,
        use: "ts-loader"
      },
      {
        test: /\.css$/,
        use: [MiniCssExtractPlugin.loader, "css-loader"]
      }
    ]
  },
  plugins: [
    new CleanWebpackPlugin(["wwwroot/*"]),
    new HtmlWebpackPlugin({
      template: "./src/index.html"
    }),
    new MiniCssExtractPlugin({
      filename: "css/[name].[chunkhash].css"
    })
  ]
};


```

The preceding file configures the Webpack compilation. Some configuration details to note:

- The `output` property overrides the default value of `dist`. The bundle is instead emitted in the `wwwroot` directory.
- The `resolve.extensions` array includes `.js` to import the SignalR client JavaScript.

6. Create a new `src` directory in the project root. Its purpose is to store the project's client-side assets.

7. Create `src/index.html` with the following content.

```

<!DOCTYPE html>
<html>
<head>
  <meta charset="utf-8" />
  <title>ASP.NET Core SignalR</title>
</head>
<body>
  <div id="divMessages" class="messages">
  </div>
  <div class="input-zone">
    <label id="lblMessage" for="tbMessage">Message:</label>
    <input id="tbMessage" class="input-zone-input" type="text" />
    <button id="btnSend">Send</button>
  </div>
</body>
</html>

```

The preceding HTML defines the homepage's boilerplate markup.

8. Create a new `src/css` directory. Its purpose is to store the project's `.css` files.

9. Create `src/css/main.css` with the following content:

```
* { *::before, *::after {  
    box-sizing: border-box;  
}  
  
html, body {  
    margin: 0;  
    padding: 0;  
}  
  
.input-zone {  
    align-items: center;  
    display: flex;  
    flex-direction: row;  
    margin: 10px;  
}  
  
.input-zone-input {  
    flex: 1;  
    margin-right: 10px;  
}  
  
.message-author {  
    font-weight: bold;  
}  
  
.messages {  
    border: 1px solid #000;  
    margin: 10px;  
    max-height: 300px;  
    min-height: 300px;  
    overflow-y: auto;  
    padding: 5px;  
}
```

The preceding `main.css` file styles the app.

10. Create `src/tsconfig.json` with the following content:

```
{  
  "compilerOptions": {  
    "target": "es5"  
  }  
}
```

The preceding code configures the TypeScript compiler to produce [ECMAScript](#) 5-compatible JavaScript.

11. Create `src/index.ts` with the following content:

```

import "./css/main.css";

const divMessages: HTMLDivElement = document.querySelector("#divMessages");
const tbMessage: HTMLInputElement = document.querySelector("#tbMessage");
const btnSend: HTMLButtonElement = document.querySelector("#btnSend");
const username = new Date().getTime();

tbMessage.addEventListener("keyup", (e: KeyboardEvent) => {
    if (e.keyCode === 13) {
        send();
    }
});

btnSend.addEventListener("click", send);

function send() {
}

```

The preceding TypeScript retrieves references to DOM elements and attaches two event handlers:

- `keyup` : This event fires when the user types something in the textbox identified as `tbMessage`. The `send` function is called when the user presses the **Enter** key.
- `click` : This event fires when the user clicks the **Send** button. The `send` function is called.

## Configure the ASP.NET Core app

1. The code provided in the `Startup.Configure` method displays *Hello World!*. Replace the `app.Run` method call with calls to `UseDefaultFiles` and `UseStaticFiles`.

```

app.UseDefaultFiles();
app.UseStaticFiles();

```

The preceding code allows the server to locate and serve the *index.html* file, whether the user enters its full URL or the root URL of the web app.

2. Call `AddSignalR` in the `Startup.ConfigureServices` method. It adds the SignalR services to your project.

```

services.AddSignalR();

```

3. Map a `/hub` route to the `ChatHub` hub. Add the following lines at the end of the `Startup.Configure` method:

```

app.UseSignalR(options =>
{
    options.MapHub<ChatHub>("/hub");
});

```

4. Create a new directory, called *Hubs*, in the project root. Its purpose is to store the SignalR hub, which is created in the next step.
5. Create hub *Hubs/ChatHub.cs* with the following code:

```
using Microsoft.AspNetCore.SignalR;
using System.Threading.Tasks;

namespace SignalRWebPack.Hubs
{
    public class ChatHub : Hub
    {
    }
}
```

6. Add the following code at the top of the *Startup.cs* file to resolve the `ChatHub` reference:

```
using SignalRWebPack.Hubs;
```

## Enable client and server communication

The app currently displays a simple form to send messages. Nothing happens when you try to do so. The server is listening to a specific route but does nothing with sent messages.

1. Execute the following command at the project root:

```
npm install @aspnet/signalr
```

The preceding command installs the [SignalR TypeScript client](#), which allows the client to send messages to the server.

2. Add the highlighted code to the *src/index.ts* file:

```

import "./css/main.css";
import * as signalR from "@aspnet/signalr";

const divMessages: HTMLDivElement = document.querySelector("#divMessages");
const tbMessage: HTMLInputElement = document.querySelector("#tbMessage");
const btnSend: HTMLButtonElement = document.querySelector("#btnSend");
const username = new Date().getTime();

const connection = new signalR.HubConnectionBuilder()
    .withUrl("/hub")
    .build();

connection.start().catch(err => document.write(err));

connection.on("messageReceived", (username: string, message: string) => {
    let m = document.createElement("div");

    m.innerHTML =
        `<div class="message__author">${username}</div><div>${message}</div>`;

    divMessages.appendChild(m);
    divMessages.scrollTop = divMessages.scrollHeight;
});

tbMessage.addEventListener("keyup", (e: KeyboardEvent) => {
    if (e.keyCode === 13) {
        send();
    }
});

btnSend.addEventListener("click", send);

function send() {
}

```

The preceding code supports receiving messages from the server. The `HubConnectionBuilder` class creates a new builder for configuring the server connection. The `withUrl` function configures the hub URL.

SignalR enables the exchange of messages between a client and a server. Each message has a specific name. For example, you can have messages with the name `messageReceived` that execute the logic responsible for displaying the new message in the messages zone. Listening to a specific message can be done via the `on` function. You can listen to any number of message names. It's also possible to pass parameters to the message, such as the author's name and the content of the message received. Once the client receives a message, a new `div` element is created with the author's name and the message content in its `innerHTML` attribute. It's added to the main `div` element displaying the messages.

- Now that the client can receive a message, configure it to send messages. Add the highlighted code to the `src/index.ts` file:

```

import "./css/main.css";
import * as signalR from "@aspnet/signalr";

const divMessages: HTMLDivElement = document.querySelector("#divMessages");
const tbMessage: HTMLInputElement = document.querySelector("#tbMessage");
const btnSend: HTMLButtonElement = document.querySelector("#btnSend");
const username = new Date().getTime();

const connection = new signalR.HubConnectionBuilder()
    .withUrl("/hub")
    .build();

connection.start().catch(err => document.write(err));

connection.on("messageReceived", (username: string, message: string) => {
    let messageContainer = document.createElement("div");

    messageContainer.innerHTML =
        `<div class="message-author">${username}</div><div>${message}</div>`;

    divMessages.appendChild(messageContainer);
    divMessages.scrollTop = divMessages.scrollHeight;
});

tbMessage.addEventListener("keyup", (e: KeyboardEvent) => {
    if (e.keyCode === 13) {
        send();
    }
});

btnSend.addEventListener("click", send);

function send() {
    connection.send("newMessage", username, tbMessage.value)
        .then(() => tbMessage.value = "");
}

```

Sending a message through the WebSockets connection requires calling the `send` method. The method's first parameter is the message name. The message data inhabits the other parameters. In this example, a message identified as `newMessage` is sent to the server. The message consists of the username and the user input from a text box. If the send works, the text box value is cleared.

4. Add the highlighted method to the `ChatHub` class:

```

using Microsoft.AspNetCore.SignalR;
using System.Threading.Tasks;

namespace SignalRWebPack.Hubs
{
    public class ChatHub : Hub
    {
        public async Task NewMessage(string username, string message)
        {
            await Clients.All.SendAsync("messageReceived", username, message);
        }
    }
}

```

The preceding code broadcasts received messages to all connected users once the server receives them. It's unnecessary to have a generic `on` method to receive all the messages. A method named after the message name suffices.

In this example, the TypeScript client sends a message identified as `newMessage`. The C# `NewMessage` method

expects the data sent by the client. A call is made to the `SendAsync` method on `Clients.All`. The received messages are sent to all clients connected to the hub.

## Test the app

Confirm that the app works with the following steps.

- [Visual Studio](#)
- [.NET Core CLI](#)

1. Run Webpack in *release* mode. Using the **Package Manager Console** window, execute the following command in the project root:

```
npm run release
```

This command yields the client-side assets to be served when running the app. The assets are placed in the `wwwroot` folder.

Webpack completed the following tasks:

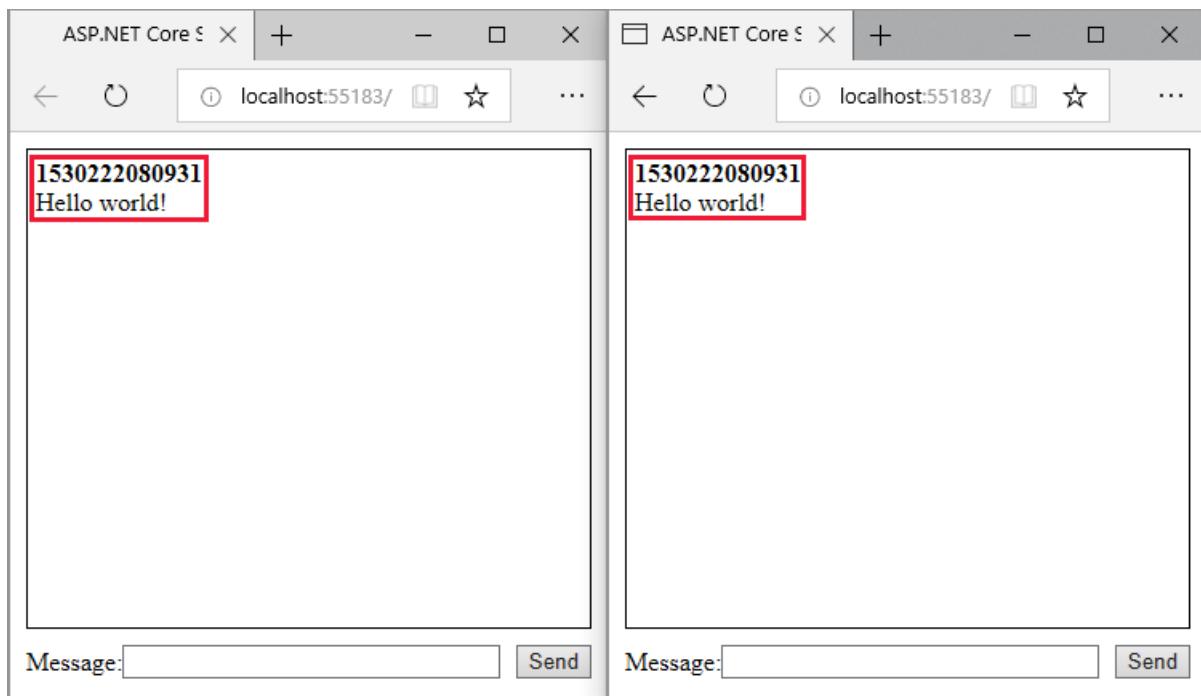
- Purged the contents of the `wwwroot` directory.
- Converted the TypeScript to JavaScript—a process known as *transpilation*.
- Mangled the generated JavaScript to reduce file size—a process known as *minification*.
- Copied the processed JavaScript, CSS, and HTML files from `src` to the `wwwroot` directory.
- Injected the following elements into the `wwwroot/index.html` file:
  - A `<link>` tag, referencing the `wwwroot/main.<hash>.css` file. This tag is placed immediately before the closing `</head>` tag.
  - A `<script>` tag, referencing the minified `wwwroot/main.<hash>.js` file. This tag is placed immediately before the closing `</body>` tag.

2. Select **Debug > Start without debugging** to launch the app in a browser without attaching the debugger.

The `wwwroot/index.html` file is served at `http://localhost:<port_number>`.

3. Open another browser instance (any browser). Paste the URL in the address bar.

4. Choose either browser, type something in the **Message** text box, and click the **Send** button. The unique user name and message are displayed on both pages instantly.



## Additional resources

- [ASP.NET Core SignalR JavaScript client](#)
- [Use hubs in ASP.NET Core SignalR](#)

# Create a web app with ASP.NET Core MVC on Windows with Visual Studio

7/10/2018 • 2 minutes to read • [Edit Online](#)

This tutorial teaches ASP.NET Core MVC web development with controllers and views. Razor Pages is a feature of the ASP.NET Core MVC framework that makes building and testing web UI easier and more productive. You can use Razor pages alongside controllers and views in the same project.

After using Razor pages, many developers prefer it over controllers and views. We recommend you try the [Razor Pages](#) tutorial before the MVC/Controller/Views version. The Razor Pages tutorial:

- Is the preferred approach for new application development.
- Is easier to follow.
- Covers more features.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub issue](#).

There are 3 versions of this tutorial:

- Windows: This series
- macOS: [Create an ASP.NET Core MVC app with Visual Studio for Mac](#)
- macOS, Linux, and Windows: [Create an ASP.NET Core MVC app with Visual Studio Code](#)

The tutorial series includes the following:

1. [Get started](#)
2. [Add a controller](#)
3. [Add a view](#)
4. [Add a model](#)
5. [Work with SQL Server LocalDB](#)
6. [Controller methods and views](#)
7. [Add search](#)
8. [Add a new field](#)
9. [Add validation](#)
10. [Examine the Details and Delete methods](#)

# Get started with ASP.NET Core MVC and Visual Studio

6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

This tutorial teaches ASP.NET Core MVC web development with controllers and views. Razor Pages is a feature of the ASP.NET Core MVC framework that makes building and testing web UI easier and more productive. You can use Razor pages alongside controllers and views in the same project.

After using Razor pages, many developers prefer it over controllers and views. We recommend you try the [Razor Pages](#) tutorial before the MVC/Controller/Views version. The Razor Pages tutorial:

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There are 3 versions of this tutorial:

- macOS: [Create an ASP.NET Core MVC app with Visual Studio for Mac](#)
- Windows: [Create an ASP.NET Core MVC app with Visual Studio](#)
- macOS, Linux, and Windows: [Create an ASP.NET Core MVC app with Visual Studio Code](#)

## Install Visual Studio and .NET Core

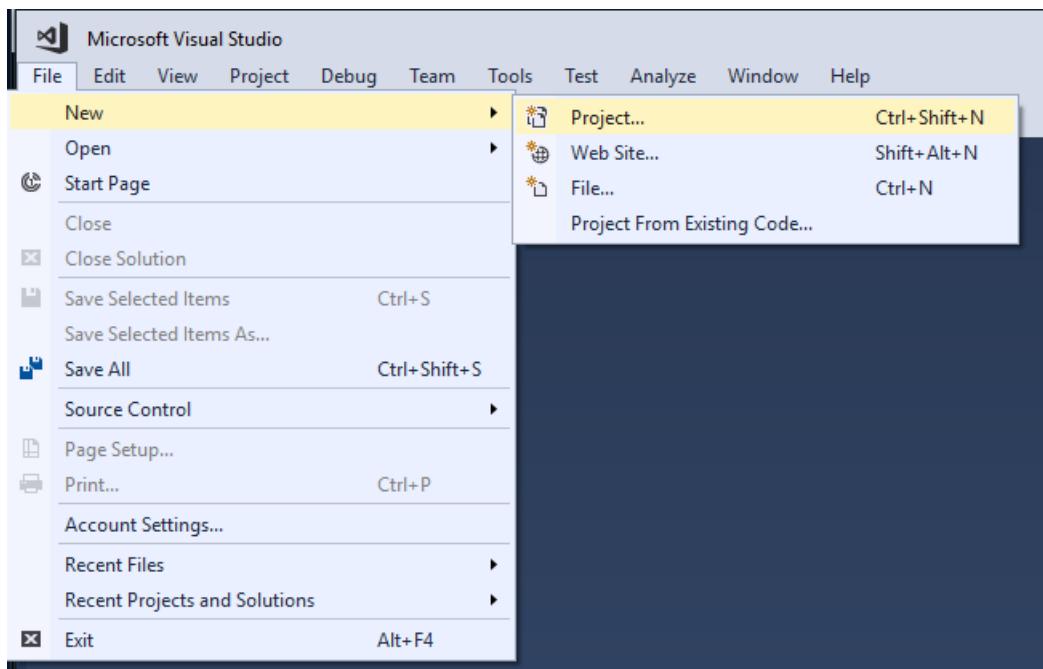
[Visual Studio 2017 version 15.7.3 or later](#) with the following workloads:

- **ASP.NET and web development**
- **.NET Core cross-platform development**

[.NET Core 2.1 SDK or later](#)

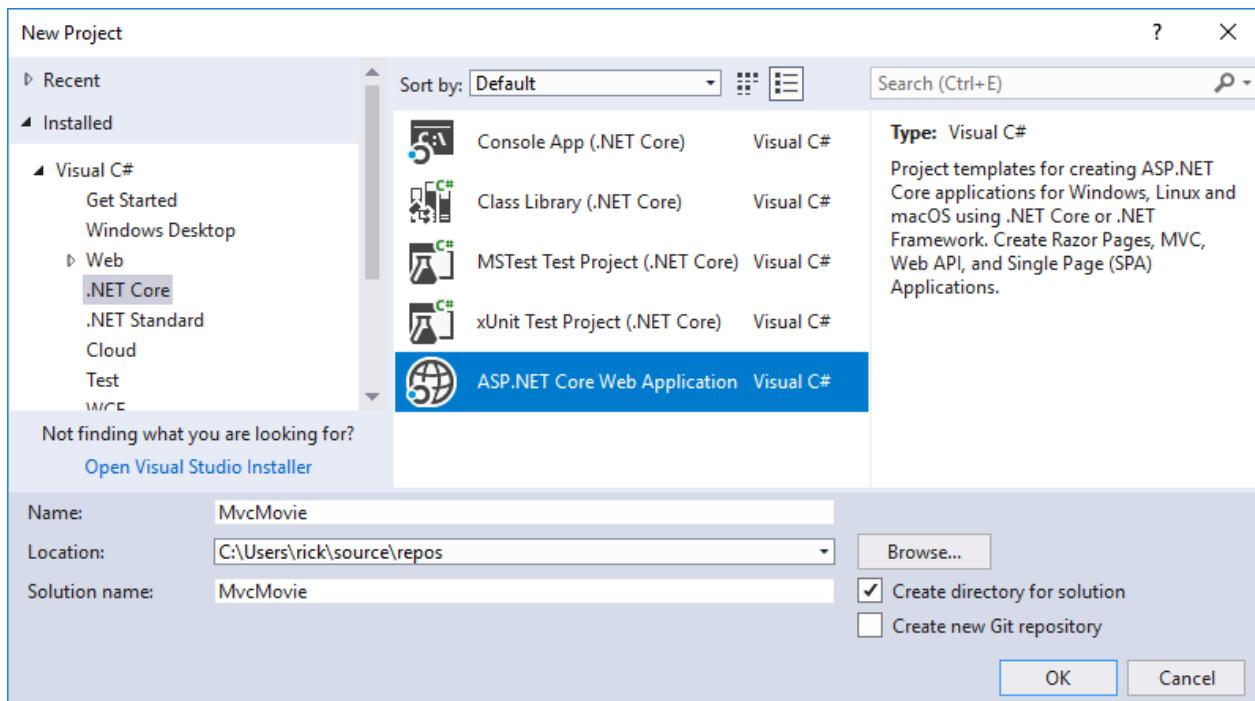
## Create a web app

From Visual Studio, select **File > New > Project**.



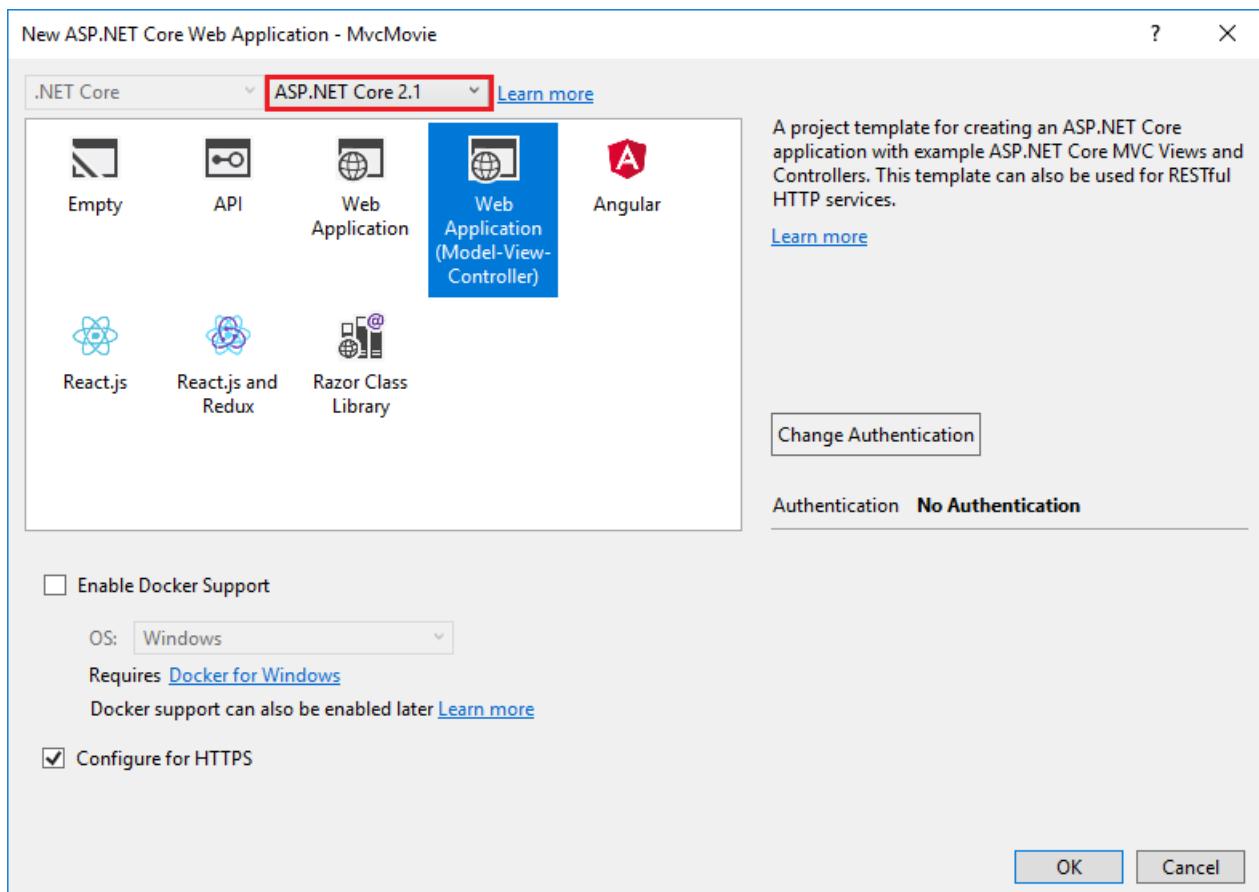
Complete the **New Project** dialog:

- In the left pane, tap **.NET Core**
- In the center pane, tap **ASP.NET Core Web Application (.NET Core)**
- Name the project "MvcMovie" (It's important to name the project "MvcMovie" so when you copy code, the namespace will match.)
- Tap **OK**



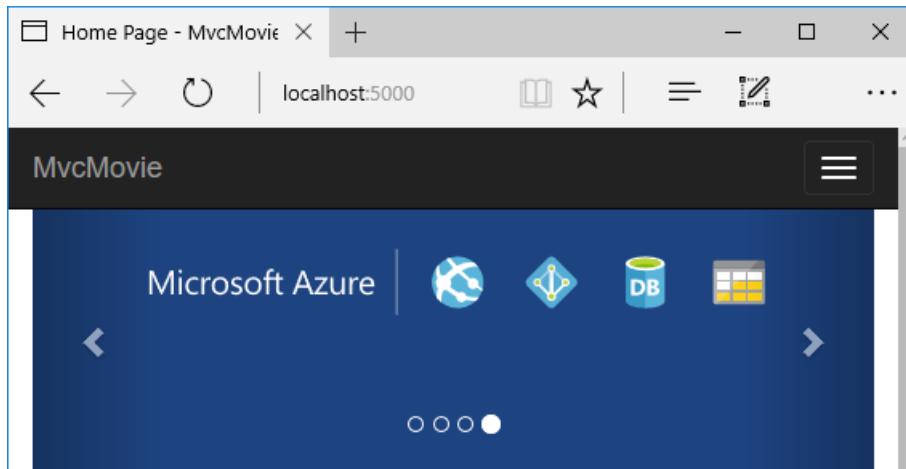
Complete the **New ASP.NET Core Web Application (.NET Core) - MvcMovie** dialog:

- In the version selector drop-down box select **ASP.NET Core 2.1**
- Select **Web Application(Model-View-Controller)**
- Tap **OK**.



Visual Studio used a default template for the MVC project you just created. You have a working app right now by entering a project name and selecting a few options. This is a basic starter project, and it's a good place to start,

Tap **F5** to run the app in debug mode or **Ctrl-F5** in non-debug mode.



## Application uses

- Sample pages using ASP.NET Core MVC
- Bower for managing client-side libraries
- Theming using Bootstrap

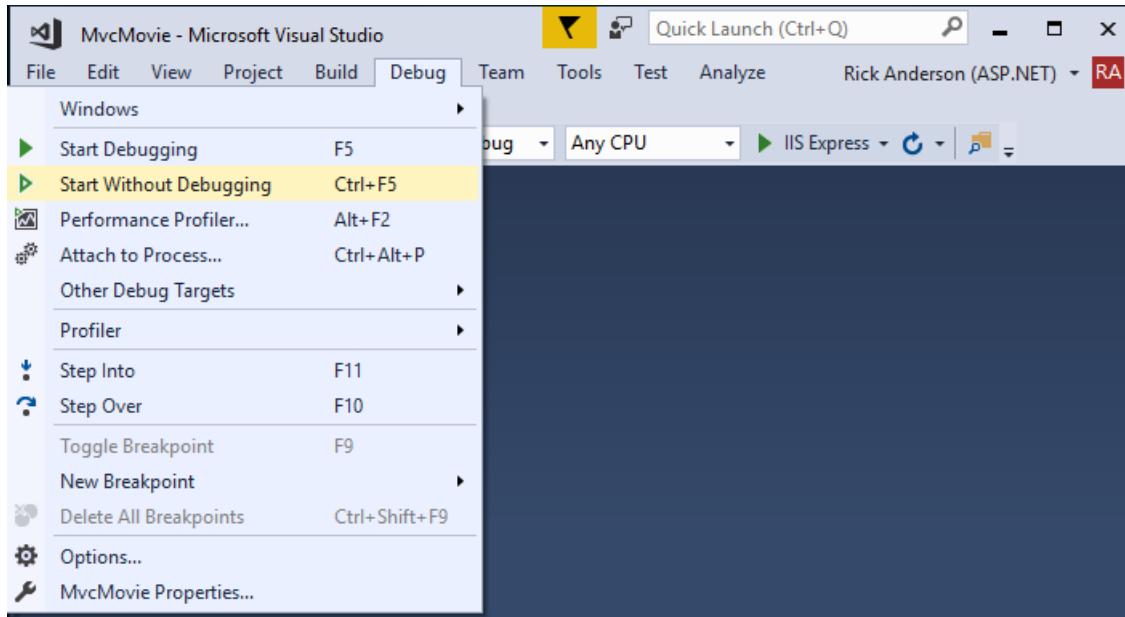
## How to

- Add a Controller and View
- Manage User Secrets using Secret Manager.
- Use logging to log a message.
- Add packages using NuGet

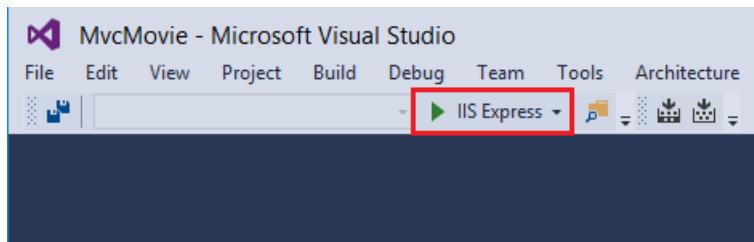
- Visual Studio starts **IIS Express** and runs your app. Notice that the address bar shows `localhost:port#` and not something like `example.com`. That's because `localhost` is the standard hostname for your local computer.

When Visual Studio creates a web project, a random port is used for the web server. In the image above, the port number is 5000. The URL in the browser shows `localhost:5000`. When you run the app, you'll see a different port number.

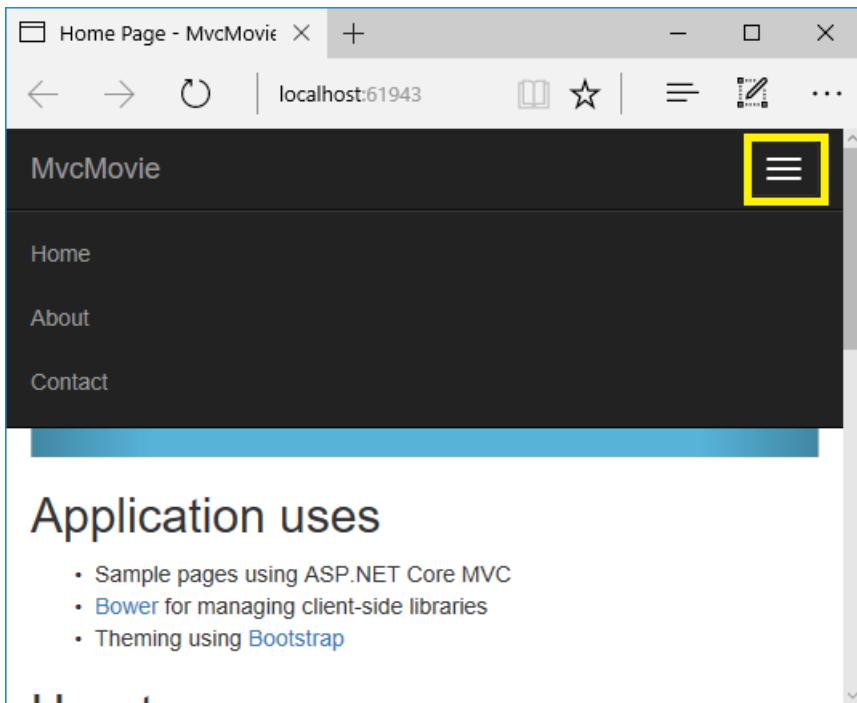
- Launching the app with **Ctrl+F5** (non-debug mode) allows you to make code changes, save the file, refresh the browser, and see the code changes. Many developers prefer to use non-debug mode to quickly launch the app and view changes.
- You can launch the app in debug or non-debug mode from the **Debug** menu item:



- You can debug the app by tapping the **IIS Express** button



The default template gives you working **Home**, **About** and **Contact** links. The browser image above doesn't show these links. Depending on the size of your browser, you might need to click the navigation icon to show them.



If you were running in debug mode, tap **Shift-F5** to stop debugging.

In the next part of this tutorial, we'll learn about MVC and start writing some code.

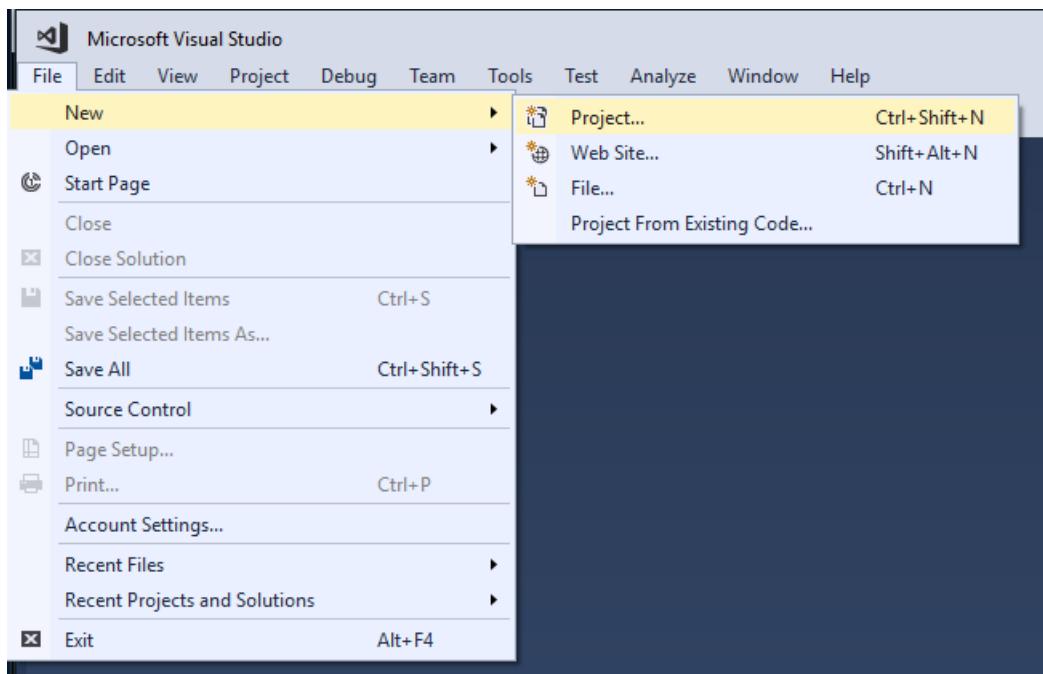
- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

Install **one** of the following:

- CLI tooling: Windows, Linux, or macOS: [.NET Core SDK 2.0 or later](#)
- IDE/editor tooling
  - Windows: [Visual Studio for Windows](#)
    - **ASP.NET and web development** workload
    - **.NET Core cross-platform development** workload
  - Linux: [Visual Studio Code](#)
  - macOS: [Visual Studio for Mac](#)

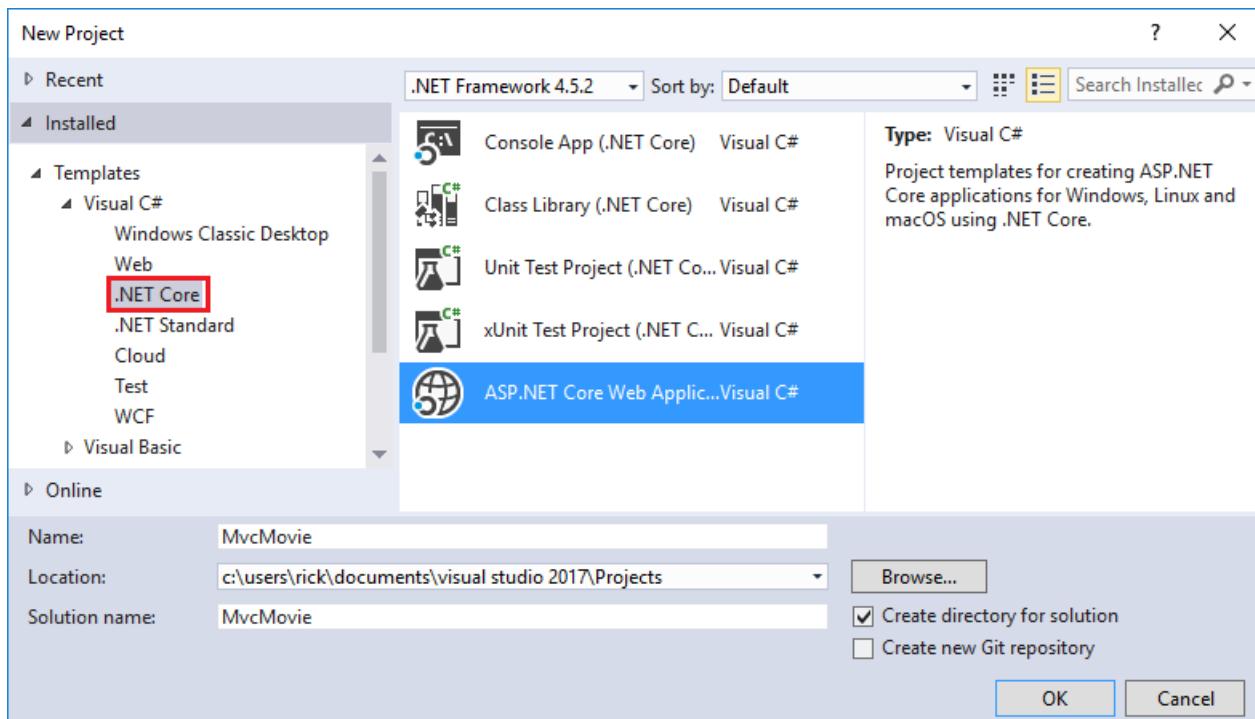
## Create a web app

From Visual Studio, select **File > New > Project**.



Complete the **New Project** dialog:

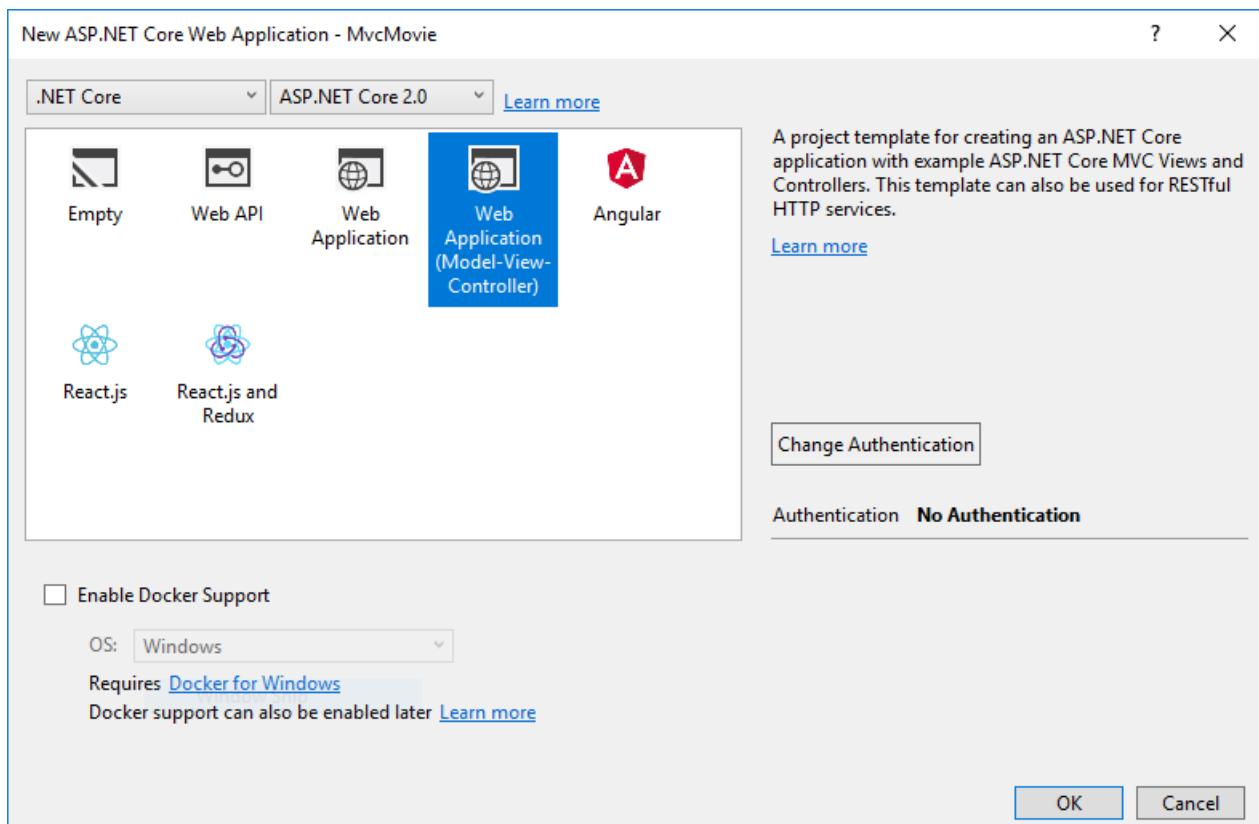
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- Name the project "MvcMovie" (It's important to name the project "MvcMovie" so when you copy code, the namespace will match.)
- Tap **OK**



- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

Complete the **New ASP.NET Core Web Application (.NET Core) - MvcMovie** dialog:

- In the version selector drop-down box select **ASP.NET Core 2.x**
- Select **Web Application(Model-View-Controller)**
- Tap **OK**.



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Home Page - MvcMovie

MvcMovie

Microsoft Azure | App Service | Functions | Database | Storage

Application uses

- Sample pages using ASP.NET Core MVC
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- Theming using Bootstrap

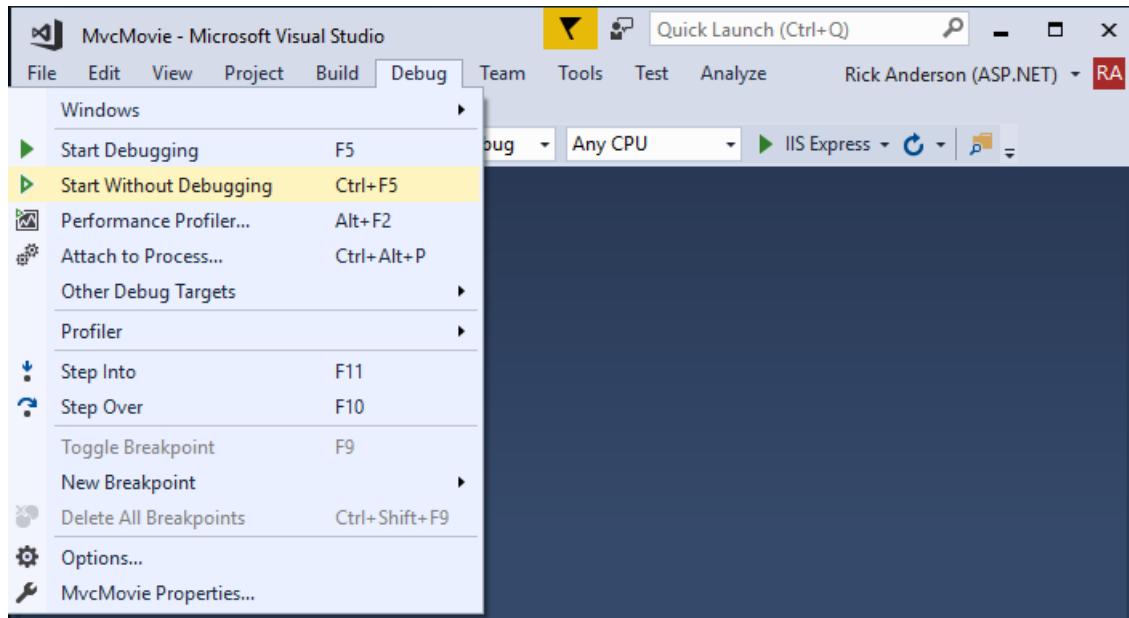
How to

- Add a Controller and View
- Manage User Secrets using Secret Manager.
- Use logging to log a message.
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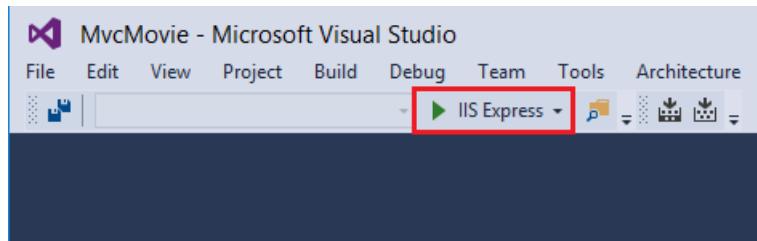
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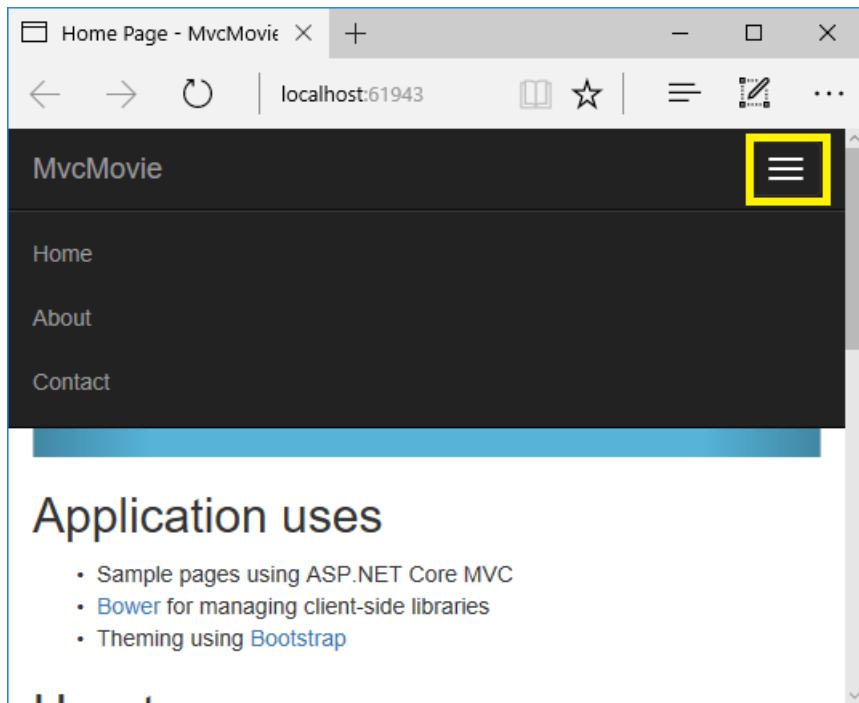
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NEXT

# Add a controller to an ASP.NET Core MVC app

7/10/2018 • 5 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

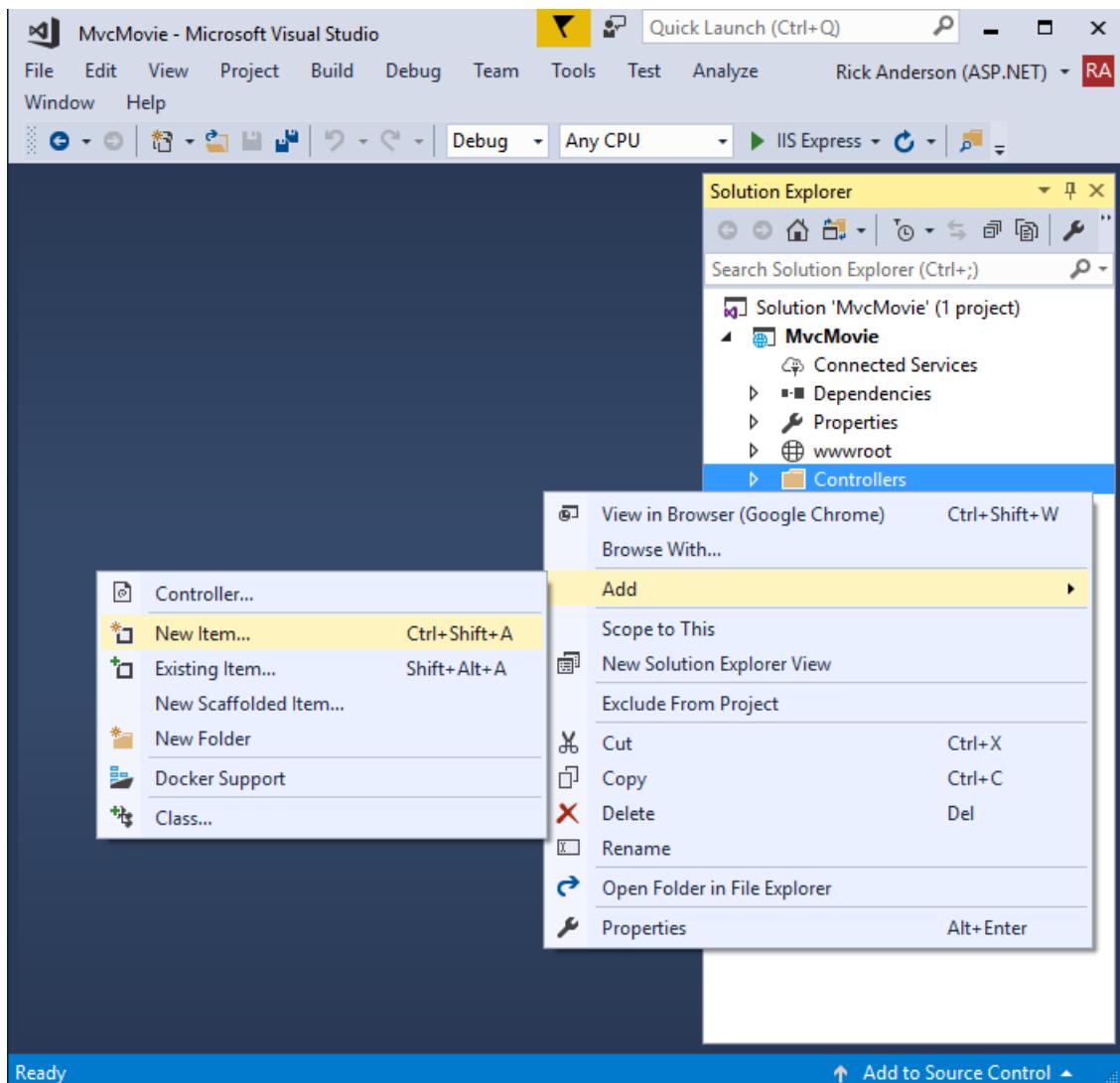
The Model-View-Controller (MVC) architectural pattern separates an app into three main components: **Model**, **View**, and **Controller**. The MVC pattern helps you create apps that are more testable and easier to update than traditional monolithic apps. MVC-based apps contain:

- **Models:** Classes that represent the data of the app. The model classes use validation logic to enforce business rules for that data. Typically, model objects retrieve and store model state in a database. In this tutorial, a `Movie` model retrieves movie data from a database, provides it to the view or updates it. Updated data is written to a database.
- **Views:** Views are the components that display the app's user interface (UI). Generally, this UI displays the model data.
- **Controllers:** Classes that handle browser requests. They retrieve model data and call view templates that return a response. In an MVC app, the view only displays information; the controller handles and responds to user input and interaction. For example, the controller handles route data and query-string values, and passes these values to the model. The model might use these values to query the database. For example, `http://localhost:1234/Home/About` has route data of `Home` (the controller) and `About` (the action method to call on the home controller). `http://localhost:1234/Movies/Edit/5` is a request to edit the movie with ID=5 using the movie controller. We'll talk about route data later in the tutorial.

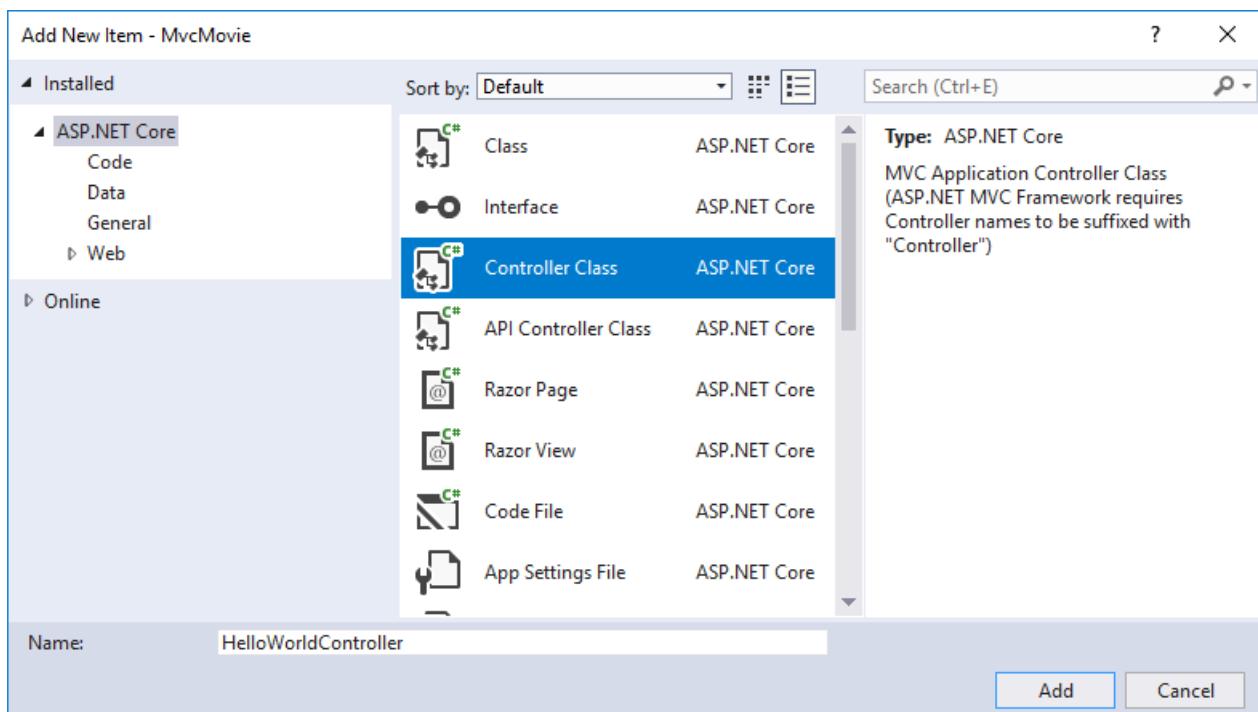
The MVC pattern helps you create apps that separate the different aspects of the app (input logic, business logic, and UI logic), while providing a loose coupling between these elements. The pattern specifies where each kind of logic should be located in the app. The UI logic belongs in the view. Input logic belongs in the controller. Business logic belongs in the model. This separation helps you manage complexity when you build an app, because it enables you to work on one aspect of the implementation at a time without impacting the code of another. For example, you can work on the view code without depending on the business logic code.

We cover these concepts in this tutorial series and show you how to use them to build a movie app. The MVC project contains folders for the *Controllers* and *Views*.

- In **Solution Explorer**, right-click **Controllers** > **Add** > **New Item**



- Select **Controller Class**
- In the **Add New Item** dialog, enter **HelloWorldController**.



Replace the contents of *Controllers/HelloWorldController.cs* with the following:

```

using Microsoft.AspNetCore.Mvc;
using System.Text.Encodings.Web;

namespace MvcMovie.Controllers
{
    public class HelloWorldController : Controller
    {
        //
        // GET: /HelloWorld/

        public string Index()
        {
            return "This is my default action...";
        }

        //
        // GET: /HelloWorld/Welcome/

        public string Welcome()
        {
            return "This is the Welcome action method...";
        }
    }
}

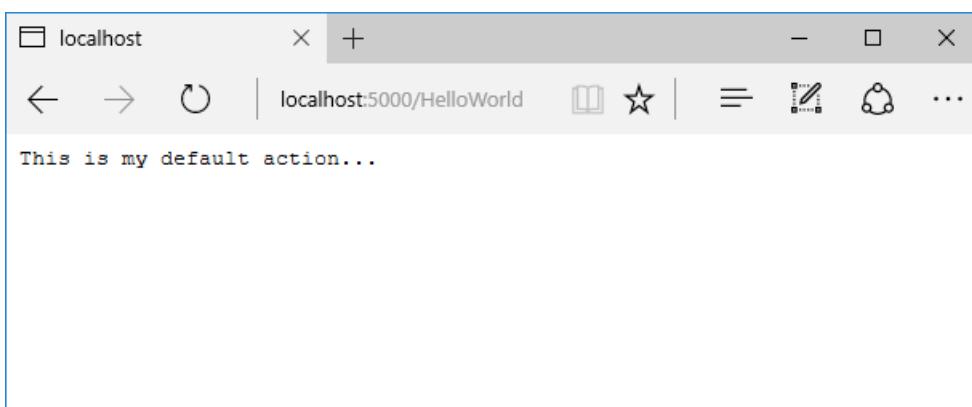
```

Every `public` method in a controller is callable as an HTTP endpoint. In the sample above, both methods return a string. Note the comments preceding each method.

An HTTP endpoint is a targetable URL in the web application, such as `http://localhost:1234/HelloWorld`, and combines the protocol used: `HTTP`, the network location of the web server (including the TCP port): `localhost:1234` and the target URI `HelloWorld`.

The first comment states this is an `HTTP GET` method that's invoked by appending `/HelloWorld/` to the base URL. The second comment specifies an `HTTP GET` method that's invoked by appending `/HelloWorld/Welcome/` to the URL. Later on in the tutorial you'll use the scaffolding engine to generate `HTTP POST` methods.

Run the app in non-debug mode and append "HelloWorld" to the path in the address bar. The `Index` method returns a string.



MVC invokes controller classes (and the action methods within them) depending on the incoming URL. The default [URL routing logic](#) used by MVC uses a format like this to determine what code to invoke:

`/[Controller]/[ActionName]/[Parameters]`

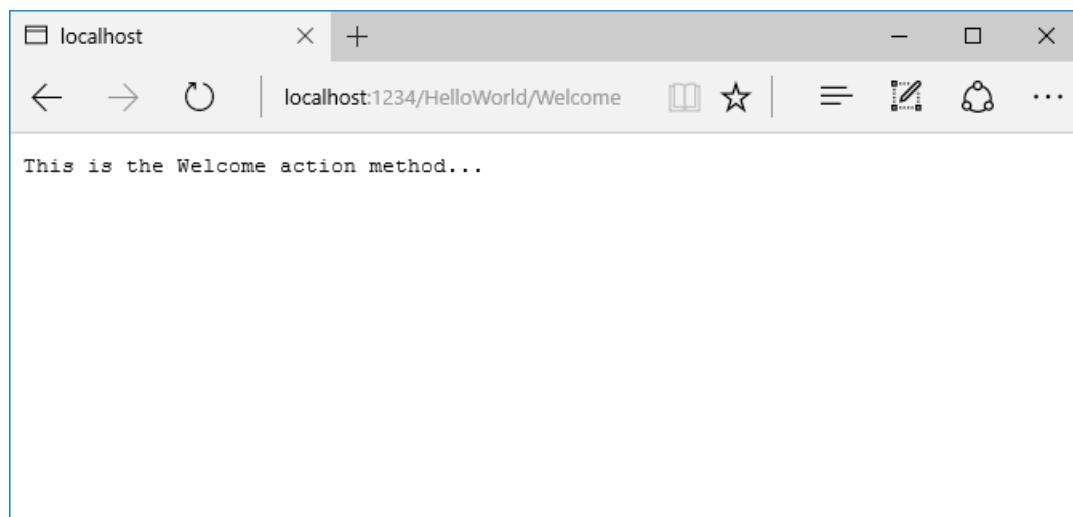
You set the format for routing in the `Configure` method in `Startup.cs` file.

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

When you run the app and don't supply any URL segments, it defaults to the "Home" controller and the "Index" method specified in the template line highlighted above.

The first URL segment determines the controller class to run. So `localhost:xxxx/HelloWorld` maps to the `HelloWorldController` class. The second part of the URL segment determines the action method on the class. So `localhost:xxxx/HelloWorld/Index` would cause the `Index` method of the `HelloWorldController` class to run. Notice that you only had to browse to `localhost:xxxx/HelloWorld` and the `Index` method was called by default. This is because `Index` is the default method that will be called on a controller if a method name isn't explicitly specified. The third part of the URL segment (`id`) is for route data. You'll see route data later on in this tutorial.

Browse to `http://localhost:xxxx/HelloWorld/Welcome`. The `Welcome` method runs and returns the string "This is the Welcome action method...". For this URL, the controller is `HelloWorld` and `Welcome` is the action method. You haven't used the `[Parameters]` part of the URL yet.



Modify the code to pass some parameter information from the URL to the controller. For example, `/HelloWorld/Welcome?name=Rick&numtimes=4`. Change the `Welcome` method to include two parameters as shown in the following code.

```
// GET: /HelloWorld/Welcome/
// Requires using System.Text.Encodings.Web;
public string Welcome(string name, int numTimes = 1)
{
    return HtmlEncoder.Default.Encode($"Hello {name}, NumTimes is: {numTimes}");
}
```

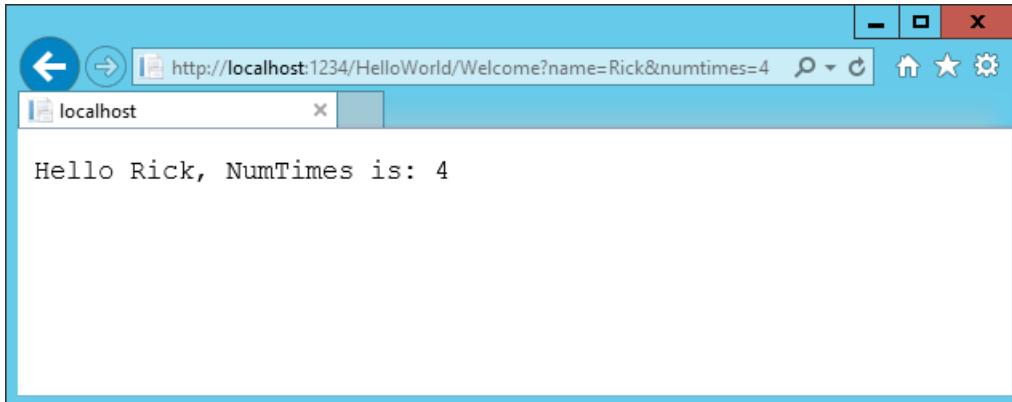
The preceding code:

- Uses the C# optional-parameter feature to indicate that the `numTimes` parameter defaults to 1 if no value is passed for that parameter.
- Uses `HtmlEncoder.Default.Encode` to protect the app from malicious input (namely JavaScript).
- Uses [Interpolated Strings](#).

Run your app and browse to:

```
http://localhost:xxxx/HelloWorld/Welcome?name=Rick&numtimes=4
```

(Replace xxxx with your port number.) You can try different values for `name` and `numtimes` in the URL. The MVC [model binding](#) system automatically maps the named parameters from the query string in the address bar to parameters in your method. See [Model Binding](#) for more information.

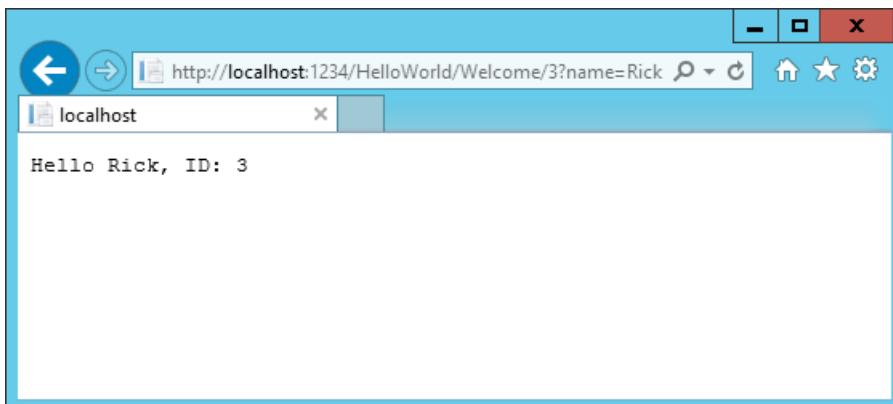


In the image above, the URL segment (`Parameters`) isn't used, the `name` and `numTimes` parameters are passed as [query strings](#). The `?` (question mark) in the above URL is a separator, and the query strings follow. The `&` character separates query strings.

Replace the `Welcome` method with the following code:

```
public string Welcome(string name, int ID = 1)
{
    return HtmlEncoder.Default.Encode($"Hello {name}, ID: {ID}");
}
```

Run the app and enter the following URL: `http://localhost:xxx/HelloWorld/Welcome/3?name=Rick`



This time the third URL segment matched the route parameter `id`. The `Welcome` method contains a parameter `id` that matched the URL template in the `MapRoute` method. The trailing `?` (in `id?`) indicates the `id` parameter is optional.

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

In these examples the controller has been doing the "VC" portion of MVC - that is, the view and controller work. The controller is returning HTML directly. Generally you don't want controllers returning HTML directly, since that becomes very cumbersome to code and maintain. Instead you typically use a separate Razor view template file to

help generate the HTML response. You do that in the next tutorial.

In Visual Studio, in non-debug mode (Ctrl+F5), you don't need to build the app after changing code. Just save the file, refresh your browser and you can see the changes.

[PREVIOUS](#)

[NEXT](#)

# Add a view to an ASP.NET Core MVC app

6/26/2018 • 8 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section you modify the `HelloWorldController` class to use Razor view template files to cleanly encapsulate the process of generating HTML responses to a client.

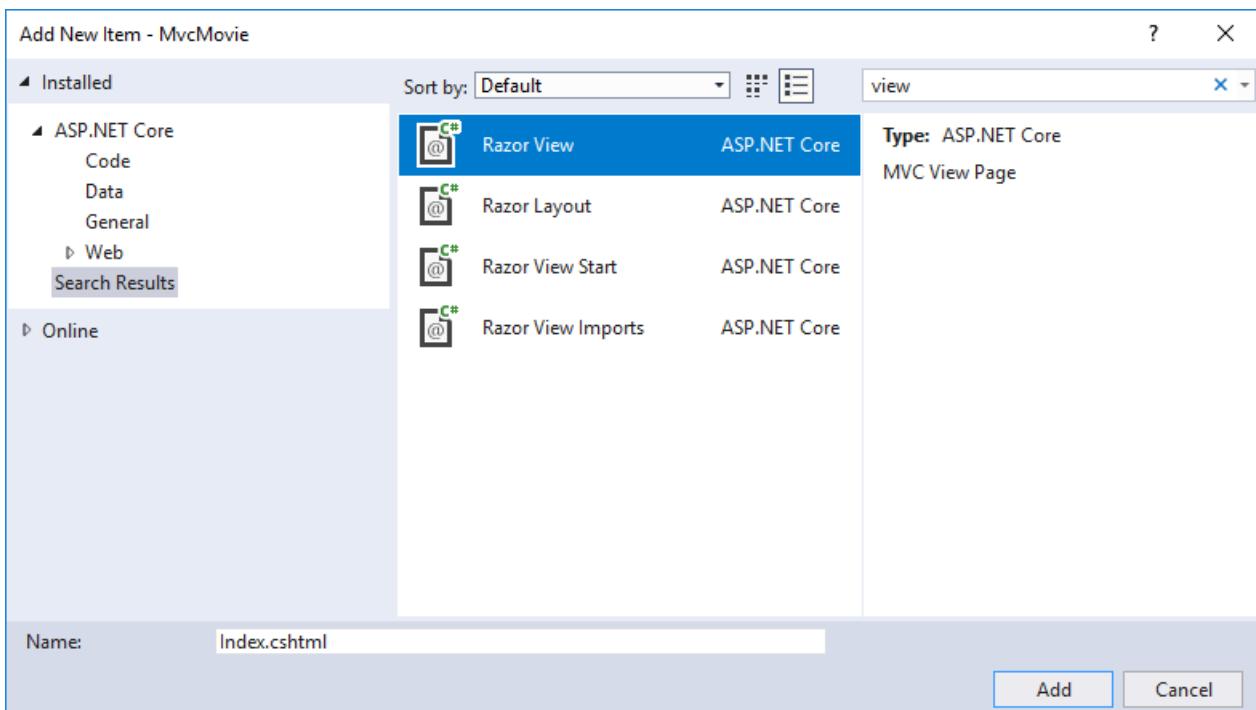
You create a view template file using Razor. Razor-based view templates have a `.cshtml` file extension. They provide an elegant way to create HTML output using C#.

Currently the `Index` method returns a string with a message that's hard-coded in the controller class. In the `HelloWorldController` class, replace the `Index` method with the following code:

```
public IActionResult Index()
{
    return View();
}
```

The preceding code returns a `View` object. It uses a view template to generate an HTML response to the browser. Controller methods (also known as action methods) such as the `Index` method above, generally return an `IActionResult` (or a class derived from `ActionResult`), not a type like `string`.

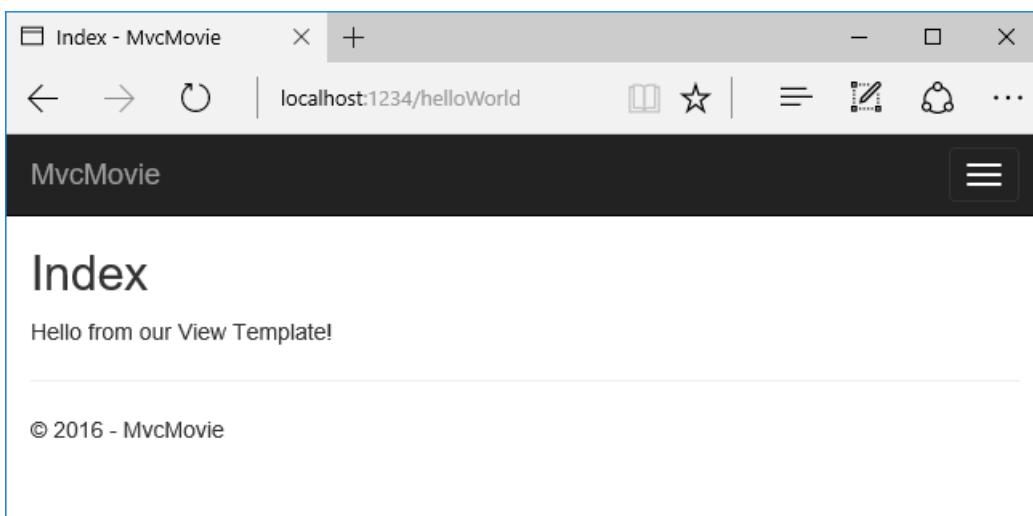
- Right click on the `Views` folder, and then **Add > New Folder** and name the folder `HelloWorld`.
- Right click on the `Views/HelloWorld` folder, and then **Add > New Item**.
- In the **Add New Item - MvcMovie** dialog
  - In the search box in the upper-right, enter `view`
  - Tap **Razor View**
  - In the **Name** box, change the name if necessary to `Index.cshtml`.
  - Tap **Add**



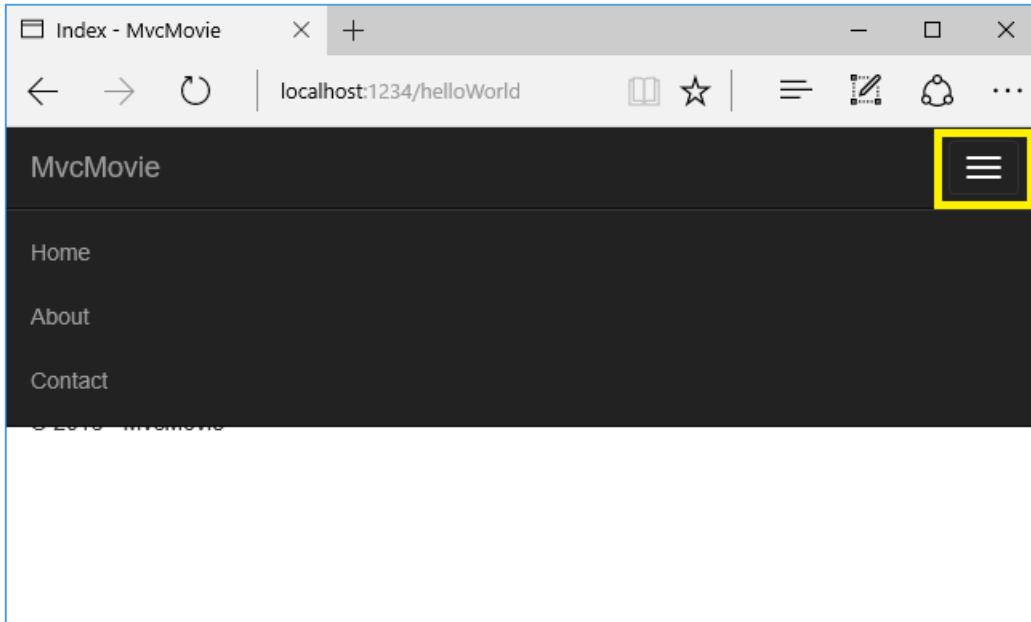
Replace the contents of the `Views/HelloWorld/Index.cshtml` Razor view file with the following:

```
@{  
    ViewData["Title"] = "Index";  
}  
  
<h2>Index</h2>  
  
<p>Hello from our View Template!</p>
```

Navigate to `http://localhost:xxxx>HelloWorld`. The `Index` method in the `HelloWorldController` didn't do much; it ran the statement `return View();`, which specified that the method should use a view template file to render a response to the browser. Because you didn't explicitly specify the name of the view template file, MVC defaulted to using the `Index.cshtml` view file in the `/Views/HelloWorld` folder. The image below shows the string "Hello from our View Template!" hard-coded in the view.



If your browser window is small (for example on a mobile device), you might need to toggle (tap) the [Bootstrap navigation button](#) in the upper right to see the **Home**, **About**, and **Contact** links.



## Changing views and layout pages

Tap the menu links (**MvcMovie**, **Home**, **About**). Each page shows the same menu layout. The menu layout is implemented in the `Views/Shared/_Layout.cshtml` file. Open the `Views/Shared/_Layout.cshtml` file.

**Layout** templates allow you to specify the HTML container layout of your site in one place and then apply it across multiple pages in your site. Find the `@RenderBody()` line. `RenderBody` is a placeholder where all the view-specific pages you create show up, *wrapped* in the layout page. For example, if you select the **About** link, the **Views/Home/About.cshtml** view is rendered inside the `RenderBody` method.

## Change the title and menu link in the layout file

In the title element, change `MvcMovie` to `Movie App`. Change the anchor text in the layout template from `MvcMovie` to `Movie App` and the controller from `Home` to `Movies` as highlighted below:

```
@inject Microsoft.ApplicationInsights.AspNetCore.JavaScriptSnippet JavaScriptSnippet
<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>@ViewData["Title"] - Movie App</title>

    <environment names="Development">
        <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />
        <link rel="stylesheet" href="~/css/site.css" />
    </environment>
    <environment names="Staging,Production">
        <link rel="stylesheet" href="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/css/bootstrap.min.css"
              asp-fallback-href="~/lib/bootstrap/dist/css/bootstrap.min.css"
              asp-fallback-test-class="sr-only" asp-fallback-test-property="position" asp-fallback-test-
              value="absolute" />
        <link rel="stylesheet" href="~/css/site.min.css" asp-append-version="true" />
    </environment>
    @Html.Raw(JavaScriptSnippet.FullScript)
</head>
<body>
    <nav class="navbar navbar-inverse navbar-fixed-top">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-
                collapse">
```

```

        <span class="sr-only">Toggle navigation</span>
        <span class="icon-bar"></span>
        <span class="icon-bar"></span>
        <span class="icon-bar"></span>
    </button>
    <a asp-area="" asp-controller="Movies" asp-action="Index" class="navbar-brand">Movie App</a>
</div>
<div class="navbar-collapse collapse">
    <ul class="nav navbar-nav">
        <li><a asp-area="" asp-controller="Home" asp-action="Index">Home</a></li>
        <li><a asp-area="" asp-controller="Home" asp-action="About">About</a></li>
        <li><a asp-area="" asp-controller="Home" asp-action="Contact">Contact</a></li>
    </ul>
</div>
</div>
</nav>
<div class="container body-content">
    @RenderBody()
    <hr />
    <footer>
        <p>&copy; 2017 - MvcMovie</p>
    </footer>
</div>

<environment names="Development">
    <script src="~/lib/jquery/dist/jquery.js"></script>
    <script src="~/lib/bootstrap/dist/js/bootstrap.js"></script>
    <script src("~/js/site.js" asp-append-version="true")></script>
</environment>
<environment names="Staging,Production">
    <script src="https://ajax.aspnetcdn.com/ajax/jquery/jquery-2.2.0.min.js"
        asp-fallback-src="~/lib/jquery/dist/jquery.min.js"
        asp-fallback-test="window.jQuery"
        crossorigin="anonymous"
        integrity="sha384-K+ctZQ+LL8q6tP7I94W+qzQsfRV2a+AfHII9k8z819ggpc8X+Ytst4yBo/hH+8Fk">
    </script>
    <script src="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/bootstrap.min.js"
        asp-fallback-src="~/lib/bootstrap/dist/js/bootstrap.min.js"
        asp-fallback-test="window.jQuery && window.jQuery.fn && window.jQuery.fn.modal"
        crossorigin="anonymous"
        integrity="sha384-Tc5IQib027qvyjSMfHjOMaLkfuWVxZxUPnCJA7l2mCWNIPG9mGCD8wGNICPD7Txa">
    </script>
    <script src "~/js/site.min.js" asp-append-version="true"></script>
</environment>

    @RenderSection("Scripts", required: false)
</body>
</html>

```

```

@inject Microsoft.ApplicationInsights.AspNetCore.JavaScriptSnippet JavaScriptSnippet
<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>@ ViewData["Title"] - Movie App</title>

    <environment names="Development">
        <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />
        <link rel="stylesheet" href="~/css/site.css" />
    </environment>
    <environment names="Staging,Production">
        <link rel="stylesheet" href="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/css/bootstrap.min.css"
            asp-fallback-href="~/lib/bootstrap/dist/css/bootstrap.min.css"
            asp-fallback-test-class="sr-only" asp-fallback-test-property="position" asp-fallback-test-
            value="absolute" />
        <link rel="stylesheet" href="~/css/site.min.css" asp-append-version="true" />
    </environment>

```

```

</environment>
    @Html.Raw(JavaScriptSnippet.FullScript)
</head>
<body>
    <nav class="navbar navbar-inverse navbar-fixed-top">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a asp-area="" asp-controller="Movies" asp-action="Index" class="navbar-brand">Movie App</a>
            </div>
            <div class="navbar-collapse collapse">
                <ul class="nav navbar-nav">
                    <li><a asp-area="" asp-controller="Home" asp-action="Index">Home</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="About">About</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="Contact">Contact</a></li>
                </ul>
            </div>
        </div>
    </nav>
    <div class="container body-content">
        @RenderBody()
        <hr />
        <footer>
            <p>&copy; 2017 - MvcMovie</p>
        </footer>
    </div>

    <environment names="Development">
        <script src="~/lib/jquery/dist/jquery.js"></script>
        <script src="~/lib/bootstrap/dist/js/bootstrap.js"></script>
        <script src="~/js/site.js" asp-append-version="true"></script>
    </environment>
    <environment names="Staging,Production">
        <script src="https://ajax.aspnetcdn.com/ajax/jquery/jquery-2.2.0.min.js"
               asp-fallback-src="~/lib/jquery/dist/jquery.min.js"
               asp-fallback-test="window.jQuery"
               crossorigin="anonymous"
               integrity="sha384-K+ctZQ+LL8q6tP7I94W+qzQsfRV2a+AfHI9k8z8l9ggpc8X+Ytst4yBo/hH+8Fk">
        </script>
        <script src="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/bootstrap.min.js"
               asp-fallback-src="~/lib/bootstrap/dist/js/bootstrap.min.js"
               asp-fallback-test="window.jQuery && window.jQuery.fn && window.jQuery.fn.modal"
               crossorigin="anonymous"
               integrity="sha384-Tc5IQib027qvyjSMfHjOMaLkfuWVxZxUPnCJA712mCWNIPG9mGCD8wGNICPD7Txa">
        </script>
        <script src="~/js/site.min.js" asp-append-version="true"></script>
    </environment>

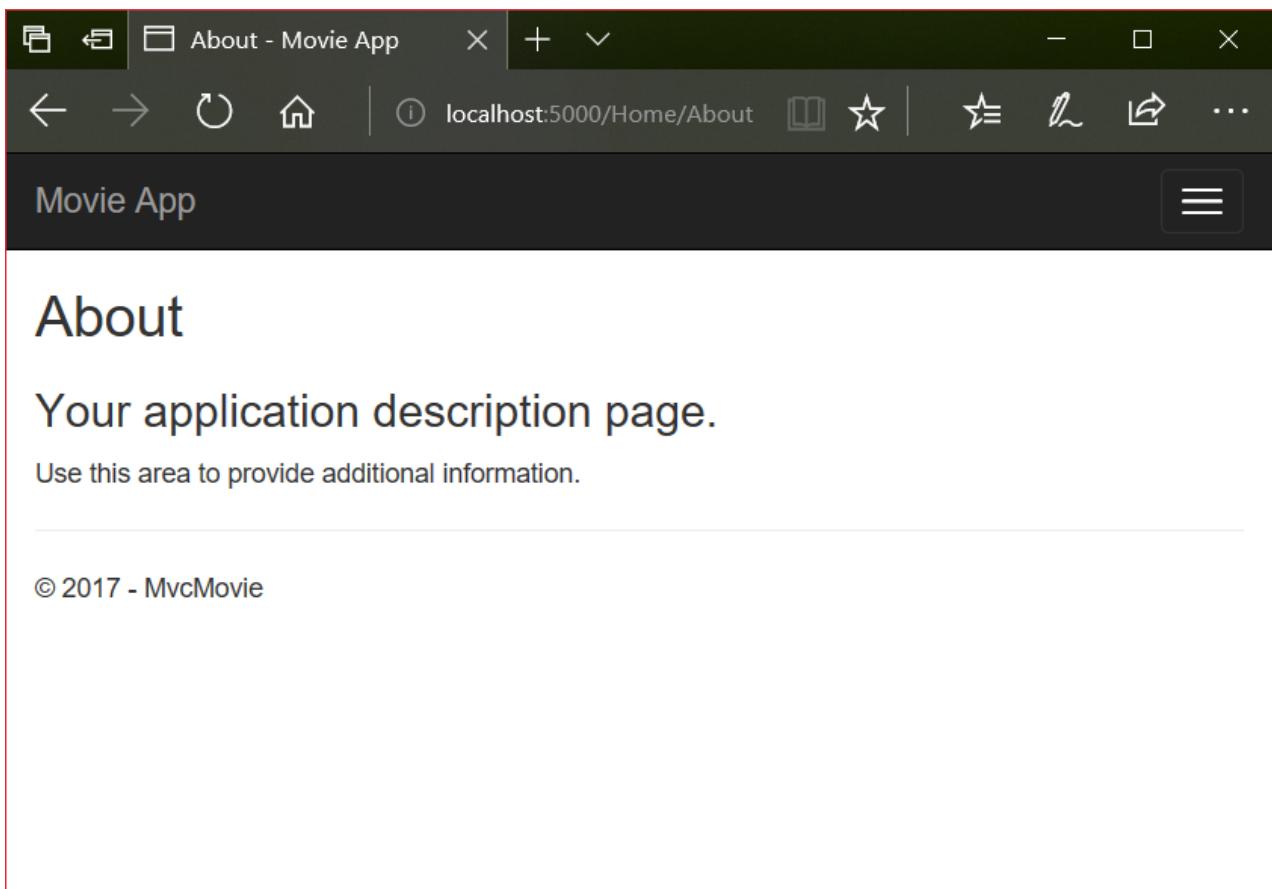
    @RenderSection("Scripts", required: false)
</body>
</html>

```

### WARNING

We haven't implemented the `Movies` controller yet, so if you click on that link, you'll get a 404 (Not found) error.

Save your changes and tap the **About** link. Notice how the title on the browser tab now displays **About - Movie App** instead of **About - Mvc Movie**:



Tap the **Contact** link and notice that the title and anchor text also display **Movie App**. We were able to make the change once in the layout template and have all pages on the site reflect the new link text and new title.

Examine the *Views/\_ViewStart.cshtml* file:

```
@{  
    Layout = "_Layout";  
}
```

The *Views/\_ViewStart.cshtml* file brings in the *Views/Shared/\_Layout.cshtml* file to each view. You can use the `Layout` property to set a different layout view, or set it to `null` so no layout file will be used.

Change the title of the `Index` view.

Open *Views/HelloWorld/Index.cshtml*. There are two places to make a change:

- The text that appears in the title of the browser.
- The secondary header (`<h2>` element).

You'll make them slightly different so you can see which bit of code changes which part of the app.

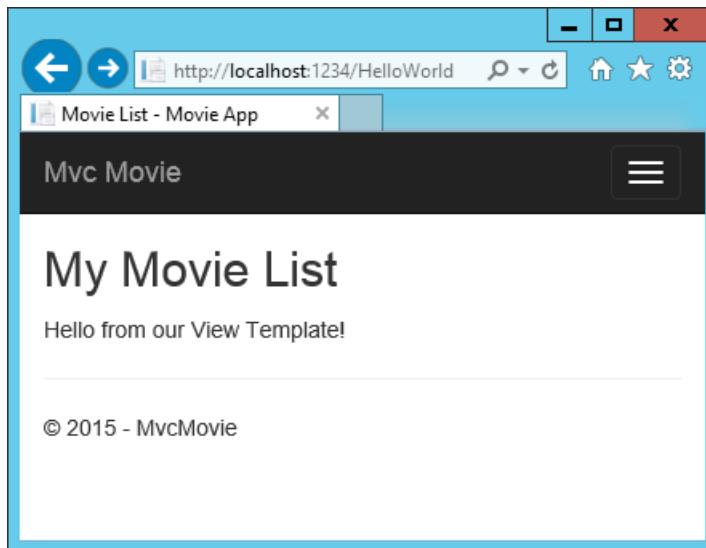
```
@{  
    ViewData["Title"] = "Movie List";  
}  
  
<h2>My Movie List</h2>  
  
<p>Hello from our View Template!</p>
```

`ViewData["Title"] = "Movie List";` in the code above sets the `Title` property of the `ViewData` dictionary to "Movie List". The `Title` property is used in the `<title>` HTML element in the layout page:

```
<title>@ViewData["Title"] - Movie App</title>
```

Save your change and navigate to `http://localhost:xxxx/HelloWorld`. Notice that the browser title, the primary heading, and the secondary headings have changed. (If you don't see changes in the browser, you might be viewing cached content. Press **Ctrl+F5** in your browser to force the response from the server to be loaded.) The browser title is created with `ViewData["Title"]` we set in the *Index.cshtml* view template and the additional "-Movie App" added in the layout file.

Also notice how the content in the *Index.cshtml* view template was merged with the *Views/Shared/\_Layout.cshtml* view template and a single HTML response was sent to the browser. Layout templates make it really easy to make changes that apply across all of the pages in your application. To learn more see [Layout](#).



Our little bit of "data" (in this case the "Hello from our View Template!" message) is hard-coded, though. The MVC application has a "V" (view) and you've got a "C" (controller), but no "M" (model) yet.

## Passing Data from the Controller to the View

Controller actions are invoked in response to an incoming URL request. A controller class is where you write the code that handles the incoming browser requests. The controller retrieves data from a data source and decides what type of response to send back to the browser. View templates can be used from a controller to generate and format an HTML response to the browser.

Controllers are responsible for providing the data required in order for a view template to render a response. A best practice: View templates should **not** perform business logic or interact with a database directly. Rather, a view template should work only with the data that's provided to it by the controller. Maintaining this "separation of concerns" helps keep your code clean, testable, and maintainable.

Currently, the `Welcome` method in the `HelloWorldController` class takes a `name` and a `ID` parameter and then outputs the values directly to the browser. Rather than have the controller render this response as a string, change the controller to use a view template instead. The view template generates a dynamic response, which means that appropriate bits of data must be passed from the controller to the view in order to generate the response. Do this by having the controller put the dynamic data (parameters) that the view template needs in a `ViewData` dictionary that the view template can then access.

Return to the `HelloWorldController.cs` file and change the `Welcome` method to add a `Message` and `NumTimes` value to the `ViewData` dictionary. The `ViewData` dictionary is a dynamic object, which means you can put whatever you want in to it; the `ViewData` object has no defined properties until you put something inside it. The [MVC model binding system](#) automatically maps the named parameters (`name` and `numTimes`) from the query string in the address bar to parameters in your method. The complete `HelloWorldController.cs` file looks like this:

```

using Microsoft.AspNetCore.Mvc;
using System.Text.Encodings.Web;

namespace MvcMovie.Controllers
{
    public class HelloWorldController : Controller
    {
        public IActionResult Index()
        {
            return View();
        }

        public IActionResult Welcome(string name, int numTimes = 1)
        {
            ViewData["Message"] = "Hello " + name;
            ViewData["NumTimes"] = numTimes;

            return View();
        }
    }
}

```

The `viewData` dictionary object contains data that will be passed to the view.

Create a Welcome view template named `Views/HelloWorld/Welcome.cshtml`.

You'll create a loop in the `Welcome.cshtml` view template that displays "Hello" `NumTimes`. Replace the contents of `Views/HelloWorld/Welcome.cshtml` with the following:

```

@{
    ViewData["Title"] = "Welcome";
}

<h2>Welcome</h2>

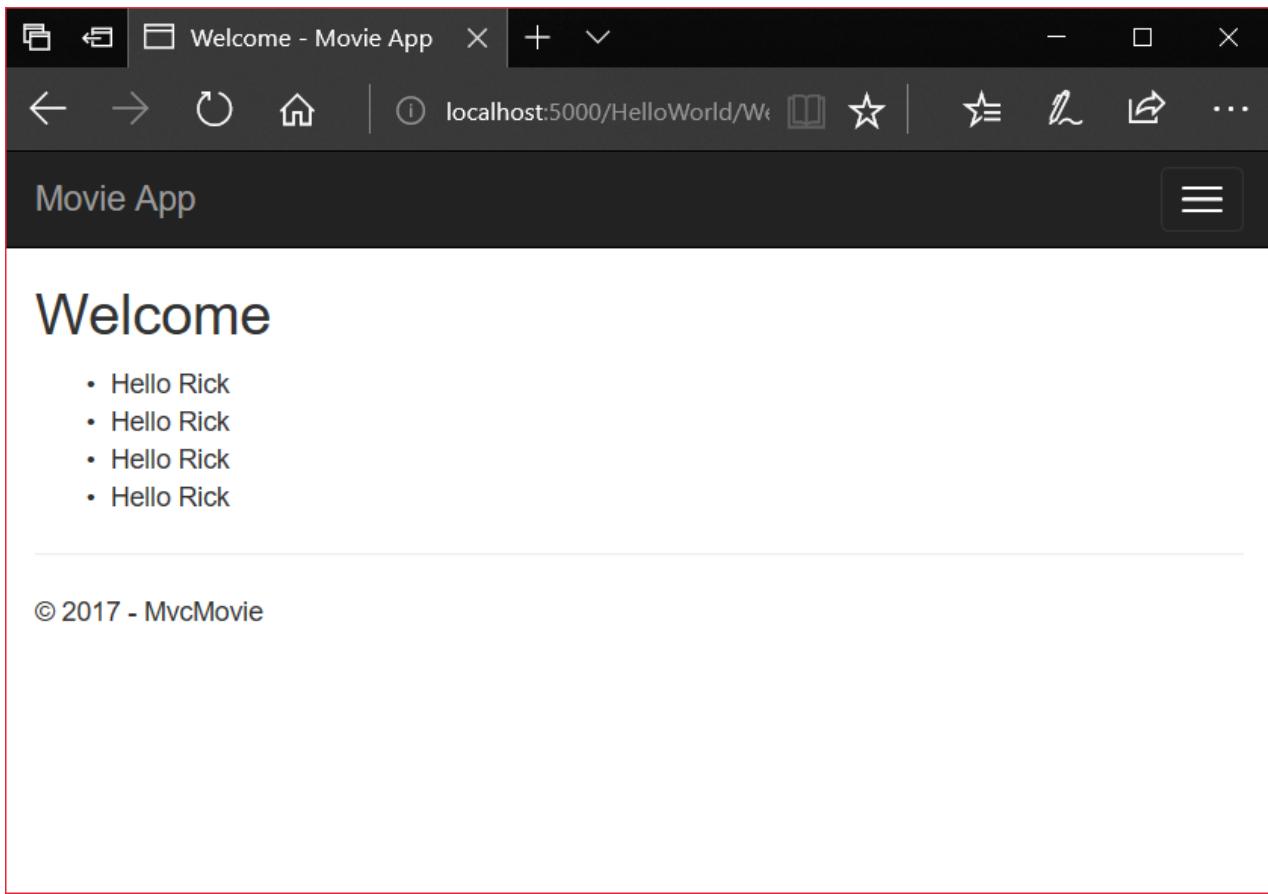
<ul>
    @for (int i = 0; i < (int)ViewData["NumTimes"]; i++)
    {
        <li>@ViewData["Message"]</li>
    }
</ul>

```

Save your changes and browse to the following URL:

`http://localhost:xxxx/HelloWorld/Welcome?name=Rick&numtimes=4`

Data is taken from the URL and passed to the controller using the [MVC model binder](#). The controller packages the data into a `viewData` dictionary and passes that object to the view. The view then renders the data as HTML to the browser.



In the sample above, we used the `ViewData` dictionary to pass data from the controller to a view. Later in the tutorial, we will use a view model to pass data from a controller to a view. The view model approach to passing data is generally much preferred over the `ViewData` dictionary approach. See [ViewModel vs ViewData vs ViewBag vs TempData vs Session in MVC](#) for more information.

Well, that was a kind of an "M" for model, but not the database kind. Let's take what we've learned and create a database of movies.

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# Add a model to an ASP.NET Core MVC app

6/26/2018 • 10 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Tom Dykstra](#)

In this section, you'll add some classes for managing movies in a database. These classes will be the "**Model**" part of the **MVC** app.

You use these classes with [Entity Framework Core](#) (EF Core) to work with a database. EF Core is an object-relational mapping (ORM) framework that simplifies the data access code that you have to write. [EF Core supports many database engines](#).

The model classes you'll create are known as POCO classes (from "plain-old CLR objects") because they don't have any dependency on EF Core. They just define the properties of the data that will be stored in the database.

In this tutorial you'll write the model classes first, and EF Core will create the database. An alternate approach not covered here is to generate model classes from an already-existing database. For information about that approach, see [ASP.NET Core - Existing Database](#).

## Add a data model class

Right-click the *Models* folder > **Add** > **Class**. Name the class **Movie** and add the following properties:

```
using System;

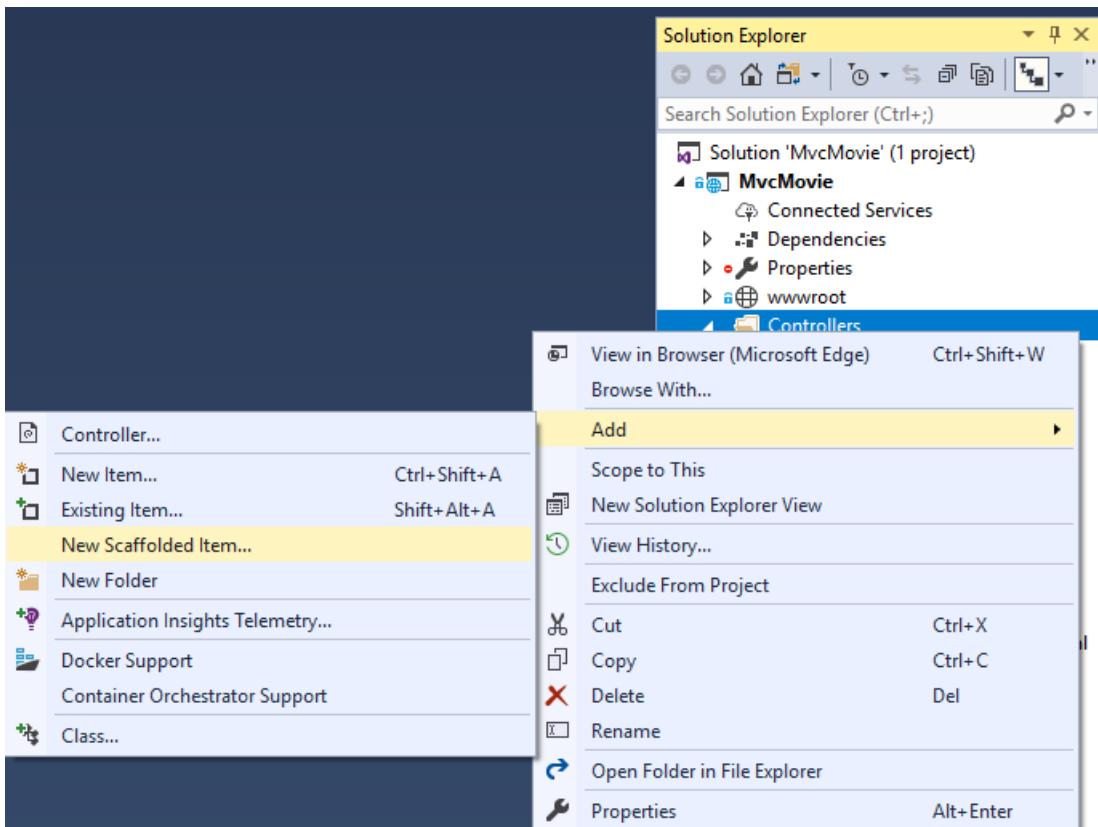
namespace MvcMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}
```

The `ID` field is required by the database for the primary key.

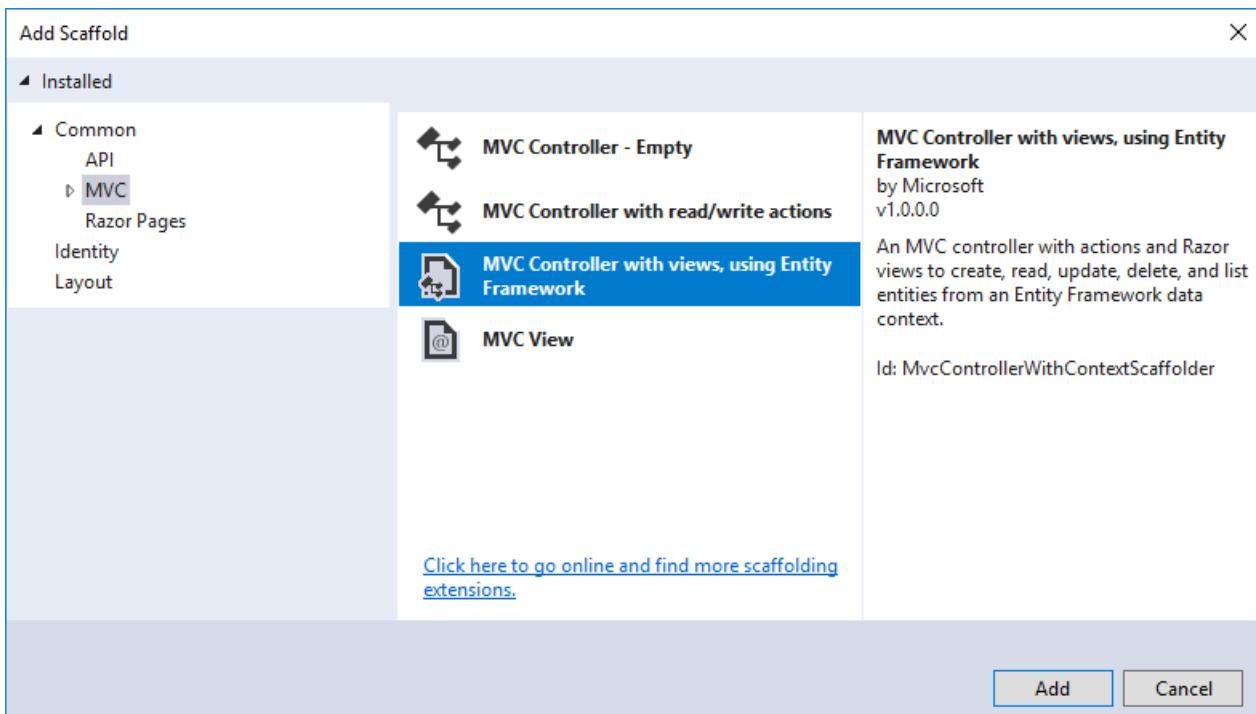
Build the project to verify you don't have any errors. You now have a **Model** in your **MVC** app.

## Scaffolding a controller

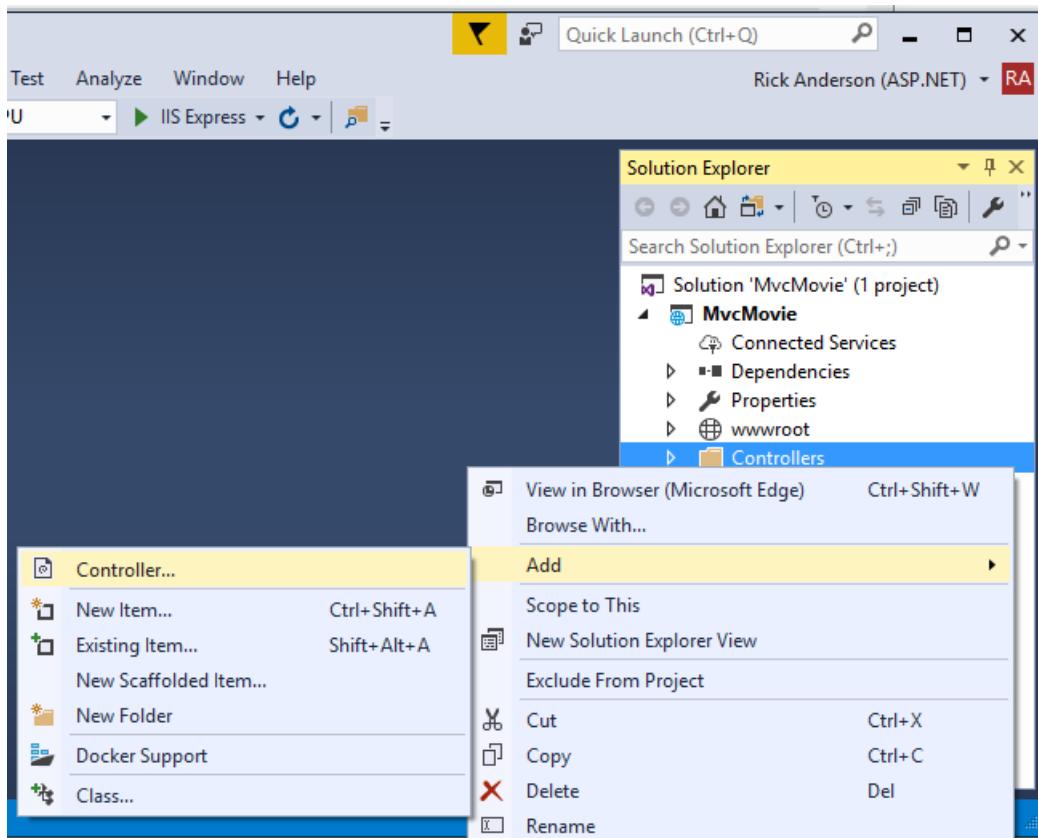
In **Solution Explorer**, right-click the *Controllers* folder > **Add** > **New Scaffolded Item**.



In the **Add Scaffold** dialog, tap **MVC Controller with views, using Entity Framework > Add**.



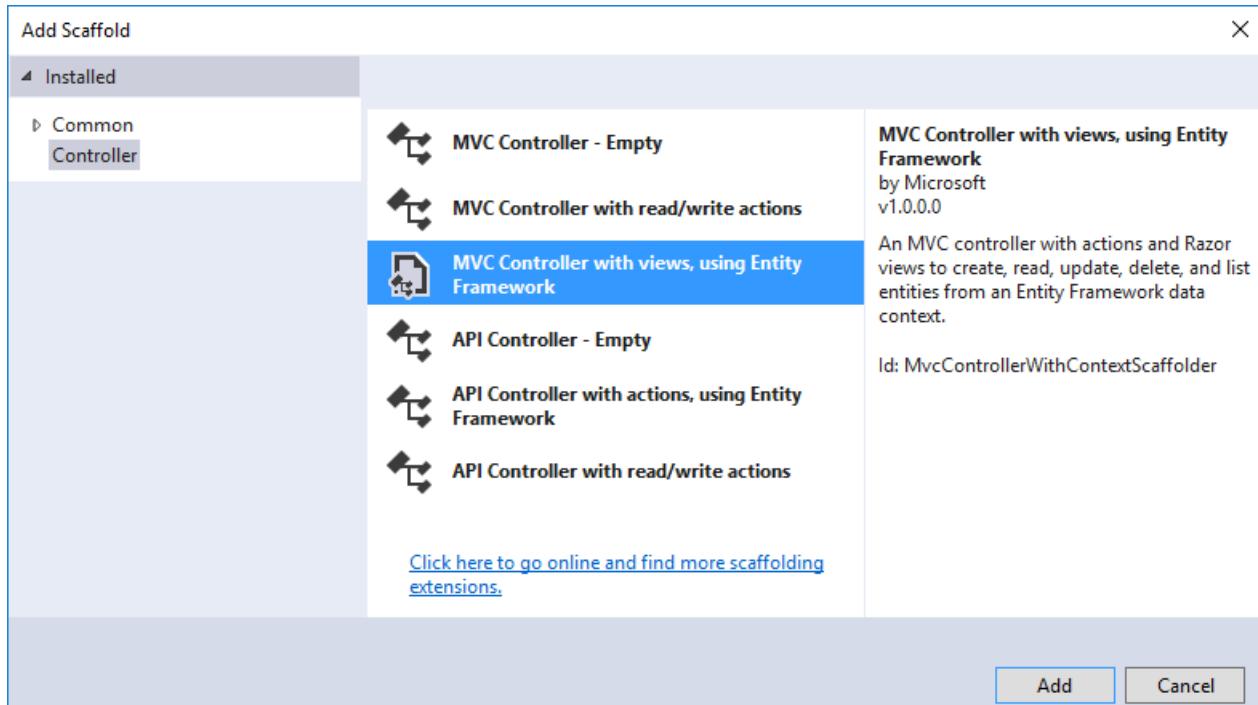
In **Solution Explorer**, right-click the *Controllers* folder > **Add > Controller**.



If the **Add MVC Dependencies** dialog appears:

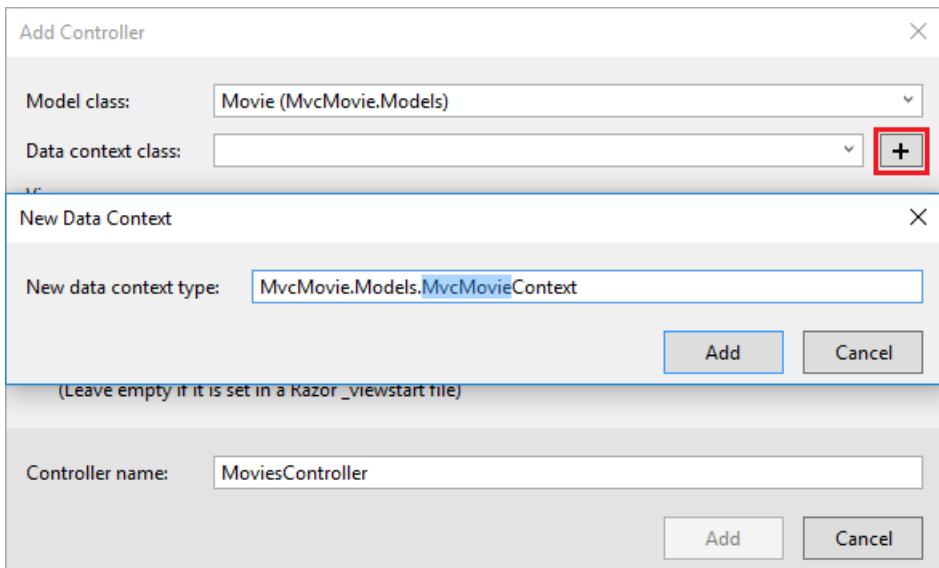
- [Update Visual Studio to the latest version](#). Visual Studio versions prior to 15.5 show this dialog.
- If you can't update, select **ADD**, and then follow the add controller steps again.

In the **Add Scaffold** dialog, tap **MVC Controller with views, using Entity Framework > Add**.

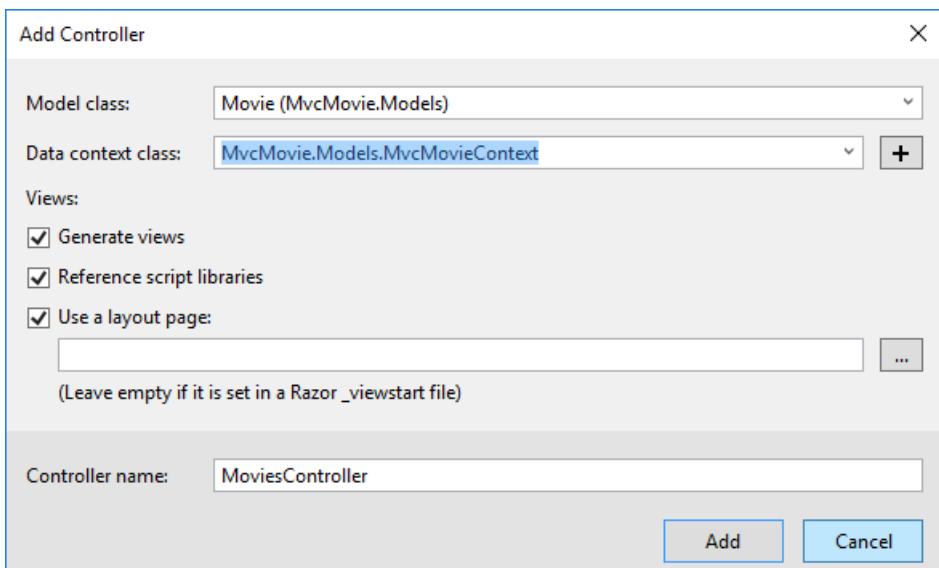


Complete the **Add Controller** dialog:

- **Model class:** Movie (`MvcMovie.Models.Movie`)
- **Data context class:** Select the + icon and add the default `MvcMovie.Models.MvcMovieContext`



- **Views:** Keep the default of each option checked
- **Controller name:** Keep the default *MoviesController*
- Tap **Add**



Visual Studio creates:

- An Entity Framework Core **database context class** (*Data/MvcMovieContext.cs*)
- A movies controller (*Controllers/MoviesController.cs*)
- Razor view files for Create, Delete, Details, Edit, and Index pages (*Views/Movies/\*.cshtml*)

The automatic creation of the database context and **CRUD** (create, read, update, and delete) action methods and views is known as *scaffolding*. You'll soon have a fully functional web application that lets you manage a movie database.

If you run the app and click on the **Mvc Movie** link, you get an error similar to the following:

```
An unhandled exception occurred while processing the request.

SqlException: Cannot open database "MvcMovieContext-<GUID removed>" requested by the login. The login failed.
Login failed for user 'Rick'.

System.Data.SqlClient.SqlInternalConnectionTds..ctor(DbConnectionPoolIdentity identity, SqlConnectionString
```

You need to create the database, and you'll use the EF Core **Migrations** feature to do that. Migrations lets you

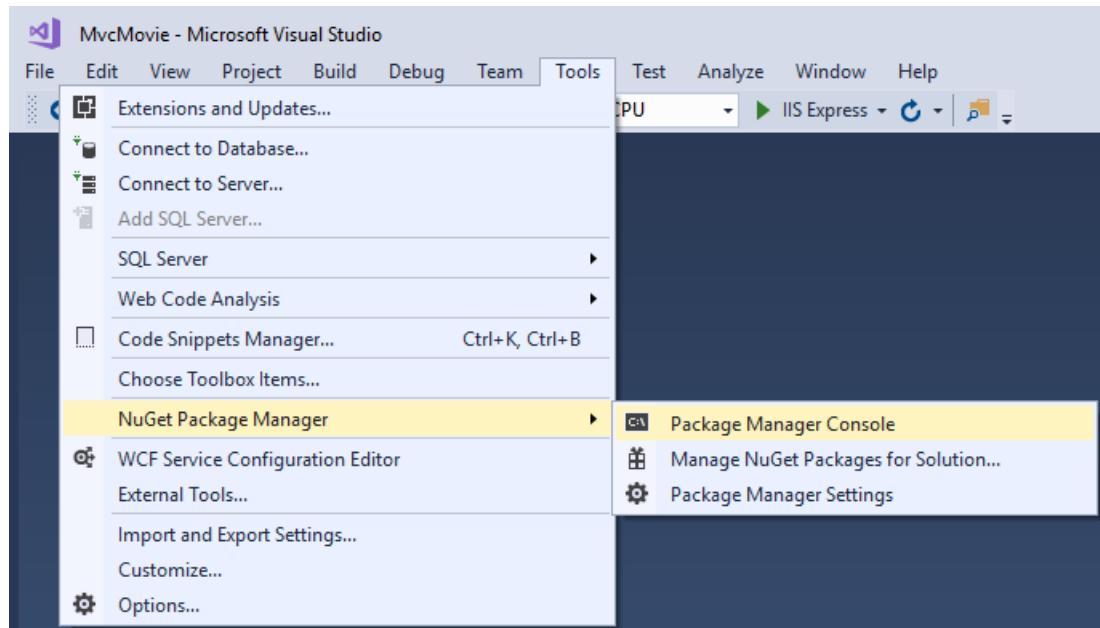
create a database that matches your data model and update the database schema when your data model changes.

## Add EF tooling and perform initial migration

In this section you'll use the Package Manager Console (PMC) to:

- Add the Entity Framework Core Tools package. This package is required to add migrations and update the database.
- Add an initial migration.
- Update the database with the initial migration.

From the **Tools** menu, select **NuGet Package Manager > Package Manager Console**.



In the PMC, enter the following commands:

```
Add-Migration Initial  
Update-Database
```

Ignore the following error message, we fix it in the next tutorial:

```
Microsoft.EntityFrameworkCore.Model.Validation[30000]  
No type was specified for the decimal column 'Price' on entity type 'Movie'. This will cause values to be silently truncated if they do not fit in the default precision and scale. Explicitly specify the SQL server column type that can accommodate all the values using 'ForHasColumnType()'.
```

```
Install-Package Microsoft.EntityFrameworkCore.Tools  
Add-Migration Initial  
Update-Database
```

**Note:** If you receive an error with the `Install-Package` command, open NuGet Package Manager and search for the `Microsoft.EntityFrameworkCore.Tools` package. This allows you to install the package or check if it's already installed. Alternatively, see the [CLI approach](#) if you have problems with the PMC.

The `Add-Migration` command creates code to create the initial database schema. The schema is based on the model specified in the `DbContext` (In the `Data/MvcMovieContext.cs` file). The `Initial` argument is used to name the migrations. You can use any name, but by convention you choose a name that describes the migration. See [Introduction to migrations](#) for more information.

The `Update-Database` command runs the `Up` method in the *Migrations/<time-stamp>\_Initial.cs* file, which creates the database.

You can perform the preceding steps using the command-line interface (CLI) rather than the PMC:

- Add [EF Core tooling](#) to the *.csproj* file.
- Run the following commands from the console (in the project directory):

```
dotnet ef migrations add Initial  
dotnet ef database update
```

If you run the app and get the error:

```
SqlException: Cannot open database "Movie" requested by the login.  
The login failed.  
Login failed for user 'user name'.
```

You probably have not run `dotnet ef database update`.

## Test the app

- Run the app and tap the **Mvc Movie** link.
- Tap the **Create New** link and create a movie.

The screenshot shows a browser window titled "Create - Movie App" with the URL "localhost:1234/Movies/". The page is titled "MvcMovie" and has a header "Create". The form is for creating a "Movie" with fields: "Title" (Conan), "Release Date" (3/3/2017), "Genre" (Comedy), and "Price" (1.99). A "Create" button is at the bottom.

- You may not be able to enter decimal points or commas in the `Price` field. To support [jQuery validation](#) for non-English locales that use a comma (",") for a decimal point, and non US-English date formats, you must take steps to globalize your app. See <https://github.com/aspnet/Docs/issues/4076> and [Additional resources](#) for more information. For now, just enter whole numbers like 10.
- In some locales you need to specify the date format. See the highlighted code below.

```
using System;
using System.ComponentModel.DataAnnotations;

namespace MvcMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}
```

We'll talk about `DataAnnotations` later in the tutorial.

Tapping **Create** causes the form to be posted to the server, where the movie information is saved in a database. The app redirects to the /Movies URL, where the newly created movie information is displayed.

The screenshot shows a browser window titled "Index - Movie App". The address bar says "localhost:1234/Movies". The main content area is titled "MvcMovie" and has a heading "Index". Below the heading is a link "Create New". A table lists one movie entry:

Title	Release Date	Genre	Price
Conan	3/3/2017	Comedy	\$1.99

Below the table is a copyright notice: © 2017 - MvcMovie.

Create a couple more movie entries. Try the **Edit**, **Details**, and **Delete** links, which are all functional.

```
public void ConfigureServices(IServiceCollection services)
{
    services.Configure<CookiePolicyOptions>(options =>
    {
        // This lambda determines whether user consent for non-essential cookies is needed for a given
        request.
        options.CheckConsentNeeded = context => true;
        options.MinimumSameSitePolicy = SameSiteMode.None;
    });

    services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1);

    services.AddDbContext<MvcMovieContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("MvcMovieContext")));
}
```

```
public void ConfigureServices(IServiceCollection services)
{
    // Add framework services.
    services.AddMvc();

    services.AddDbContext<MvcMovieContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("MvcMovieContext")));
}
```

The highlighted code above shows the movie database context being added to the [Dependency Injection](#) container (In the *Startup.cs* file). `services.AddDbContext<MvcMovieContext>(options =>` specifies the database to use and the connection string. `=>` is a [lambda operator](#).

Open the *Controllers/MoviesController.cs* file and examine the constructor:

```
public class MoviesController : Controller
{
    private readonly MvcMovieContext _context;

    public MoviesController(MvcMovieContext context)
    {
        _context = context;
    }
}
```

The constructor uses [Dependency Injection](#) to inject the database context (`MvcMovieContext`) into the controller. The database context is used in each of the [CRUD](#) methods in the controller.

## Strongly typed models and the `@model` keyword

Earlier in this tutorial, you saw how a controller can pass data or objects to a view using the `ViewData` dictionary. The `ViewData` dictionary is a dynamic object that provides a convenient late-bound way to pass information to a view.

MVC also provides the ability to pass strongly typed model objects to a view. This strongly typed approach enables better compile-time checking of your code. The scaffolding mechanism used this approach (that is, passing a strongly typed model) with the `MoviesController` class and views when it created the methods and views.

Examine the generated `Details` method in the `Controllers/MoviesController.cs` file:

```
// GET: Movies/Details/5
public async Task<IActionResult> Details(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie
        .FirstOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }

    return View(movie);
}
```

```
// GET: Movies/Details/5
public async Task<IActionResult> Details(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie
        .SingleOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }

    return View(movie);
}
```

The `id` parameter is generally passed as route data. For example `http://localhost:5000/movies/details/1` sets:

- The controller to the `movies` controller (the first URL segment).
- The action to `details` (the second URL segment).
- The id to 1 (the last URL segment).

You can also pass in the `id` with a query string as follows:

```
http://localhost:1234/movies/details?id=1
```

The `id` parameter is defined as a [nullable type](#) (`int?`) in case an ID value isn't provided.

A [lambda expression](#) is passed in to `FirstOrDefaultAsync` to select movie entities that match the route data or query string value.

```
var movie = await _context.Movie
    .FirstOrDefaultAsync(m => m.ID == id);
```

A [lambda expression](#) is passed in to `SingleOrDefaultAsync` to select movie entities that match the route data or query string value.

```
var movie = await _context.Movie
    .SingleOrDefaultAsync(m => m.ID == id);
```

If a movie is found, an instance of the `Movie` model is passed to the `Details` view:

```
return View(movie);
```

Examine the contents of the `Views/Movies/Details.cshtml` file:

```

@model MvcMovie.Models.Movie

 @{
    ViewData["Title"] = "Details";
}

<h2>Details</h2>

<div>
    <h4>Movie</h4>
    <hr />
    <dl class="dl-horizontal">
        <dt>
            @Html.DisplayNameFor(model => model.Title)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Title)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.ReleaseDate)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.ReleaseDate)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Genre)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Genre)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Price)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Price)
        </dd>
    </dl>
</div>
<div>
    <a asp-action="Edit" asp-route-id="@Model.ID">Edit</a> |
    <a asp-action="Index">Back to List</a>
</div>

```

By including a `@model` statement at the top of the view file, you can specify the type of object that the view expects. When you created the movie controller, Visual Studio automatically included the following `@model` statement at the top of the *Details.cshtml* file:

```

@model MvcMovie.Models.Movie

```

This `@model` directive allows you to access the movie that the controller passed to the view by using a `Model` object that's strongly typed. For example, in the *Details.cshtml* view, the code passes each movie field to the `DisplayNameFor` and `DisplayFor` HTML Helpers with the strongly typed `Model` object. The `Create` and `Edit` methods and views also pass a `Movie` model object.

Examine the *Index.cshtml* view and the `Index` method in the *Movies* controller. Notice how the code creates a `List` object when it calls the `View` method. The code passes this `Movies` list from the `Index` action method to the view:

```
// GET: Movies
public async Task<IActionResult> Index()
{
    return View(await _context.Movie.ToListAsync());
}
```

When you created the movies controller, scaffolding automatically included the following `@model` statement at the top of the *Index.cshtml* file:

```
@model IEnumerable<MvcMovie.Models.Movie>
```

The `@model` directive allows you to access the list of movies that the controller passed to the view by using a `Model` object that's strongly typed. For example, in the *Index.cshtml* view, the code loops through the movies with a `foreach` statement over the strongly typed `Model` object:

```

@model IEnumerable<MvcMovie.Models.Movie>

 @{
    ViewData["Title"] = "Index";
}

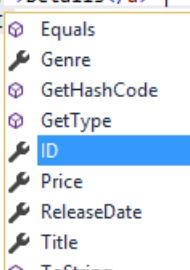
<h2>Index</h2>

<p>
    <a asp-action="Create">Create New</a>
</p>
<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.ReleaseDate)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Genre)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Price)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
@foreach (var item in Model) {
        <tr>
            <td>
                @Html.DisplayFor(modelItem => item.Title)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.ReleaseDate)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.Genre)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.Price)
            </td>
            <td>
                <a asp-action="Edit" asp-route-id="@item.ID">Edit</a> |
                <a asp-action="Details" asp-route-id="@item.ID">Details</a> |
                <a asp-action="Delete" asp-route-id="@item.ID">Delete</a>
            </td>
        </tr>
}
    </tbody>
</table>

```

Because the `Model` object is strongly typed (as an `IEnumerable<Movie>` object), each item in the loop is typed as `Movie`. Among other benefits, this means that you get compile-time checking of the code:

```
@foreach (var item in Model) {
    <tr>
        <td>
            @Html.DisplayFor(modelItem => item.Genre)
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.Price)
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.ReleaseDate)
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.Title)
        </td>
        <td>
            <a asp-action="Edit" asp-route-id="@item.ID">Edit</a> | 
            <a asp-action="Details" asp-route-id="@item.ID">Details</a> | 
            <a asp-action="Delete" asp-route-id="@item.ID">Delete</a>
        </td>
    </tr>
}
</table>
```



## Additional resources

- [Tag Helpers](#)
- [Globalization and localization](#)

PREVIOUS ADDING A

VIEW

NEXT WORKING WITH

SQL

# Work with SQL Server LocalDB in ASP.NET Core

7/6/2018 • 3 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

The `MvcMovieContext` object handles the task of connecting to the database and mapping `Movie` objects to database records. The database context is registered with the [Dependency Injection](#) container in the `ConfigureServices` method in the `Startup.cs` file:

```
public void ConfigureServices(IServiceCollection services)
{
    services.Configure<CookiePolicyOptions>(options =>
    {
        // This lambda determines whether user consent for non-essential cookies is needed for a given
        request.
        options.CheckConsentNeeded = context => true;
        options.MinimumSameSitePolicy = SameSiteMode.None;
    });

    services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1);

    services.AddDbContext<MvcMovieContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("MvcMovieContext")));
}
```

```
public void ConfigureServices(IServiceCollection services)
{
    // Add framework services.
    services.AddMvc();

    services.AddDbContext<MvcMovieContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("MvcMovieContext")));
}
```

The ASP.NET Core [Configuration](#) system reads the `ConnectionString`. For local development, it gets the connection string from the `appsettings.json` file:

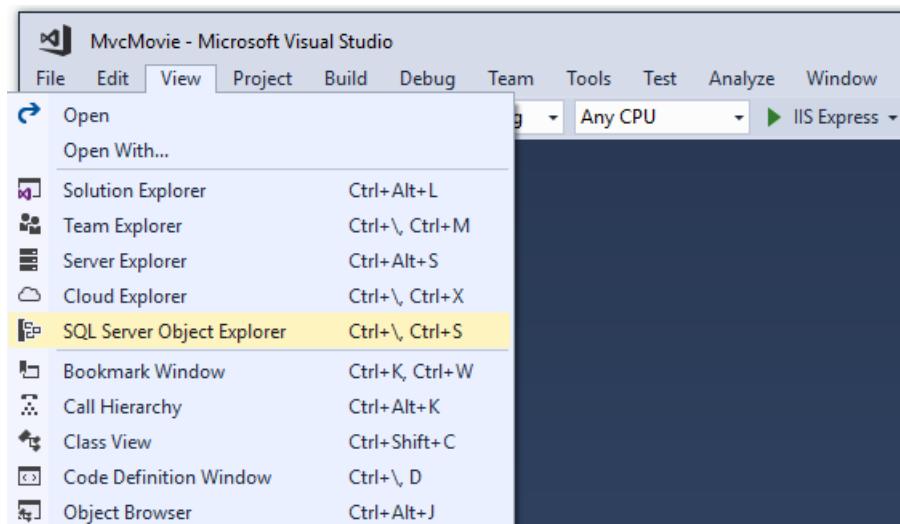
```
"ConnectionStrings": {
    "MvcMovieContext": "Server=(localdb)\\mssqllocaldb;Database=MvcMovieContext-
    2;Trusted_Connection=True;MultipleActiveResultSets=true"
}
```

When you deploy the app to a test or production server, you can use an environment variable or another approach to set the connection string to a real SQL Server. See [Configuration](#) for more information.

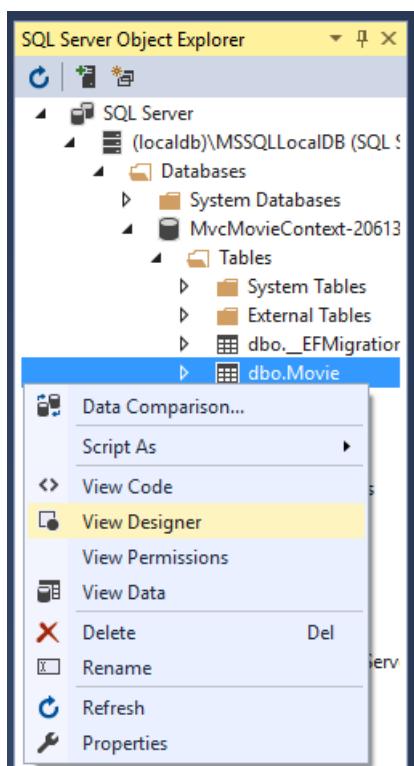
## SQL Server Express LocalDB

LocalDB is a lightweight version of the SQL Server Express Database Engine that's targeted for program development. LocalDB starts on demand and runs in user mode, so there's no complex configuration. By default, LocalDB database creates ".mdf" files in the `C:/Users/<user>` directory.

- From the **View** menu, open **SQL Server Object Explorer** (SSOX).



- Right click on the `Movie` table > **View Designer**



**dbo.Movie [Design]**

**Update | Script File: dbo.Movie.sql**

	Name	Data Type	Allow Nulls
PK	ID	int	<input type="checkbox"/>
	Genre	nvarchar(MAX)	<input checked="" type="checkbox"/>
	Price	decimal(18,2)	<input type="checkbox"/>
	ReleaseDate	datetime2(7)	<input type="checkbox"/>
	Title	nvarchar(MAX)	<input checked="" type="checkbox"/>
			<input type="checkbox"/>

**Keys (1)**  
PK\_Movie (Primary Key, Clustered: 1)

**Check Constraints (0)**

**Indexes (0)**

**Foreign Keys (0)**

**Triggers (0)**

**T-SQL**

```

1 CREATE TABLE [dbo].[Movie] (
2     [ID] INT IDENTITY (1, 1) NOT NULL,
3     [Genre] NVARCHAR (MAX) NULL,
4     [Price] DECIMAL (18, 2) NOT NULL,
5     [ReleaseDate] DATETIME2 (7) NOT NULL,
6     [Title] NVARCHAR (MAX) NULL,
7     CONSTRAINT [PK_Movie] PRIMARY KEY CLUSTERED ([ID] ASC)
8 );
9

```

100 %

Connection Ready (localdb)\MSSQLLocalDB REDMOND\riande aspnet5-MvcMovie-8f261...

Note the key icon next to `ID`. By default, EF will make a property named `ID` the primary key.

- Right click on the `Movie` table > **View Data**

**SQL Server Object Explorer**

**SQL Server**

(localdb)\MSSQLLocalDB (SQL Server Database)

Databases

System Databases

MvcMovieContext-20613

Tables

System Tables

External Tables

dbo.\_EFMigration

dbo.Movie

**View Data**

**Properties**

The screenshot shows the 'MvcMovie' project in Microsoft Visual Studio. The 'dbo.Movie' table is open in the 'Data' view. The table structure is as follows:

	ID	Genre	Price	ReleaseDate	Title
▶	1	Comedy	1.99	11/18/2015 12:0...	When Harry Me...
▶	2	Comedy	2.99	1/11/2016 12:00...	Ghost Busters IV
*	3	Comedy	3.99	12/11/2015 12:0...	Ghost Busters 7
*	NULL	NULL	NULL	NULL	NULL

Below the table, the connection information is shown: Connection Re... | (localdb)\MSSQLLocalDB | REDMOND\riande | aspnet5-MvcMovie-8f261... . The status bar at the bottom indicates 3 Rows | Cell is Read Only | Ln 1 | Col 1.

## Seed the database

Create a new class named `SeedData` in the *Models* folder. Replace the generated code with the following:

```

using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using System;
using System.Linq;

namespace MvcMovie.Models
{
    public static class SeedData
    {
        public static void Initialize(IServiceProvider serviceProvider)
        {
            using (var context = new MvcMovieContext(
                serviceProvider.GetRequiredService<DbContextOptions<MvcMovieContext>>()))
            {
                // Look for any movies.
                if (context.Movie.Any())
                {
                    return; // DB has been seeded
                }

                context.Movie.AddRange(
                    new Movie
                    {
                        Title = "When Harry Met Sally",
                        ReleaseDate = DateTime.Parse("1989-1-11"),
                        Genre = "Romantic Comedy",
                        Price = 7.99M
                    },
                    new Movie
                    {
                        Title = "Ghostbusters ",
                        ReleaseDate = DateTime.Parse("1984-3-13"),
                        Genre = "Comedy",
                        Price = 8.99M
                    },
                    new Movie
                    {
                        Title = "Ghostbusters 2",
                        ReleaseDate = DateTime.Parse("1986-2-23"),
                        Genre = "Comedy",
                        Price = 9.99M
                    },
                    new Movie
                    {
                        Title = "Rio Bravo",
                        ReleaseDate = DateTime.Parse("1959-4-15"),
                        Genre = "Western",
                        Price = 3.99M
                    }
                );
                context.SaveChanges();
            }
        }
    }
}

```

If there are any movies in the DB, the seed initializer returns and no movies are added.

```
if (context.Movie.Any())
{
    return; // DB has been seeded.
}
```

## Add the seed initializer

Replace the contents of *Program.cs* with the following code:

```
using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;
using System;
using Microsoft.EntityFrameworkCore;
using MvcMovie.Models;
using MvcMovie;

namespace MvcMovie
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = CreateWebHostBuilder(args).Build();

            using (var scope = host.Services.CreateScope())
            {
                var services = scope.ServiceProvider;

                try
                {
                    var context = services.GetRequiredService<MvcMovieContext>();
                    context.Database.Migrate();
                    SeedData.Initialize(services);
                }
                catch (Exception ex)
                {
                    var logger = services.GetRequiredService<ILogger<Program>>();
                    logger.LogError(ex, "An error occurred seeding the DB.");
                }
            }

            host.Run();
        }

        public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>();
    }
}
```

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

Add the seed initializer to the `Main` method in the *Program.cs* file:

```

using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;
using MvcMovie.Models;
using System;

namespace MvcMovie
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = BuildWebHost(args);

            using (var scope = host.Services.CreateScope())
            {
                var services = scope.ServiceProvider;

                try
                {
                    // Requires using MvcMovie.Models;
                    SeedData.Initialize(services);
                }
                catch (Exception ex)
                {
                    var logger = services.GetRequiredService<ILogger<Program>>();
                    logger.LogError(ex, "An error occurred seeding the DB.");
                }
            }

            host.Run();
        }

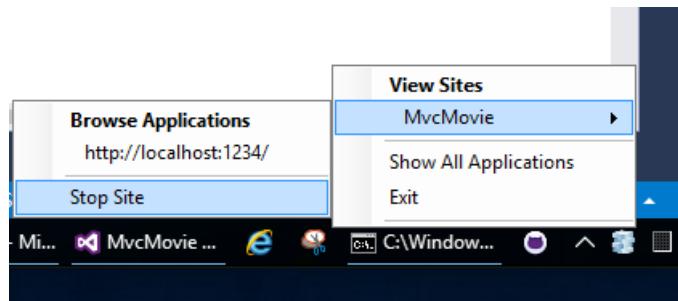
        public static IWebHost BuildWebHost(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>()
                .Build();
    }
}

```

## Test the app

- Delete all the records in the DB. You can do this with the delete links in the browser or from SSOX.
- Force the app to initialize (call the methods in the `Startup` class) so the seed method runs. To force initialization, IIS Express must be stopped and restarted. You can do this with any of the following approaches:
  - Right click the IIS Express system tray icon in the notification area and tap **Exit** or **Stop Site**





- o If you were running VS in non-debug mode, press F5 to run in debug mode
- o If you were running VS in debug mode, stop the debugger and press F5

The app shows the seeded data.

A screenshot of a Microsoft Edge browser window. The title bar says '- Movie App' and the address bar shows 'localhost:5000/Movies'. The main content area displays a table titled 'Create New' with four columns: 'Title', 'ReleaseDate', 'Genre', and 'Price'. There are four rows of data:

Title	ReleaseDate	Genre	Price
When Harry Met Sally	1/11/1989 12:00:00 AM	Romantic Comedy	7.99
Ghostbusters	3/13/1984 12:00:00 AM	Comedy	8.99
Ghostbusters 2	2/23/1986 12:00:00 AM	Comedy	9.99

Each row has 'Edit | Details | Delete' links. At the bottom of the page, it says '© 2017 - MvcMovie'.

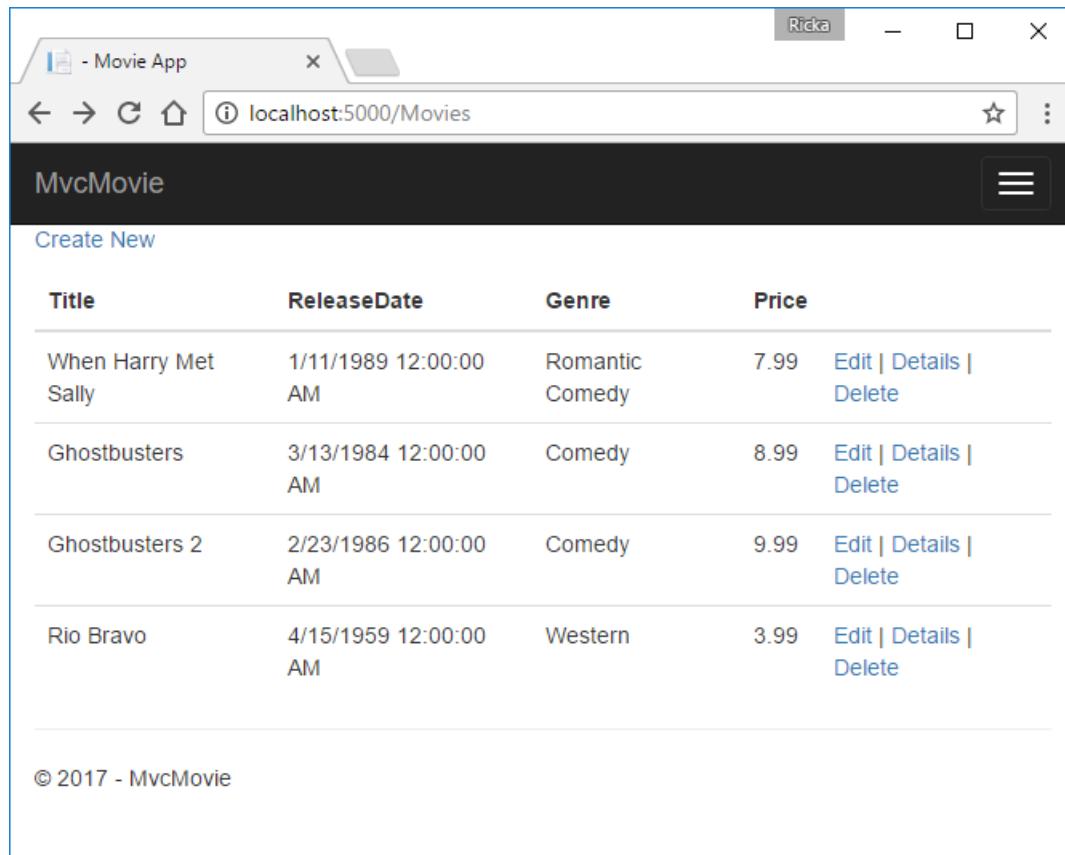
[PREVIOUS](#) [NEXT](#)

# Controller methods and views in ASP.NET Core

6/21/2018 • 10 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

We have a good start to the movie app, but the presentation isn't ideal. We don't want to see the time (12:00:00 AM in the image below) and **ReleaseDate** should be two words.



The screenshot shows a browser window titled "Movie App" with the URL "localhost:5000/Movies". The page is titled "MvcMovie" and has a "Create New" link. Below is a table listing four movies:

Title	ReleaseDate	Genre	Price	
When Harry Met Sally	1/11/1989 12:00:00 AM	Romantic Comedy	7.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Ghostbusters	3/13/1984 12:00:00 AM	Comedy	8.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Ghostbusters 2	2/23/1986 12:00:00 AM	Comedy	9.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Rio Bravo	4/15/1959 12:00:00 AM	Western	3.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

At the bottom left, it says "© 2017 - MvcMovie".

Open the *Models/Movie.cs* file and add the highlighted lines shown below:

```
using System;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace MvcMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }

        [Display(Name = "Release Date")]
        [DataType(DataType.Date)]
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }

        [Column(TypeName = "decimal(18, 2)")]
        public decimal Price { get; set; }
    }
}
```

```

using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;

namespace MvcMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }

        [Display(Name = "Release Date")]
        [DataType(DataType.Date)]
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}

```

We cover [DataAnnotations](#) in the next tutorial. The [Display](#) attribute specifies what to display for the name of a field (in this case "Release Date" instead of "ReleaseDate"). The [DataType](#) attribute specifies the type of the data (Date), so the time information stored in the field isn't displayed.

The `[Column(TypeName = "decimal(18, 2)")]` data annotation is required so Entity Framework Core can correctly map `Price` to currency in the database. For more information, see [Data Types](#).

Browse to the `Movies` controller and hold the mouse pointer over an **Edit** link to see the target URL.

Genre	Price	Release Date	Title	
Romantic Comedy	7.99	1/11/1989	When Harry Met Sally	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	8.99	3/13/1984	Ghostbusters	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	9.99	2/23/1986	Ghostbusters 2	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Western	3.99	4/15/1959	Rio Bravo	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

© 2016 - MvcMovie

<http://localhost:1234/Movies/Edit/5>

The **Edit**, **Details**, and **Delete** links are generated by the Core MVC Anchor Tag Helper in the `Views/Movies/Index.cshtml` file.

```
<a asp-action="Edit" asp-route-id="@item.ID">Edit</a> |  
<a asp-action="Details" asp-route-id="@item.ID">Details</a> |  
<a asp-action="Delete" asp-route-id="@item.ID">Delete</a>  
</td>  
</tr>
```

Tag Helpers enable server-side code to participate in creating and rendering HTML elements in Razor files. In the code above, the `AnchorTagHelper` dynamically generates the HTML `href` attribute value from the controller action method and route id. You use **View Source** from your favorite browser or use the developer tools to examine the generated markup. A portion of the generated HTML is shown below:

```
<td>  
  <a href="/Movies/Edit/4"> Edit </a> |  
  <a href="/Movies/Details/4"> Details </a> |  
  <a href="/Movies/Delete/4"> Delete </a>  
</td>
```

Recall the format for **routing** set in the *Startup.cs* file:

```
app.UseMvc(routes =>  
{  
    routes.MapRoute(  
        name: "default",  
        template: "{controller=Home}/{action=Index}/{id?}");  
});
```

ASP.NET Core translates `http://localhost:1234/Movies/Edit/4` into a request to the `Edit` action method of the `Movies` controller with the parameter `Id` of 4. (Controller methods are also known as action methods.)

Tag Helpers are one of the most popular new features in ASP.NET Core. See [Additional resources](#) for more information.

Open the `Movies` controller and examine the two `Edit` action methods. The following code shows the `HTTP GET Edit` method, which fetches the movie and populates the edit form generated by the *Edit.cshtml* Razor file.

```
// GET: Movies/Edit/5  
public async Task<IActionResult> Edit(int? id)  
{  
    if (id == null)  
    {  
        return NotFound();  
    }  
  
    var movie = await _context.Movie.FindAsync(id);  
    if (movie == null)  
    {  
        return NotFound();  
    }  
    return View(movie);  
}
```

The following code shows the `HTTP POST Edit` method, which processes the posted movie values:

```

// POST: Movies/Edit/5
// To protect from overposting attacks, please enable the specific properties you want to bind to, for
// more details see http://go.microsoft.com/fwlink/?LinkId=317598.
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction("Index");
    }
    return View(movie);
}

```

```

// GET: Movies/Edit/5
public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }
    return View(movie);
}

```

The following code shows the `HTTP POST Edit` method, which processes the posted movie values:

```

// POST: Movies/Edit/5
// To protect from overposting attacks, please enable the specific properties you want to bind to, for
// more details see http://go.microsoft.com/fwlink/?LinkId=317598.
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction("Index");
    }
    return View(movie);
}

```

The `[Bind]` attribute is one way to protect against [over-posting](#). You should only include properties in the `[Bind]` attribute that you want to change. See [Protect your controller from over-posting](#) for more information.

[ViewModels](#) provide an alternative approach to prevent over-posting.

Notice the second `Edit` action method is preceded by the `[HttpPost]` attribute.

```
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction(nameof(Index));
    }
    return View(movie);
}
```

```

// POST: Movies/Edit/5
// To protect from overposting attacks, please enable the specific properties you want to bind to, for
// more details see http://go.microsoft.com/fwlink/?LinkId=317598.
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction("Index");
    }
    return View(movie);
}

```

The `[HttpPost]` attribute specifies that this `Edit` method can be invoked *only* for `POST` requests. You could apply the `[HttpGet]` attribute to the first edit method, but that's not necessary because `[HttpGet]` is the default.

The `[ValidateAntiForgeryToken]` attribute is used to [prevent forgery of a request](#) and is paired up with an anti-forgery token generated in the edit view file (`Views/Movies/Edit.cshtml`). The edit view file generates the anti-forgery token with the [Form Tag Helper](#).

```
<form asp-action="Edit">
```

The [Form Tag Helper](#) generates a hidden anti-forgery token that must match the `[ValidateAntiForgeryToken]` generated anti-forgery token in the `Edit` method of the Movies controller. For more information, see [Anti-Request Forgery](#).

The `[HttpGet Edit]` method takes the movie `ID` parameter, looks up the movie using the Entity Framework `SingleOrDefaultAsync` method, and returns the selected movie to the Edit view. If a movie cannot be found, `NotFound` (HTTP 404) is returned.

```
// GET: Movies/Edit/5
public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie.FindAsync(id);
    if (movie == null)
    {
        return NotFound();
    }
    return View(movie);
}
```

```
// GET: Movies/Edit/5
public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }
    return View(movie);
}
```

When the scaffolding system created the Edit view, it examined the `Movie` class and created code to render `<label>` and `<input>` elements for each property of the class. The following example shows the Edit view that was generated by the Visual Studio scaffolding system:

```

@model MvcMovie.Models.Movie

 @{
     ViewData["Title"] = "Edit";
 }

<h2>Edit</h2>

<form asp-action="Edit">
    <div class="form-horizontal">
        <h4>Movie</h4>
        <hr />
        <div asp-validation-summary="ModelOnly" class="text-danger"></div>
        <input type="hidden" asp-for="ID" />
        <div class="form-group">
            <label asp-for="Title" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="Title" class="form-control" />
                <span asp-validation-for="Title" class="text-danger"></span>
            </div>
        </div>
        <div class="form-group">
            <label asp-for="ReleaseDate" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="ReleaseDate" class="form-control" />
                <span asp-validation-for="ReleaseDate" class="text-danger"></span>
            </div>
        </div>
        <div class="form-group">
            <label asp-for="Genre" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="Genre" class="form-control" />
                <span asp-validation-for="Genre" class="text-danger"></span>
            </div>
        </div>
        <div class="form-group">
            <label asp-for="Price" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="Price" class="form-control" />
                <span asp-validation-for="Price" class="text-danger"></span>
            </div>
        </div>
        <div class="form-group">
            <div class="col-md-offset-2 col-md-10">
                <input type="submit" value="Save" class="btn btn-default" />
            </div>
        </div>
    </div>
</form>

<div>
    <a asp-action="Index">Back to List</a>
</div>

@section Scripts {
    @{await Html.RenderPartialAsync("_ValidationScriptsPartial");}
}

```

Notice how the view template has a `@model MvcMovie.Models.Movie` statement at the top of the file.

`@model MvcMovie.Models.Movie` specifies that the view expects the model for the view template to be of type `Movie`.

The scaffolded code uses several Tag Helper methods to streamline the HTML markup. The - [Label Tag Helper](#) displays the name of the field ("Title", "ReleaseDate", "Genre", or "Price"). The [Input Tag Helper](#) renders an HTML `<input>` element. The [Validation Tag Helper](#) displays any validation messages associated with that property.

Run the application and navigate to the `/Movies` URL. Click an **Edit** link. In the browser, view the source for the page. The generated HTML for the `<form>` element is shown below.

```
<form action="/Movies/Edit/7" method="post">
    <div class="form-horizontal">
        <h4>Movie</h4>
        <hr />
        <div class="text-danger" />
        <input type="hidden" data-val="true" data-val-required="The ID field is required." id="ID" name="ID" value="7" />
        <div class="form-group">
            <label class="control-label col-md-2" for="Genre" />
            <div class="col-md-10">
                <input class="form-control" type="text" id="Genre" name="Genre" value="Western" />
                <span class="text-danger field-validation-valid" data-valmsg-for="Genre" data-valmsg-replace="true"></span>
            </div>
        </div>
        <div class="form-group">
            <label class="control-label col-md-2" for="Price" />
            <div class="col-md-10">
                <input class="form-control" type="text" data-val="true" data-val-number="The field Price must be a number." data-val-required="The Price field is required." id="Price" name="Price" value="3.99" />
                <span class="text-danger field-validation-valid" data-valmsg-for="Price" data-valmsg-replace="true"></span>
            </div>
        </div>
        <!-- Markup removed for brevity -->
        <div class="form-group">
            <div class="col-md-offset-2 col-md-10">
                <input type="submit" value="Save" class="btn btn-default" />
            </div>
        </div>
    </div>
    <input name="__RequestVerificationToken" type="hidden" value="CfDJ8Inyxp63fRFqUePGvuI5jGZsloJu1L7X9le1gy7NCI1SduCRx9jDQC1rV9pOTTmqUyXnJBXhmrjcUVDJyDUMm7-MF_9rK8aAZdRdl0ri7FmKVkRe_2v5LIHGKFcTjPrWPYnc9AdSbomki0SaTEg7RU" />
</form>
```

The `<input>` elements are in an `HTML <form>` element whose `action` attribute is set to post to the `/Movies/Edit/id` URL. The form data will be posted to the server when the `Save` button is clicked. The last line before the closing `</form>` element shows the hidden **XSRF** token generated by the [Form Tag Helper](#).

## Processing the POST Request

The following listing shows the `[HttpPost]` version of the `Edit` action method.

```
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction(nameof(Index));
    }
    return View(movie);
}
```

```

// POST: Movies/Edit/5
// To protect from overposting attacks, please enable the specific properties you want to bind to, for
// more details see http://go.microsoft.com/fwlink/?LinkId=317598.
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

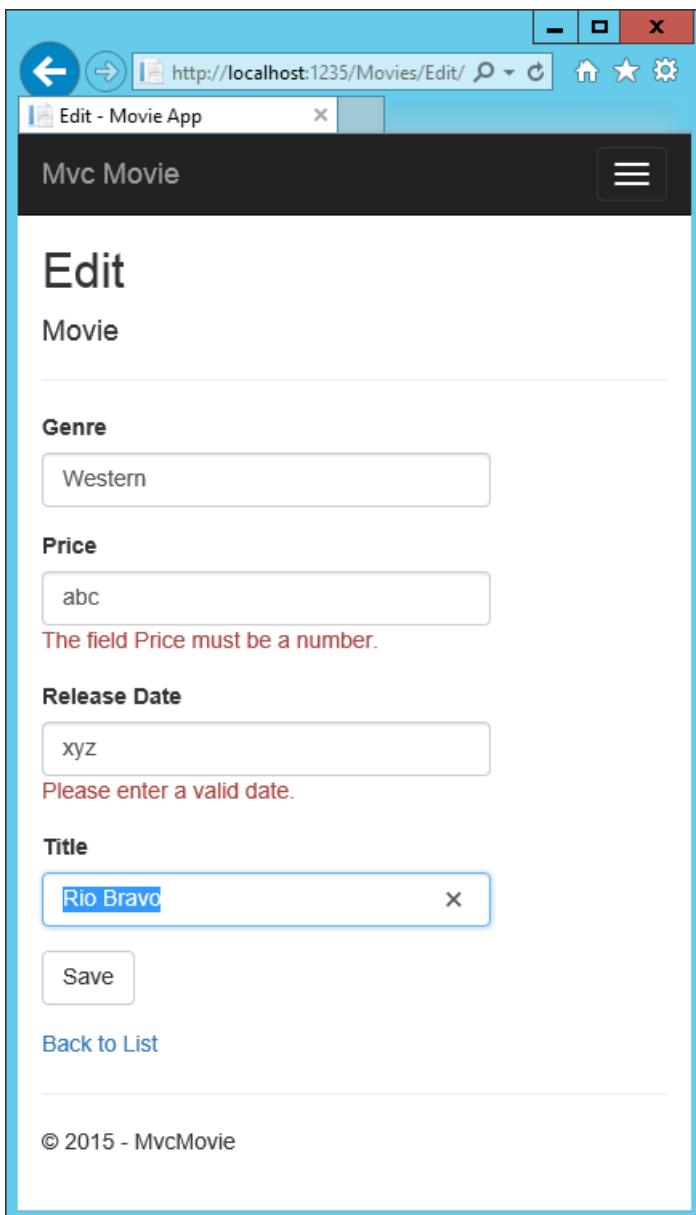
    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction("Index");
    }
    return View(movie);
}

```

The `[ValidateAntiForgeryToken]` attribute validates the hidden [XSRF](#) token generated by the anti-forgery token generator in the [Form Tag Helper](#)

The [model binding](#) system takes the posted form values and creates a `Movie` object that's passed as the `movie` parameter. The `ModelState.IsValid` method verifies that the data submitted in the form can be used to modify (edit or update) a `Movie` object. If the data is valid it's saved. The updated (edited) movie data is saved to the database by calling the `SaveChangesAsync` method of database context. After saving the data, the code redirects the user to the `Index` action method of the `MoviesController` class, which displays the movie collection, including the changes just made.

Before the form is posted to the server, client side validation checks any validation rules on the fields. If there are any validation errors, an error message is displayed and the form isn't posted. If JavaScript is disabled, you won't have client side validation but the server will detect the posted values that are not valid, and the form values will be redisplayed with error messages. Later in the tutorial we examine [Model Validation](#) in more detail. The [Validation Tag Helper](#) in the `Views/Movies/Edit.cshtml` view template takes care of displaying appropriate error messages.



All the `[HttpGet]` methods in the movie controller follow a similar pattern. They get a movie object (or list of objects, in the case of `Index`), and pass the object (model) to the view. The `Create` method passes an empty movie object to the `Create` view. All the methods that create, edit, delete, or otherwise modify data do so in the `[HttpPost]` overload of the method. Modifying data in an `HTTP GET` method is a security risk. Modifying data in an `HTTP GET` method also violates HTTP best practices and the architectural `REST` pattern, which specifies that GET requests shouldn't change the state of your application. In other words, performing a GET operation should be a safe operation that has no side effects and doesn't modify your persisted data.

## Additional resources

- [Globalization and localization](#)
- [Introduction to Tag Helpers](#)
- [Author Tag Helpers](#)
- [Anti-Request Forgery](#)
- Protect your controller from [over-posting](#)
- [ViewModels](#)
- [Form Tag Helper](#)
- [Input Tag Helper](#)
- [Label Tag Helper](#)
- [Select Tag Helper](#)

- Validation Tag Helper

[PREVIOUS](#)

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# Add search to an ASP.NET Core MVC app

6/26/2018 • 7 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section you add search capability to the `Index` action method that lets you search movies by *genre* or *name*.

Update the `Index` method with the following code:

```
public async Task<IActionResult> Index(string searchString)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    return View(await movies.ToListAsync());
}
```

The first line of the `Index` action method creates a [LINQ](#) query to select the movies:

```
var movies = from m in _context.Movie
             select m;
```

The query is *only* defined at this point, it has **not** been run against the database.

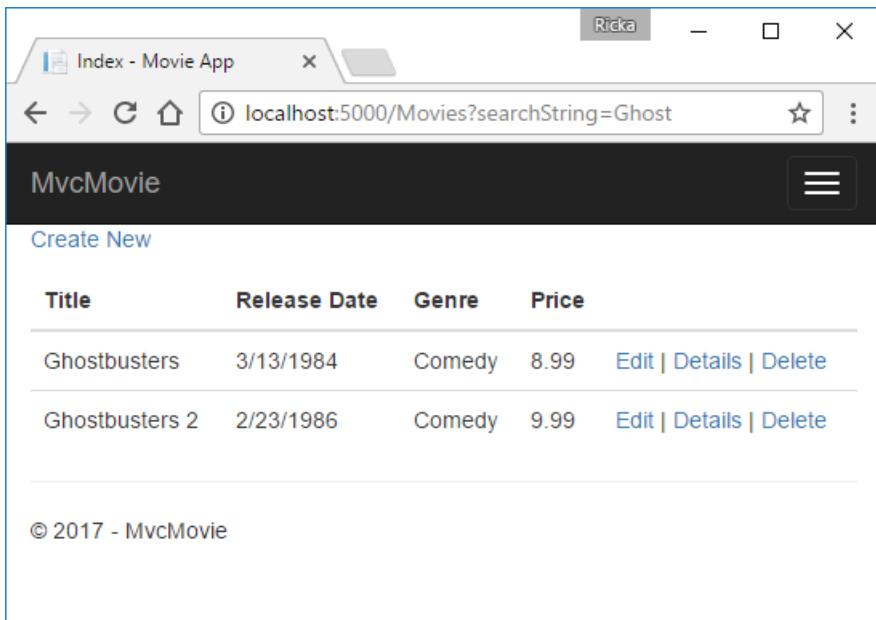
If the `searchString` parameter contains a string, the movies query is modified to filter on the value of the search string:

```
if (!String.IsNullOrEmpty(searchString))
{
    movies = movies.Where(s => s.Title.Contains(searchString));
}
```

The `s => s.Title.Contains()` code above is a [Lambda Expression](#). Lambdas are used in method-based [LINQ](#) queries as arguments to standard query operator methods such as the `Where` method or `Contains` (used in the code above). LINQ queries are not executed when they're defined or when they're modified by calling a method such as `Where`, `Contains` or `OrderBy`. Rather, query execution is deferred. That means that the evaluation of an expression is delayed until its realized value is actually iterated over or the `ToListAsync` method is called. For more information about deferred query execution, see [Query Execution](#).

Note: The `Contains` method is run on the database, not in the c# code shown above. The case sensitivity on the query depends on the database and the collation. On SQL Server, `Contains` maps to [SQL LIKE](#), which is case insensitive. In SQLite, with the default collation, it's case sensitive.

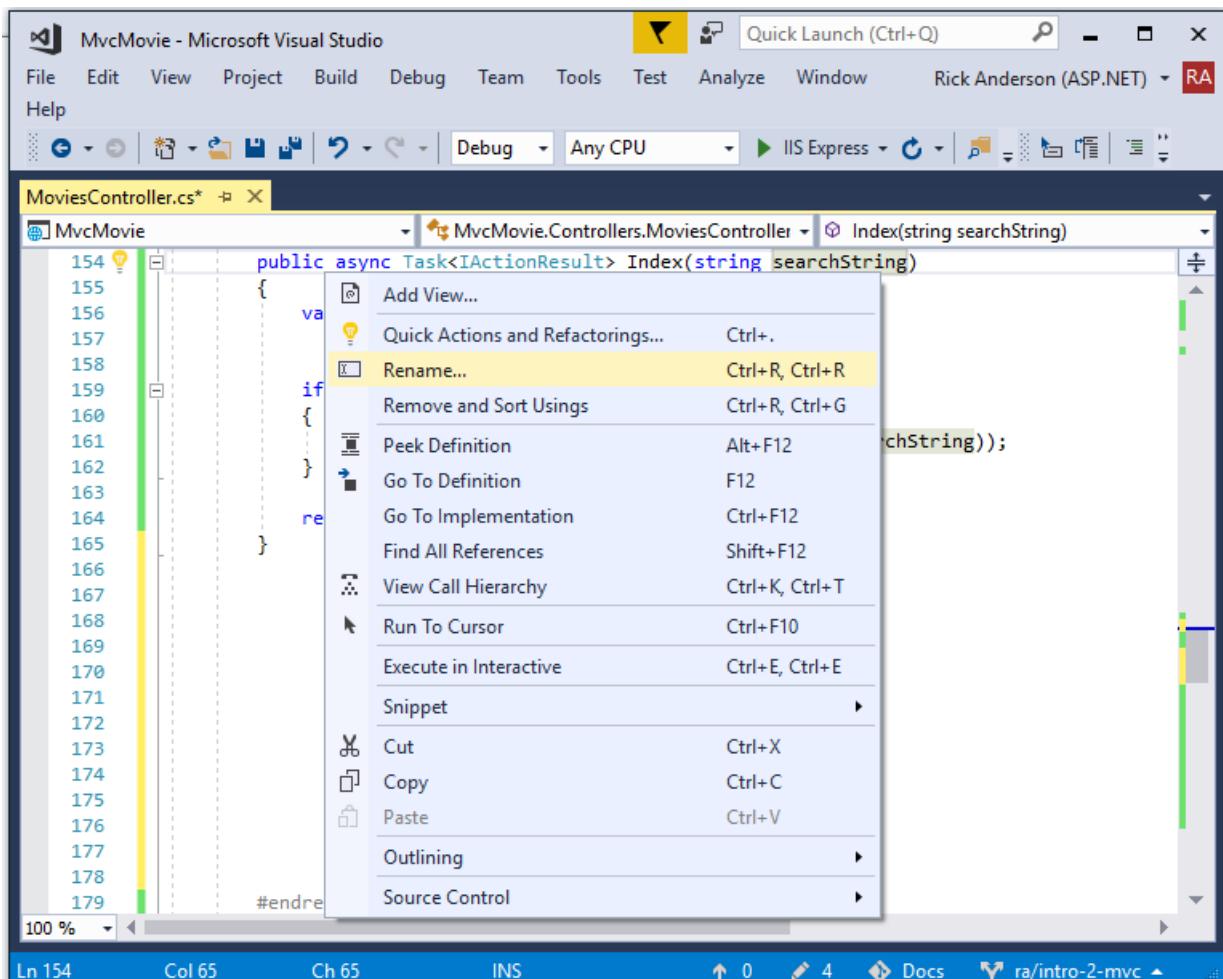
Navigate to `/Movies/Index`. Append a query string such as `?searchString=Ghost` to the URL. The filtered movies are displayed.



If you change the signature of the `Index` method to have a parameter named `id`, the `id` parameter will match the optional `{id}` placeholder for the default routes set in `Startup.cs`.

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

You can quickly rename the `searchString` parameter to `id` with the **rename** command. Right click on `searchString` > **Rename**.



The rename targets are highlighted.

```
public ActionResult Index(string searchString)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    return View(movies);
}
```

Change the parameter to `id` and all occurrences of `searchString` change to `id`.

```
public ActionResult Index(string id)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(id))
    {
        movies = movies.Where(s => s.Title.Contains(id));
    }

    return View(movies);
}
```

The previous `Index` method:

```

public async Task<IActionResult> Index(string searchString)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    return View(await movies.ToListAsync());
}

```

The updated `Index` method with `id` parameter:

```

public async Task<IActionResult> Index(string id)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(id))
    {
        movies = movies.Where(s => s.Title.Contains(id));
    }

    return View(await movies.ToListAsync());
}

```

You can now pass the search title as route data (a URL segment) instead of as a query string value.

Genre	Price	Release Date	Title	
Comedy	8.99	3/13/1984	Ghostbusters	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	9.99	2/23/1986	Ghostbusters 2	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

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However, you can't expect users to modify the URL every time they want to search for a movie. So now you'll add UI elements to help them filter movies. If you changed the signature of the `Index` method to test how to pass the route-bound `ID` parameter, change it back so that it takes a parameter named `searchString`:

```

public async Task<IActionResult> Index(string searchString)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    return View(await movies.ToListAsync());
}

```

Open the `Views/Movies/Index.cshtml` file, and add the `<form>` markup highlighted below:

```

        ViewData["Title"] = "Index";
    }

<h2>Index</h2>

<p>
    <a asp-action="Create">Create New</a>
</p>

<form asp-controller="Movies" asp-action="Index">
    <p>
        Title: <input type="text" name="SearchString">
        <input type="submit" value="Filter" />
    </p>
</form>

<table class="table">
    <thead>

```

The HTML `<form>` tag uses the [Form Tag Helper](#), so when you submit the form, the filter string is posted to the `Index` action of the movies controller. Save your changes and then test the filter.

Genre	Price	Release Date	Title	
Romantic Comedy	7.99	1/11/1989	When Harry Met Sally	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	8.99	3/13/1984	Ghostbusters	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	9.99	2/23/1986	Ghostbusters 2	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Western	3.99	4/15/1959	Rio Bravo	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

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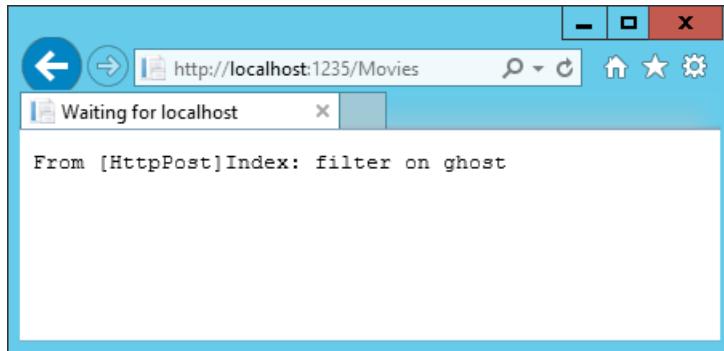
There's no `[HttpPost]` overload of the `Index` method as you might expect. You don't need it, because the method isn't changing the state of the app, just filtering data.

You could add the following `[HttpPost] Index` method.

```
[HttpPost]
public string Index(string searchString, bool notUsed)
{
    return "From [HttpPost]Index: filter on " + searchString;
}
```

The `notUsed` parameter is used to create an overload for the `Index` method. We'll talk about that later in the tutorial.

If you add this method, the action invoker would match the `[HttpPost] Index` method, and the `[HttpPost] Index` method would run as shown in the image below.



However, even if you add this `[HttpPost]` version of the `Index` method, there's a limitation in how this has all been implemented. Imagine that you want to bookmark a particular search or you want to send a link to friends that they can click in order to see the same filtered list of movies. Notice that the URL for the HTTP POST request is the same as the URL for the GET request (`localhost:xxxxx/Movies/Index`) -- there's no search information in the URL. The search string information is sent to the server as a [form field value](#). You can verify that with the browser Developer tools or the excellent [Fiddler tool](#). The image below shows the Chrome browser Developer tools:

The screenshot shows the Chrome DevTools Network tab for a 'Movie App' at `localhost:5000/Movies`. A red box highlights the 'Movies' entry in the list, which corresponds to the search term entered in the application. Another red box highlights the 'Request Headers' section, showing the search parameter and the XSRF token. A third red box highlights the 'Form Data' section, showing the search parameter and the XSRF token.

**Request Headers:**

- Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,\*/\*;q=0.8
- Accept-Encoding: gzip, deflate, br
- Accept-Language: en-US,en;q=0.8
- Cache-Control: max-age=0
- Connection: keep-alive
- Content-Length: 201
- Content-Type: application/x-www-form-urlencoded
- Cookie: .AspNetCore.Antiforgery.txPTUN878m8=CfDJ8B98MxUF...  
L5pAq2aeCj59HP3vvTrLPK1krIeXsJFchnazuWjLRxzWQjTw-tsEJDQr...  
8bQg-xCdy7DdpfcQ-Hi2HAxOin1R838CvFU6oyWz7VIKmIKjUuXI371...  
S-YZR0pBdNaP0mTxZX9JMy\_jX\_zIig; .AspNetCore.Antiforgery.Mkg1\_D\_R5qY=CfDJ8B98MxUFL5pAq2aeCj59HP2tNs0B01ewBFztib...  
CoKKfe2wxo9rL6Z-9YP41jarbKyJ\_I5aQvz98MWGfPpwwbH71Jw4I8qg...  
C-CklyxAsFxWKQyP0MysYab98gk-z\_M4jh1\_Lw90DBZJuBVS80fzF4tM8
- Host: localhost:5000
- Origin: http://localhost:5000
- Referer: http://localhost:5000/Movies
- Upgrade-Insecure-Requests: 1
- User-Agent: Mozilla/5.0 (Windows NT 10.0; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/57.0.2987.133 Safari/537.36

**Form Data:**

- SearchString: Ghost
- \_RequestVerificationToken: CfDJ8B98MxUFL5pAq2aeCj59HP1g2HXMD176MabW7uuk20AGre8b3y0NufBTMAjxmJCjRFe-2sF50PVla72IyfcA9Pao3muZ0f4jtjDND1XEagdJk\_g67wBX12qOKI7DLD980GjMjBB\_-5rvRhJuQCroPRw

You can see the search parameter and [XSRF](#) token in the request body. Note, as mentioned in the previous tutorial, the [Form Tag Helper](#) generates an [XSRF](#) anti-forgery token. We're not modifying data, so we don't need to validate the token in the controller method.

Because the search parameter is in the request body and not the URL, you can't capture that search information to bookmark or share with others. We'll fix this by specifying the request should be `HTTP GET`.

Notice how intelliSense helps us update the markup.

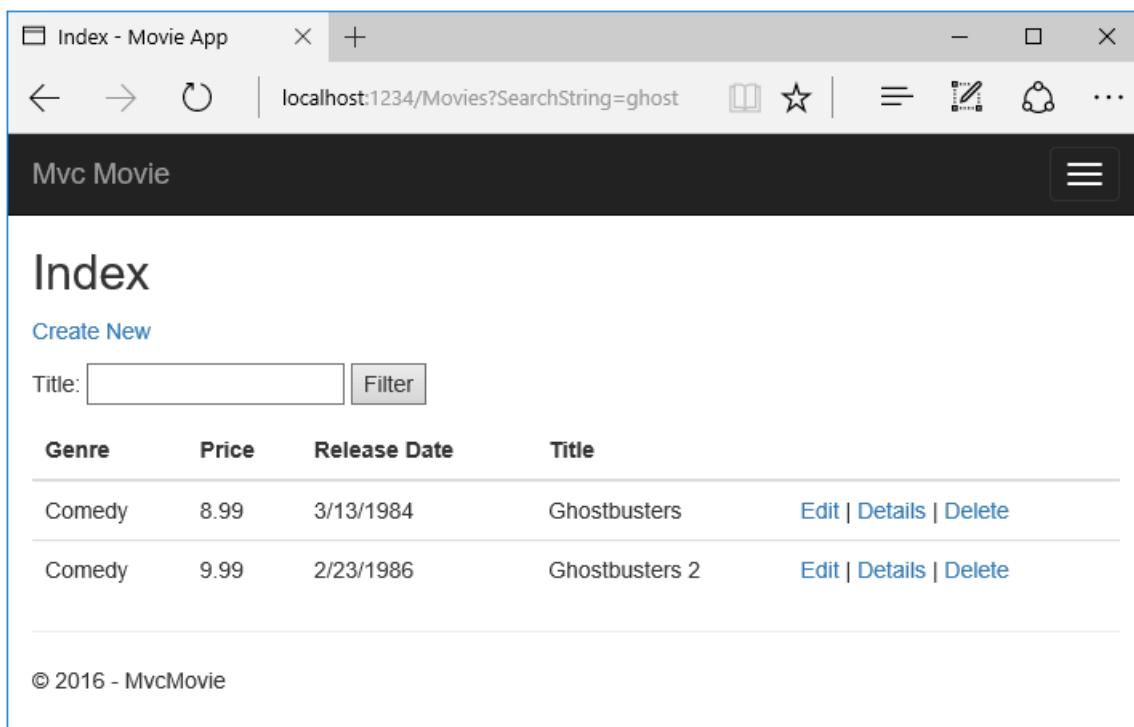
```
<form asp-controller="Movies" asp-action="Index" method="get">
  <p>
    Title: <input type="text" name="SearchString" />
    <input type="submit" value="Filter" />
  </p>
</form>
```

```
<form asp-controller="Movies" asp-action="Index" method="get">
  <p>
    Title: <input type="text" name="SearchString" />
    <input type="submit" value="Filter" />
  </p>
</form>
```

Notice the distinctive font in the `<form>` tag. That distinctive font indicates the tag is supported by Tag Helpers.

```
<form asp-controller="Movies" asp-action="Index">
  <p>
    Title: <input type="text" name="SearchString" />
    <input type="submit" value="Filter" />
  </p>
</form>
```

Now when you submit a search, the URL contains the search query string. Searching will also go to the `HttpGet Index` action method, even if you have a `HttpPost Index` method.



The following markup shows the change to the `form` tag:

```
<form asp-controller="Movies" asp-action="Index" method="get">
```

## Adding Search by genre

Add the following `MovieGenreViewModel` class to the *Models* folder:

```

using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace MvcMovie.Models
{
    public class MovieGenreViewModel
    {
        public List<Movie> movies;
        public SelectList genres;
        public string movieGenre { get; set; }
    }
}

```

The movie-genre view model will contain:

- A list of movies.
- A `SelectList` containing the list of genres. This will allow the user to select a genre from the list.
- `movieGenre`, which contains the selected genre.

Replace the `Index` method in `MoviesController.cs` with the following code:

```

// Requires using Microsoft.AspNetCore.Mvc.Rendering;
public async Task<IActionResult> Index(string movieGenre, string searchString)
{
    // Use LINQ to get list of genres.
    IQueryable<string> genreQuery = from m in _context.Movie
                                         orderby m.Genre
                                         select m.Genre;

    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    if (!String.IsNullOrEmpty(movieGenre))
    {
        movies = movies.Where(x => x.Genre == movieGenre);
    }

    var movieGenreVM = new MovieGenreViewModel();
    movieGenreVM.genres = new SelectList(await genreQuery.Distinct().ToListAsync());
    movieGenreVM.movies = await movies.ToListAsync();

    return View(movieGenreVM);
}

```

The following code is a `LINQ` query that retrieves all the genres from the database.

```

// Use LINQ to get list of genres.
IQueryable<string> genreQuery = from m in _context.Movie
                                         orderby m.Genre
                                         select m.Genre;

```

The `SelectList` of genres is created by projecting the distinct genres (we don't want our select list to have duplicate genres).

```
movieGenreVM.genres = new SelectList(await genreQuery.Distinct().ToListAsync())
```

## Adding search by genre to the Index view

Update `Index.cshtml` as follows:

```

@model MvcMovie.Models.MovieGenreViewModel

 @{
     ViewData["Title"] = "Index";
 }

<h2>Index</h2>

<p>
    <a asp-action="Create">Create New</a>
</p>

<form asp-controller="Movies" asp-action="Index" method="get">
    <p>
        <select asp-for="movieGenre" asp-items="Model.genres">
            <option value="">All</option>
        </select>

        Title: <input type="text" name="SearchString">
        <input type="submit" value="Filter" />
    </p>
</form>

<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].ReleaseDate)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Genre)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Price)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model.movies)
        {
            <tr>
                <td>
                    @Html.DisplayFor(modelItem => item.Title)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.ReleaseDate)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Genre)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Price)
                </td>
                <td>
                    <a asp-action="Edit" asp-route-id="@item.ID">Edit</a> |
                    <a asp-action="Details" asp-route-id="@item.ID">Details</a> |
                    <a asp-action="Delete" asp-route-id="@item.ID">Delete</a>
                </td>
            </tr>
        }
    </tbody>
</table>

```

Examine the lambda expression used in the following HTML Helper:

```
@Html.DisplayNameFor(model => model.movies[0].Title)
```

In the preceding code, the `DisplayNameFor` HTML Helper inspects the `Title` property referenced in the lambda expression to determine the display name. Since the lambda expression is inspected rather than evaluated, you don't receive an access violation when `model`, `model.movies`, or `model.movies[0]` are `null` or empty. When the lambda expression is evaluated (for example, `@Html.DisplayFor(modelItem => item.Title)`), the model's property values are evaluated.

Test the app by searching by genre, by movie title, and by both.

[PREVIOUS](#)

[NEXT](#)

# Add a new field to an ASP.NET Core MVC app

6/26/2018 • 4 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section you'll use [Entity Framework](#) Code First Migrations to add a new field to the model and migrate that change to the database.

When you use EF Code First to automatically create a database, Code First adds a table to the database to help track whether the schema of the database is in sync with the model classes it was generated from. If they aren't in sync, EF throws an exception. This makes it easier to find inconsistent database/code issues.

## Adding a Rating Property to the Movie Model

Open the `Models/Movie.cs` file and add a `Rating` property:

```
public class Movie
{
    public int ID { get; set; }
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }
    public string Genre { get; set; }

    [Column(TypeName = "decimal(18, 2)")]
    public decimal Price { get; set; }
    public string Rating { get; set; }
}
```

```
public class Movie
{
    public int ID { get; set; }
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }
    public string Genre { get; set; }
    public decimal Price { get; set; }
    public string Rating { get; set; }
}
```

Build the app (Ctrl+Shift+B).

Because you've added a new field to the `Movie` class, you also need to update the binding white list so this new property will be included. In `MoviesController.cs`, update the `[Bind]` attribute for both the `Create` and `Edit` action methods to include the `Rating` property:

```
[Bind("ID,Title,ReleaseDate,Genre,Price,Rating")]
```

You also need to update the view templates in order to display, create and edit the new `Rating` property in the browser view.

Edit the `/Views/Movies/Index.cshtml` file and add a `Rating` field:

```
<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].ReleaseDate)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Genre)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Price)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Rating)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model.movies)
        {
            <tr>
                <td>
                    @Html.DisplayFor(modelItem => item.Title)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.ReleaseDate)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Genre)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Price)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Rating)
                </td>
                <td>
```

Update the `/Views/Movies/Create.cshtml` with a `Rating` field. You can copy/paste the previous "form group" and let intelliSense help you update the fields. IntelliSense works with [Tag Helpers](#). Note: In the RTM verison of Visual Studio 2017 you need to install the [Razor Language Services](#) for Razor intelliSense. This will be fixed in the next release.

```

        </div>
        <div class="form-group">
            <label asp-for="Title" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="Title" class="form-control" />
                <span asp-validation-for="Title" class="text-danger" />
            </div>
        </div>
        <div class="form-group">
            <label asp-for="R" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="R" class="form-control" />
                <span asp-validation-for="R" class="text-danger" />
            </div>
        </div>
        <div class="form-group">
            <label asp-for="Rating" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="Rating" type="text" class="form-control" />
                <span asp-validation-for="Rating" class="text-danger" />
            </div>
        </div>
    </div>
</form>

```



The app won't work until we update the DB to include the new field. If you run it now, you'll get the following `SqlException`:

```
SqlException: Invalid column name 'Rating'.
```

You're seeing this error because the updated Movie model class is different than the schema of the Movie table of the existing database. (There's no Rating column in the database table.)

There are a few approaches to resolving the error:

1. Have the Entity Framework automatically drop and re-create the database based on the new model class schema. This approach is very convenient early in the development cycle when you are doing active development on a test database; it allows you to quickly evolve the model and database schema together. The downside, though, is that you lose existing data in the database — so you don't want to use this approach on a production database! Using an initializer to automatically seed a database with test data is often a productive way to develop an application.
2. Explicitly modify the schema of the existing database so that it matches the model classes. The advantage of this approach is that you keep your data. You can make this change either manually or by creating a database change script.
3. Use Code First Migrations to update the database schema.

For this tutorial, we'll use Code First Migrations.

Update the `SeedData` class so that it provides a value for the new column. A sample change is shown below, but you'll want to make this change for each `new Movie`.

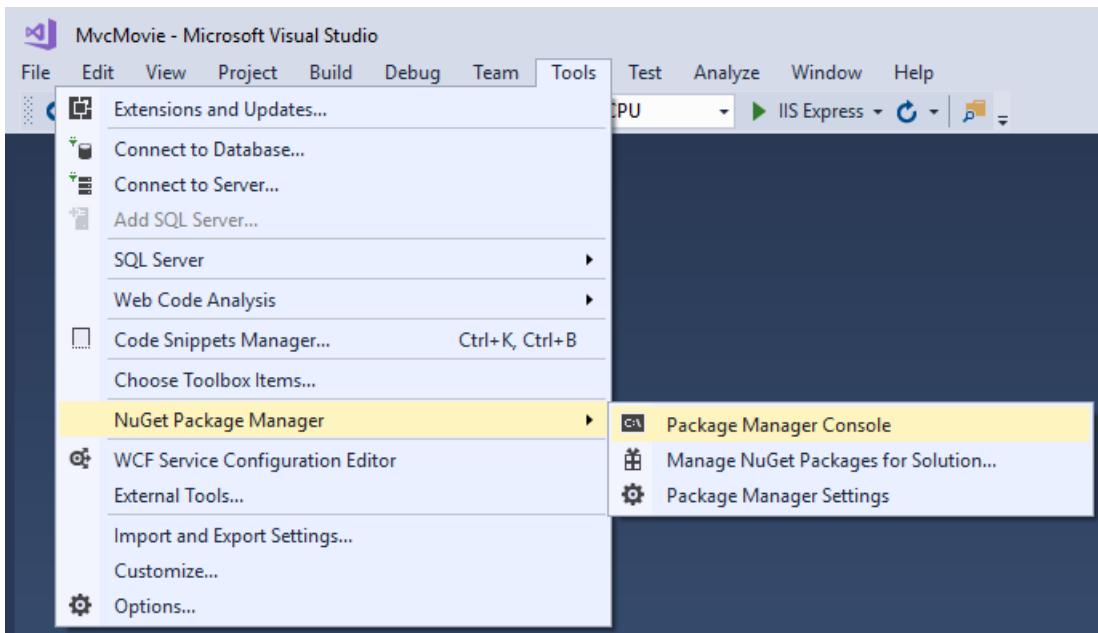
```

new Movie
{
    Title = "When Harry Met Sally",
    ReleaseDate = DateTime.Parse("1989-1-11"),
    Genre = "Romantic Comedy",
    Rating = "R",
    Price = 7.99M
},

```

Build the solution.

From the **Tools** menu, select **NuGet Package Manager > Package Manager Console**.



In the PMC, enter the following commands:

```
Add-Migration Rating  
Update-Database
```

The `Add-Migration` command tells the migration framework to examine the current `Movie` model with the current `Movie` DB schema and create the necessary code to migrate the DB to the new model. The name "Rating" is arbitrary and is used to name the migration file. It's helpful to use a meaningful name for the migration file.

If you delete all the records in the DB, the initialize will seed the DB and include the `Rating` field. You can do this with the delete links in the browser or from SSOX.

Run the app and verify you can create/edit/display movies with a `Rating` field. You should also add the `Rating` field to the `Edit`, `Details`, and `Delete` view templates.

[PREVIOUS](#) [NEXT](#)

# Add validation to an ASP.NET Core MVC app

6/26/2018 • 10 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section you'll add validation logic to the `Movie` model, and you'll ensure that the validation rules are enforced any time a user creates or edits a movie.

## Keeping things DRY

One of the design tenets of MVC is [DRY](#) ("Don't Repeat Yourself"). ASP.NET MVC encourages you to specify functionality or behavior only once, and then have it be reflected everywhere in an app. This reduces the amount of code you need to write and makes the code you do write less error prone, easier to test, and easier to maintain.

The validation support provided by MVC and Entity Framework Core Code First is a good example of the DRY principle in action. You can declaratively specify validation rules in one place (in the model class) and the rules are enforced everywhere in the app.

## Adding validation rules to the movie model

Open the `Movie.cs` file. DataAnnotations provides a built-in set of validation attributes that you apply declaratively to any class or property. (It also contains formatting attributes like `DataType` that help with formatting and don't provide any validation.)

Update the `Movie` class to take advantage of the built-in `Required`, `StringLength`, `RegularExpression`, and `Range` validation attributes.

```
public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3)]
    [Required]
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [Range(1, 100)]
    [DataType(DataType.Currency)]
    [Column(TypeName = "decimal(18, 2)")]
    public decimal Price { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z\s-]*$")]
    [Required]
    [StringLength(30)]
    public string Genre { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z0-9\s-]*$")]
    [StringLength(5)]
    [Required]
    public string Rating { get; set; }
}
```

```

public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3)]
    [Required]
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [Range(1, 100)]
    [DataType(DataType.Currency)]
    public decimal Price { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z''"\s-]*$")]
    [Required]
    [StringLength(30)]
    public string Genre { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z0-9"""\s-]*$")]
    [StringLength(5)]
    [Required]
    public string Rating { get; set; }
}

```

The validation attributes specify behavior that you want to enforce on the model properties they're applied to. The `Required` and `MinimumLength` attributes indicate that a property must have a value, but nothing prevents a user from entering white space to satisfy this validation. The `RegularExpression` attribute is used to limit what characters can be input. In the code above, `Genre` and `Rating` must use only letters (First letter uppercase, white space, numbers and special characters are not allowed). The `Range` attribute constrains a value to within a specified range. The `StringLength` attribute lets you set the maximum length of a string property, and optionally its minimum length. Value types (such as `decimal`, `int`, `float`, `DateTime`) are inherently required and don't need the `[Required]` attribute.

Having validation rules automatically enforced by ASP.NET helps make your app more robust. It also ensures that you can't forget to validate something and inadvertently let bad data into the database.

## Validation Error UI in MVC

Run the app and navigate to the Movies controller.

Tap the **Create New** link to add a new movie. Fill out the form with some invalid values. As soon as jQuery client side validation detects the error, it displays an error message.

The screenshot shows a browser window titled "Create - Movie App" with the URL "localhost:5000/Movies/Cre". The page is titled "MvcMovie" and has a "Create" heading. Below it is a "Movie" section. The form contains five fields: "Title", "Release Date", "Genre", "Price", and "Rating". Each field has a validation error message below it. The "Title" field says "The field Title must be a string with a minimum length of 3 and a maximum length of 60.". The "Genre" field says "The Genre field is required.". The "Price" field says "The field Price must be a number.". The "Rating" field says "The field Rating must match the regular expression ^[A-Z]+[a-zA-Z]+\s\*\\$.". At the bottom left is a "Create" button, and at the bottom center is a link "Back to List".

#### NOTE

You may not be able to enter decimal commas in the `Price` field. To support [jQuery validation](#) for non-US-English locales that use a comma (",") for a decimal point, and non US-English date formats, you must take steps to globalize your app. This [GitHub issue 4076](#) for instructions on adding decimal comma.

Notice how the form has automatically rendered an appropriate validation error message in each field containing an invalid value. The errors are enforced both client-side (using JavaScript and jQuery) and server-side (in case a user has JavaScript disabled).

A significant benefit is that you didn't need to change a single line of code in the `MoviesController` class or in the `Create.cshtml` view in order to enable this validation UI. The controller and views you created earlier in this tutorial automatically picked up the validation rules that you specified by using validation attributes on the properties of the `Movie` model class. Test validation using the `Edit` action method, and the same validation is applied.

The form data isn't sent to the server until there are no client side validation errors. You can verify this by putting a break point in the `HTTP Post` method, by using the [Fiddler tool](#), or the [F12 Developer tools](#).

## How validation works

You might wonder how the validation UI was generated without any updates to the code in the controller or views. The following code shows the two `Create` methods.

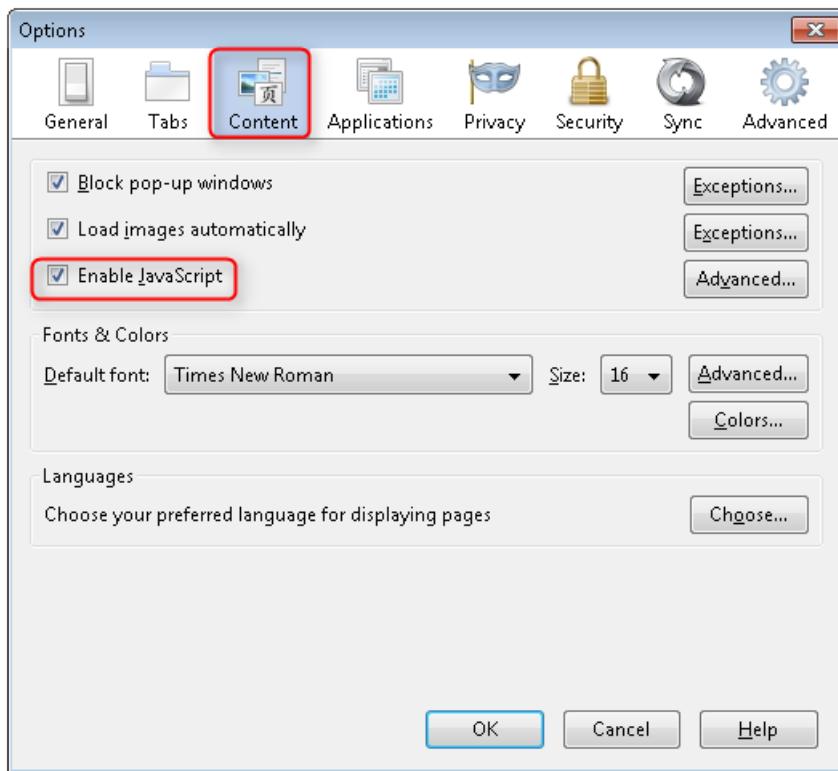
```
// GET: Movies/Create
public IActionResult Create()
{
    return View();
}

// POST: Movies/Create
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Create(
    [Bind("ID,Title,ReleaseDate,Genre,Price, Rating")] Movie movie)
{
    if (ModelState.IsValid)
    {
        _context.Add(movie);
        await _context.SaveChangesAsync();
        return RedirectToAction("Index");
    }
    return View(movie);
}
```

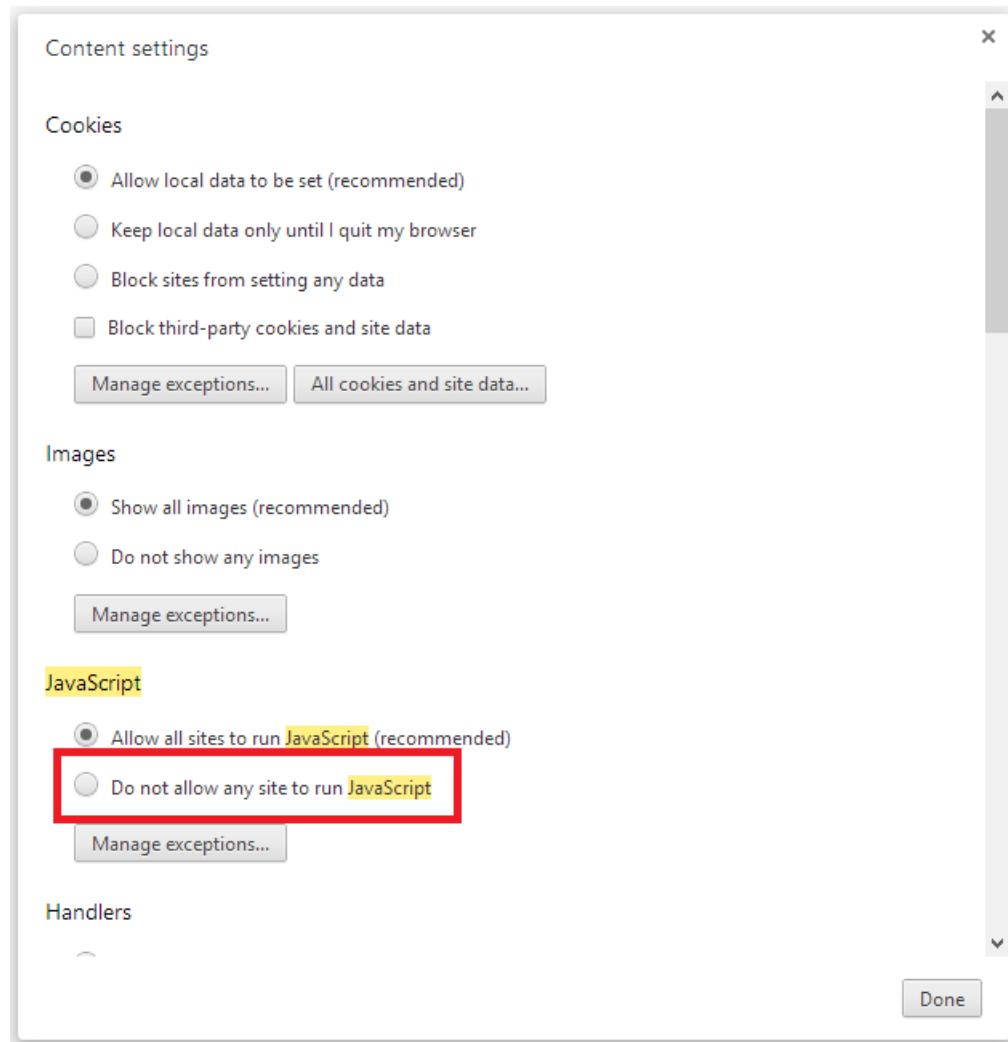
The first (HTTP GET) `Create` action method displays the initial Create form. The second (`[HttpPost]`) version handles the form post. The second `Create` method (The `[HttpPost]` version) calls `ModelState.IsValid` to check whether the movie has any validation errors. Calling this method evaluates any validation attributes that have been applied to the object. If the object has validation errors, the `Create` method re-displays the form. If there are no errors, the method saves the new movie in the database. In our movie example, the form isn't posted to the server when there are validation errors detected on the client side; the second `Create` method is never called when there are client side validation errors. If you disable JavaScript in your browser, client validation is disabled and you can test the HTTP POST `Create` method `ModelState.IsValid` detecting any validation errors.

You can set a break point in the `[HttpPost] Create` method and verify the method is never called, client side validation won't submit the form data when validation errors are detected. If you disable JavaScript in your browser, then submit the form with errors, the break point will be hit. You still get full validation without JavaScript.

The following image shows how to disable JavaScript in the FireFox browser.



The following image shows how to disable JavaScript in the Chrome browser.



After you disable JavaScript, post invalid data and step through the debugger.

```

74         // POST: Movies/Create
75         // To protect from overposting attacks, please enable t
76         // more details see http://go.microsoft.com/fwlink/?LinkID=147393
77         [HttpPost]
78         [ValidateAntiForgeryToken]
79         0 references
80         public async Task<ActionResult> Create([Bind("ID,Title",
81                                         false)]
81             if (ModelState.IsValid)
82             {
83                 _context.Add(movie);
84                 await _context.SaveChangesAsync();
85                 return RedirectToAction("Index");
86             }
87             return View(movie);
88         }
89

```

Below is portion of the *Create.cshtml* view template that you scaffolded earlier in the tutorial. It's used by the action methods shown above both to display the initial form and to redisplay it in the event of an error.

```

<form asp-action="Create">
    <div class="form-horizontal">
        <h4>Movie</h4>
        <hr />

        <div asp-validation-summary="ModelOnly" class="text-danger"></div>
        <div class="form-group">
            <label asp-for="Title" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="Title" class="form-control" />
                <span asp-validation-for="Title" class="text-danger"></span>
            </div>
        </div>
    </div>

    @*Markup removed for brevity.*@
    </div>
</form>

```

The [Input Tag Helper](#) uses the [DataAnnotations](#) attributes and produces HTML attributes needed for jQuery Validation on the client side. The [Validation Tag Helper](#) displays validation errors. See [Validation](#) for more information.

What's really nice about this approach is that neither the controller nor the `create` view template knows anything about the actual validation rules being enforced or about the specific error messages displayed. The validation rules and the error strings are specified only in the `Movie` class. These same validation rules are automatically applied to the `Edit` view and any other views templates you might create that edit your model.

When you need to change validation logic, you can do so in exactly one place by adding validation attributes to the model (in this example, the `Movie` class). You won't have to worry about different parts of the application being inconsistent with how the rules are enforced — all validation logic will be defined in one place and used everywhere. This keeps the code very clean, and makes it easy to maintain and evolve. And it means that you'll be fully honoring the DRY principle.

## Using DataType Attributes

Open the `Movie.cs` file and examine the `Movie` class. The `System.ComponentModel.DataAnnotations` namespace provides formatting attributes in addition to the built-in set of validation attributes. We've already applied a `DataType` enumeration value to the release date and to the price fields. The following code shows the `ReleaseDate` and `Price` properties with the appropriate `DataType` attribute.

```
[Display(Name = "Release Date")]
[DataType(DataType.Date)]
public DateTime ReleaseDate { get; set; }

[Range(1, 100)]
[DataType(DataType.Currency)]
public decimal Price { get; set; }
```

The `DataType` attributes only provide hints for the view engine to format the data (and supplies elements/attributes such as `<a>` for URL's and `<a href="mailto:EmailAddress.com">` for email. You can use the `RegularExpression` attribute to validate the format of the data. The `DataType` attribute is used to specify a data type that's more specific than the database intrinsic type, they're not validation attributes. In this case we only want to keep track of the date, not the time. The `DataType` Enumeration provides for many data types, such as Date, Time, PhoneNumber, Currency, EmailAddress and more. The `DataType` attribute can also enable the application to automatically provide type-specific features. For example, a `mailto:` link can be created for `DataType.EmailAddress`, and a date selector can be provided for `DataType.Date` in browsers that support HTML5. The `DataType` attributes emits HTML 5 `data-` (pronounced data dash) attributes that HTML 5 browsers can understand. The `DataType` attributes do **not** provide any validation.

`DataType.Date` doesn't specify the format of the date that's displayed. By default, the data field is displayed according to the default formats based on the server's `CultureInfo`.

The `DisplayFormat` attribute is used to explicitly specify the date format:

```
[DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
public DateTime ReleaseDate { get; set; }
```

The `ApplyFormatInEditMode` setting specifies that the formatting should also be applied when the value is displayed in a text box for editing. (You might not want that for some fields — for example, for currency values, you probably don't want the currency symbol in the text box for editing.)

You can use the `DisplayFormat` attribute by itself, but it's generally a good idea to use the `DataType` attribute. The `DataType` attribute conveys the semantics of the data as opposed to how to render it on a screen, and provides the following benefits that you don't get with `DisplayFormat`:

- The browser can enable HTML5 features (for example to show a calendar control, the locale-appropriate currency symbol, email links, etc.)
- By default, the browser will render data using the correct format based on your locale.
- The `DataType` attribute can enable MVC to choose the right field template to render the data (the `DisplayFormat` if used by itself uses the string template).

#### NOTE

jQuery validation doesn't work with the `Range` attribute and `DateTime`. For example, the following code will always display a client side validation error, even when the date is in the specified range:

```
[Range(typeof(DateTime), "1/1/1966", "1/1/2020")]
```

You will need to disable jQuery date validation to use the `Range` attribute with `DateTime`. It's generally not a good practice to compile hard dates in your models, so using the `Range` attribute and `DateTime` is discouraged.

The following code shows combining attributes on one line:

```

public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3)]
    public string Title { get; set; }

    [Display(Name = "Release Date"), DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [RegularExpression(@"^([A-Z][a-zA-Z\s-]*$"), Required, StringLength(30)]
    public string Genre { get; set; }

    [Range(1, 100), DataType(DataType.Currency)]
    [Column(TypeName = "decimal(18, 2)")]
    public decimal Price { get; set; }

    [RegularExpression(@"^([A-Z][a-zA-Z0-9\s-]*$"), StringLength(5)]
    public string Rating { get; set; }
}

```

```

public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3), Required]
    public string Title { get; set; }

    [Display(Name = "Release Date"), DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [RegularExpression(@"^([A-Z][a-zA-Z\s-]*$"), Required, StringLength(30)]
    public string Genre { get; set; }

    [Range(1, 100), DataType(DataType.Currency)]
    public decimal Price { get; set; }

    [RegularExpression(@"^([A-Z][a-zA-Z0-9\s-]*$"), Required, StringLength(5)]
    public string Rating { get; set; }
}

```

In the next part of the series, we'll review the application and make some improvements to the automatically generated `Details` and `Delete` methods.

## Additional resources

- [Working with Forms](#)
- [Globalization and localization](#)
- [Introduction to Tag Helpers](#)
- [Author Tag Helpers](#)

# Examine the Details and Delete methods of an ASP.NET Core app

6/21/2018 • 3 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

Open the Movie controller and examine the `Details` method:

```
// GET: Movies/Details/5
public async Task<IActionResult> Details(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie
        .FirstOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }

    return View(movie);
}
```

```
// GET: Movies/Details/5
public async Task<IActionResult> Details(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie
        .SingleOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }

    return View(movie);
}
```

The MVC scaffolding engine that created this action method adds a comment showing an HTTP request that invokes the method. In this case it's a GET request with three URL segments, the `Movies` controller, the `Details` method and an `id` value. Recall these segments are defined in *Startup.cs*.

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

EF makes it easy to search for data using the `SingleOrDefaultAsync` method. An important security feature built into the method is that the code verifies that the search method has found a movie before it tries to do anything with it. For example, a hacker could introduce errors into the site by changing the URL created by the links from `http://localhost:xxxx/Movies/Details/1` to something like `http://localhost:xxxx/Movies/Details/12345` (or some other value that doesn't represent an actual movie). If you didn't check for a null movie, the app would throw an exception.

Examine the `Delete` and `DeleteConfirmed` methods.

```
// GET: Movies/Delete/5
public async Task<IActionResult> Delete(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie
        .FirstOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }

    return View(movie);
}

// POST: Movies/Delete/5
[HttpPost, ActionName("Delete")]
[ValidateAntiForgeryToken]
public async Task<IActionResult> DeleteConfirmed(int id)
{
    var movie = await _context.Movie.FindAsync(id);
    _context.Movie.Remove(movie);
    await _context.SaveChangesAsync();
    return RedirectToAction(nameof(Index));
}
```

```

// GET: Movies/Delete/5
public async Task<IActionResult> Delete(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie
        .SingleOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }

    return View(movie);
}

// POST: Movies/Delete/5
[HttpPost, ActionName("Delete")]
[ValidateAntiForgeryToken]
public async Task<IActionResult> DeleteConfirmed(int id)
{
    var movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);
    _context.Movie.Remove(movie);
    await _context.SaveChangesAsync();
    return RedirectToAction("Index");
}

```

Note that the `HTTP GET Delete` method doesn't delete the specified movie, it returns a view of the movie where you can submit (`HttpPost`) the deletion. Performing a delete operation in response to a GET request (or for that matter, performing an edit operation, create operation, or any other operation that changes data) opens up a security hole.

The `[HttpPost]` method that deletes the data is named `DeleteConfirmed` to give the HTTP POST method a unique signature or name. The two method signatures are shown below:

```

// GET: Movies/Delete/5
public async Task<IActionResult> Delete(int? id)
{
```

```

// POST: Movies/Delete/5
[HttpPost, ActionName("Delete")]
[ValidateAntiForgeryToken]
public async Task<IActionResult> DeleteConfirmed(int id)
{
```

The common language runtime (CLR) requires overloaded methods to have a unique parameter signature (same method name but different list of parameters). However, here you need two `Delete` methods -- one for GET and one for POST -- that both have the same parameter signature. (They both need to accept a single integer as a parameter.)

There are two approaches to this problem, one is to give the methods different names. That's what the scaffolding mechanism did in the preceding example. However, this introduces a small problem: ASP.NET maps segments of a URL to action methods by name, and if you rename a method, routing normally wouldn't be able to find that method. The solution is what you see in the example, which is to add the `ActionName("Delete")` attribute to the `DeleteConfirmed` method. That attribute performs mapping for the routing system so that a URL that includes `/Delete/` for a POST request will find the `DeleteConfirmed` method.

Another common work around for methods that have identical names and signatures is to artificially change the

signature of the POST method to include an extra (unused) parameter. That's what we did in a previous post when we added the `notUsed` parameter. You could do the same thing here for the `[HttpPost] Delete` method:

```
// POST: Movies/Delete/6
[ValidateAntiForgeryToken]
public async Task<IActionResult> Delete(int id, bool notUsed)
```

## Publish to Azure

See [Publish an ASP.NET Core web app to Azure App Service using Visual Studio](#) for instructions on how to publish this app to Azure using Visual Studio. The app can also be published from the [command line](#).

[PREVIOUS](#)

# Build web APIs with ASP.NET Core

7/11/2018 • 4 minutes to read • [Edit Online](#)

By [Scott Addie](#)

[View or download sample code](#) ([how to download](#))

This document explains how to build a web API in ASP.NET Core and when it's most appropriate to use each feature.

## Derive class from ControllerBase

Inherit from the [ControllerBase](#) class in a controller that's intended to serve as a web API. For example:

```
[Produces("application/json")]
[Route("api/[controller]")]
public class PetsController : ControllerBase
{
    private readonly PetsRepository _repository;

    public PetsController(PetsRepository repository)
    {
        _repository = repository;
    }

    [HttpGet]
    public async Task<ActionResult<List<Pet>>> GetAllAsync()
    {
        return await _repository.GetPetsAsync();
    }

    [HttpGet("{id}")]
    [ProducesResponseType(404)]
    public async Task<ActionResult<Pet>> GetByIdAsync(int id)
    {
        var pet = await _repository.GetPetAsync(id);

        if (pet == null)
        {
            return NotFound();
        }

        return pet;
    }

    [HttpPost]
    [ProducesResponseType(400)]
    public async Task<ActionResult<Pet>> CreateAsync(Pet pet)
    {
        if (!ModelState.IsValid)
        {
            return BadRequest(ModelState);
        }

        await _repository.AddPetAsync(pet);

        return CreatedAtAction(nameof(GetByIdAsync),
            new { id = pet.Id }, pet);
    }
}
```

```

[Produces("application/json")]
[Route("api/[controller]")]
public class PetsController : ControllerBase
{
    private readonly PetsRepository _repository;

    public PetsController(PetsRepository repository)
    {
        _repository = repository;
    }

    [HttpGet]
    [ProducesResponseType(typeof(IEnumerable<Pet>), 200)]
    public async Task<IActionResult> GetAllAsync()
    {
        var pets = await _repository.GetPetsAsync();

        return Ok(pets);
    }

    [HttpGet("{id}")]
    [ProducesResponseType(typeof(Pet), 200)]
    [ProducesResponseType(404)]
    public async Task<IActionResult> GetByIdAsync(int id)
    {
        var pet = await _repository.GetPetAsync(id);

        if (pet == null)
        {
            return NotFound();
        }

        return Ok(pet);
    }

    [HttpPost]
    [ProducesResponseType(typeof(Pet), 201)]
    [ProducesResponseType(400)]
    public async Task<IActionResult> CreateAsync([FromBody] Pet pet)
    {
        if (!ModelState.IsValid)
        {
            return BadRequest(ModelState);
        }

        await _repository.AddPetAsync(pet);

        return CreatedAtAction(nameof(GetByIdAsync),
            new { id = pet.Id }, pet);
    }
}

```

The  `ControllerBase` class provides access to several properties and methods. In the preceding code, examples include `BadRequest` and `CreatedAtAction`. These methods are called within action methods to return HTTP 400 and 201 status codes, respectively. The  `ModelState` property, also provided by  `ControllerBase`, is accessed to handle request model validation.

## Annotate class with ApiControllerAttribute

ASP.NET Core 2.1 introduces the `[ApiController]` attribute to denote a web API controller class. For example:

```
[Route("api/[controller]")]
[ApiController]
public class ProductsController : ControllerBase
```

A compatibility version of 2.1 or later, set via [SetCompatibilityVersion](#), is required to use this attribute. For example, the highlighted code in `Startup.ConfigureServices` sets the 2.1 compatibility flag:

```
services.AddMvc()
    .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
```

The `[ApiController]` attribute is commonly coupled with `ControllerBase` to enable REST-specific behavior for controllers. `ControllerBase` provides access to methods such as [NotFound](#) and [File](#).

Another approach is to create a custom base controller class annotated with the `[ApiController]` attribute:

```
[ApiController]
public class MyBaseController
{}
```

The following sections describe convenience features added by the attribute.

### Automatic HTTP 400 responses

Validation errors automatically trigger an HTTP 400 response. The following code becomes unnecessary in your actions:

```
[ProducesResponseType(typeof(Pet), 201)]
[ProducesResponseType(400)]
public async Task<IActionResult> CreateAsync([FromBody] Pet pet)
```

The default behavior is disabled when the [SuppressModelStateInvalidFilter](#) property is set to `true`. Add the following code in `Startup.ConfigureServices` after

```
services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1); :
```

```
services.Configure<ApiBehaviorOptions>(options =>
{
    options.SuppressConsumesConstraintForFormFileParameters = true;
    options.SuppressInferBindingSourcesForParameters = true;
    options.SuppressModelStateInvalidFilter = true;
});
```

### Binding source parameter inference

A binding source attribute defines the location at which an action parameter's value is found. The following binding source attributes exist:

ATTRIBUTE	BINDING SOURCE
<a href="#">[FromBody]</a>	Request body
<a href="#">[FromForm]</a>	Form data in the request body
<a href="#">[FromHeader]</a>	Request header

ATTRIBUTE	BINDING SOURCE
[FromQuery]	Request query string parameter
[FromRoute]	Route data from the current request
[FromServices]	The request service injected as an action parameter

## **WARNING**

Don't use `[FromRoute]` when values might contain `%2f` (that is `/`). `%2f` won't be unescaped to `/`. Use `[FromQuery]` if the value might contain `%2f`.

Without the `[ApiController]` attribute, binding source attributes are explicitly defined. In the following example, the `[FromQuery]` attribute indicates that the `discontinuedOnly` parameter value is provided in the request URL's query string:

```
[HttpGet]
public async Task<ActionResult<List<Product>>> GetAsync(
    [FromQuery] bool discontinuedOnly = false)
{
    List<Product> products = null;

    if (discontinuedOnly)
    {
        products = await _repository.GetDiscontinuedProductsAsync();
    }
    else
    {
        products = await _repository.GetProductsAsync();
    }

    return products;
}
```

Inference rules are applied for the default data sources of action parameters. These rules configure the binding sources you're otherwise likely to manually apply to the action parameters. The binding source attributes behave as follows:

- **[FromBody]** is inferred for complex type parameters. An exception to this rule is any complex, built-in type with a special meaning, such as `IFormCollection` and `CancellationToken`. The binding source inference code ignores those special types. When an action has more than one parameter explicitly specified (via `[FromBody]`) or inferred as bound from the request body, an exception is thrown. For example, the following action signatures cause an exception:

- **[FromForm]** is inferred for action parameters of type [IFormFile](#) and [IFormFileCollection](#). It's not inferred for any simple or user-defined types.
- **[FromRoute]** is inferred for any action parameter name matching a parameter in the route template. When more than one route matches an action parameter, any route value is considered **[FromRoute]**.
- **[FromQuery]** is inferred for any other action parameters.

The default inference rules are disabled when the [SuppressInferBindingSourcesForParameters](#) property is set to `true`. Add the following code in `Startup.ConfigureServices` after

```
services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
```

```
services.Configure<ApiBehaviorOptions>(options =>
{
    options.SuppressConsumesConstraintForFormFileParameters = true;
    options.SuppressInferBindingSourcesForParameters = true;
    options.SuppressModelStateInvalidFilter = true;
});
```

## Multipart/form-data request inference

When an action parameter is annotated with the **[FromForm]** attribute, the `multipart/form-data` request content type is inferred.

The default behavior is disabled when the [SuppressConsumesConstraintForFormFileParameters](#) property is set to `true`. Add the following code in `Startup.ConfigureServices` after

```
services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
```

```
services.Configure<ApiBehaviorOptions>(options =>
{
    options.SuppressConsumesConstraintForFormFileParameters = true;
    options.SuppressInferBindingSourcesForParameters = true;
    options.SuppressModelStateInvalidFilter = true;
});
```

## Attribute routing requirement

Attribute routing becomes a requirement. For example:

```
[Route("api/[controller]")]
[ApiController]
public class ProductsController : ControllerBase
```

Actions are inaccessible via [conventional routes](#) defined in [UseMvc](#) or by [UseMvcWithDefaultRoute](#) in `Startup.Configure`.

## Additional resources

- [Controller action return types in ASP.NET Core Web API](#)
- [Custom formatters in ASP.NET Core Web API](#)
- [Format response data in ASP.NET Core Web API](#)
- [ASP.NET Core Web API help pages with Swagger / Open API](#)
- [Routing to controller actions in ASP.NET Core](#)

# Create a Web API with ASP.NET Core and Visual Studio Code

6/21/2018 • 15 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Mike Wasson](#)

In this tutorial, build a web API for managing a list of "to-do" items. A UI isn't constructed.

There are three versions of this tutorial:

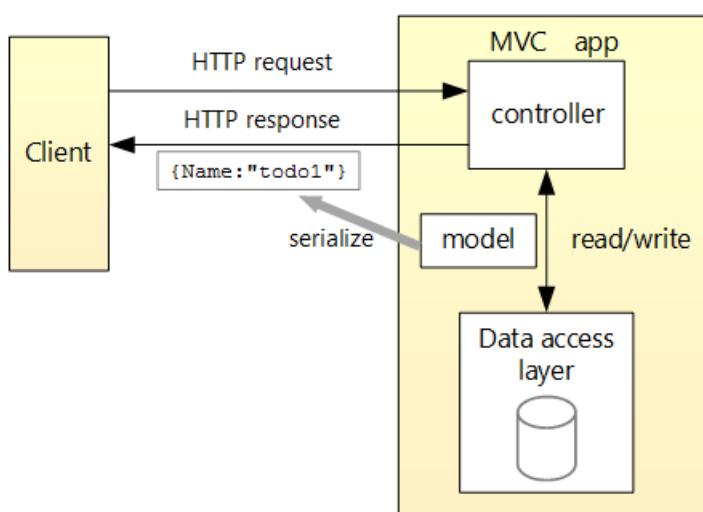
- macOS, Linux, Windows: Web API with Visual Studio Code (This tutorial)
- macOS: [Web API with Visual Studio for Mac](#)
- Windows: [Web API with Visual Studio for Windows](#)

## Overview

This tutorial creates the following API:

API	DESCRIPTION	REQUEST BODY	RESPONSE BODY
GET /api/todo	Get all to-do items	None	Array of to-do items
GET /api/todo/{id}	Get an item by ID	None	To-do item
POST /api/todo	Add a new item	To-do item	To-do item
PUT /api/todo/{id}	Update an existing item	To-do item	None
DELETE /api/todo/{id}	Delete an item	None	None

The following diagram shows the basic design of the app.



- The client is whatever consumes the web API (mobile app, browser, etc.). This tutorial doesn't create a client. [Postman](#) or [curl](#) is used as the client to test the app.
- A *model* is an object that represents the data in the app. In this case, the only model is a to-do item. Models are represented as C# classes, also known as **Plain Old CLR Object** (POCOs).

- A *controller* is an object that handles HTTP requests and creates the HTTP response. This app has a single controller.
- To keep the tutorial simple, the app doesn't use a persistent database. The sample app stores to-do items in an in-memory database.

## Prerequisites

Install the following:

- .NET Core SDK 2.0 or later
- Visual Studio Code
- C# for Visual Studio Code
- .NET Core 2.1 SDK or later
- Visual Studio Code
- C# for Visual Studio Code

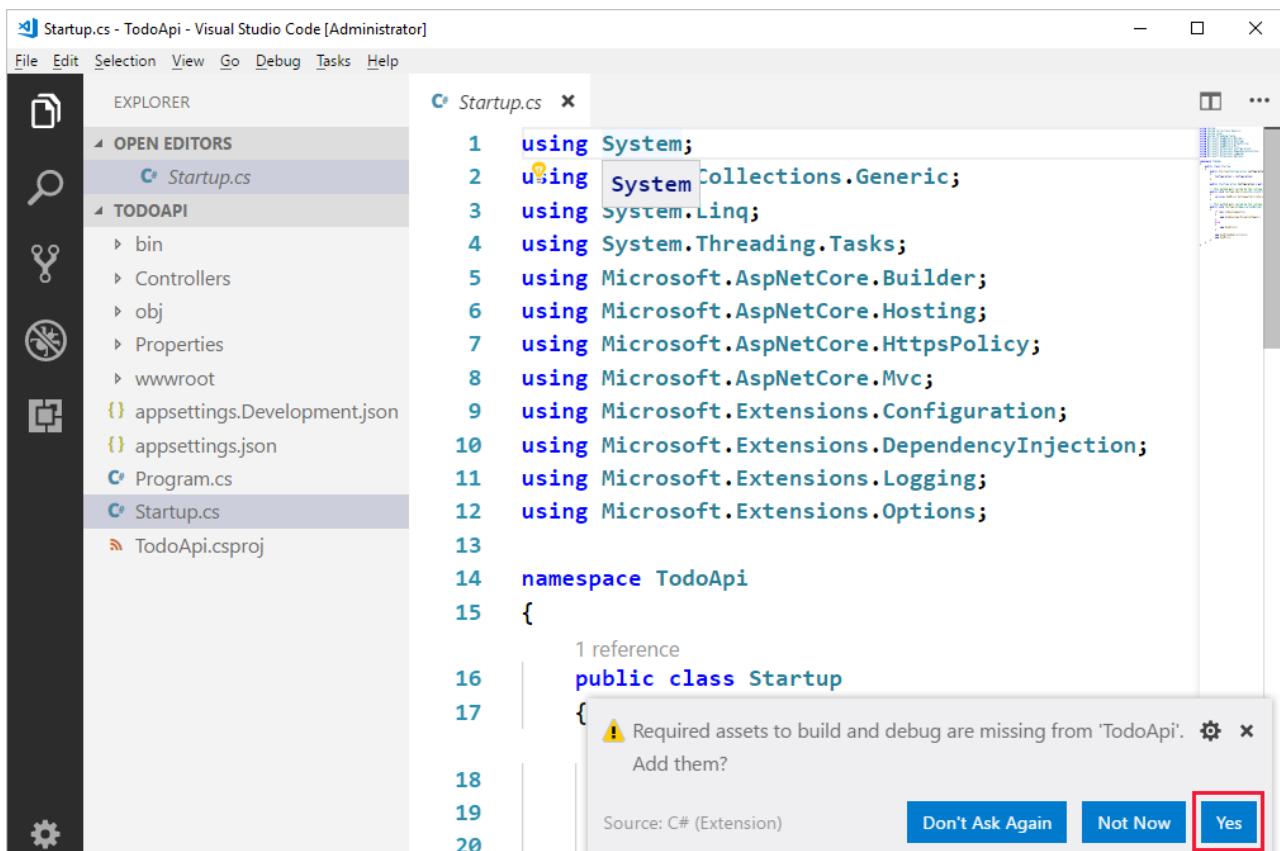
## Create the project

From a console, run the following commands:

```
dotnet new webapi -o TodoApi
code TodoApi
```

The *TodoApi* folder opens in Visual Studio Code (VS Code). Select the *Startup.cs* file.

- Select **Yes** to the **Warn** message "Required assets to build and debug are missing from 'TodoApi'. Add them?"
- Select **Restore** to the **Info** message "There are unresolved dependencies".



Press **Debug** (F5) to build and run the program. In a browser, navigate to <http://localhost:5000/api/values>. The

following output is displayed:

```
["value1","value2"]
```

See [Visual Studio Code help](#) for tips on using VS Code.

## Add support for Entity Framework Core

Creating a new project in ASP.NET Core 2.0 adds the [Microsoft.AspNetCore.All](#) package reference to the `TodoApi.csproj` file:

```
<ItemGroup>
  <PackageReference Include="Microsoft.AspNetCore.All" Version="2.0.3" />
</ItemGroup>
```

Creating a new project in ASP.NET Core 2.1 or later adds the [Microsoft.AspNetCore.App](#) package reference to the `TodoApi.csproj` file:

```
<ItemGroup>
  <PackageReference Include="Microsoft.AspNetCore.App" Version="2.1.1" />
</ItemGroup>
```

There's no need to install the [Entity Framework Core InMemory](#) database provider separately. This database provider allows Entity Framework Core to be used with an in-memory database.

## Add a model class

A model is an object representing the data in your app. In this case, the only model is a to-do item.

Add a folder named `Models`. You can put model classes anywhere in your project, but the `Models` folder is used by convention.

Add a `TodoItem` class with the following code:

```
namespace TodoApi.Models
{
    public class TodoItem
    {
        public long Id { get; set; }
        public string Name { get; set; }
        public bool IsComplete { get; set; }
    }
}
```

The database generates the `Id` when a `TodoItem` is created.

## Create the database context

The *database context* is the main class that coordinates Entity Framework functionality for a given data model. You create this class by deriving from the [Microsoft.EntityFrameworkCore.DbContext](#) class.

Add a `TodoContext` class in the `Models` folder:

```
using Microsoft.EntityFrameworkCore;

namespace TodoApi.Models
{
    public class TodoContext : DbContext
    {
        public TodoContext(DbContextOptions<TodoContext> options)
            : base(options)
        {
        }

        public DbSet<TodoItem> TodoItems { get; set; }
    }
}
```

## Register the database context

In this step, the database context is registered with the [dependency injection](#) container. Services (such as the DB context) that are registered with the dependency injection (DI) container are available to the controllers.

Register the DB context with the service container using the built-in support for [dependency injection](#). Replace the contents of the *Startup.cs* file with the following code:

```
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Mvc;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using TodoApi.Models;

namespace TodoApi
{
    public class Startup
    {
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<TodoContext>(opt =>
                opt.UseInMemoryDatabase("TodoList"));
            services.AddMvc()
                .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
        }

        public void Configure(IApplicationBuilder app)
        {
            app.UseMvc();
        }
    }
}
```

```

using Microsoft.AspNetCore.Builder;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using TodoApi.Models;

namespace TodoApi
{
    public class Startup
    {
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<TodoContext>(opt =>
                opt.UseInMemoryDatabase("TodoList"));
            services.AddMvc();
        }

        public void Configure(IApplicationBuilder app)
        {
            app.UseMvc();
        }
    }
}

```

The preceding code:

- Removes the unused code.
- Specifies an in-memory database is injected into the service container.

## Add a controller

In the *Controllers* folder, create a class named `TodoController`. Replace its contents with the following code:

```

using Microsoft.AspNetCore.Mvc;
using System.Collections.Generic;
using System.Linq;
using TodoApi.Models;

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

        public TodoController(TodoContext context)
        {
            _context = context;

            if (_context.TodoItems.Count() == 0)
            {
                _context.TodoItems.Add(new TodoItem { Name = "Item1" });
                _context.SaveChanges();
            }
        }
    }
}

```

The preceding code defines an API controller class without methods. In the next sections, methods are added to implement the API.

```

using Microsoft.AspNetCore.Mvc;
using System.Collections.Generic;
using System.Linq;
using TodoApi.Models;

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    [ApiController]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

        public TodoController(TodoContext context)
        {
            _context = context;

            if (_context.TodoItems.Count() == 0)
            {
                _context.TodoItems.Add(new TodoItem { Name = "Item1" });
                _context.SaveChanges();
            }
        }
    }
}

```

The preceding code defines an API controller class without methods. In the next sections, methods are added to implement the API. The class is annotated with an `[ApiController]` attribute to enable some convenient features. For information on features enabled by the attribute, see [Annotate class with ApiControllerAttribute](#).

The controller's constructor uses [Dependency Injection](#) to inject the database context (`TodoContext`) into the controller. The database context is used in each of the [CRUD](#) methods in the controller. The constructor adds an item to the in-memory database if one doesn't exist.

## Get to-do items

To get to-do items, add the following methods to the `TodoController` class:

```

[HttpGet]
public List<TodoItem> GetAll()
{
    return _context.TodoItems.ToList();
}

[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}

```

```

[HttpGet]
public ActionResult<List<TodoItem>> GetAll()
{
    return _context.TodoItems.ToList();
}

[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}

```

These methods implement the two GET methods:

- `GET /api/todo`
- `GET /api/todo/{id}`

Here's a sample HTTP response for the `GetAll` method:

```
[
{
    "id": 1,
    "name": "Item1",
    "isComplete": false
}
]
```

Later in the tutorial, I'll show how the HTTP response can be viewed with [Postman](#) or [curl](#).

## Routing and URL paths

The `[HttpGet]` attribute denotes a method that responds to an HTTP GET request. The URL path for each method is constructed as follows:

- Take the template string in the controller's `Route` attribute:

```

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;
    }
}
```

```

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    [ApiController]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;
    }
}
```

- Replace `[controller]` with the name of the controller, which is the controller class name minus the "Controller" suffix. For this sample, the controller class name is **TodoController** and the root name is "todo". ASP.NET Core [routing](#) is case insensitive.

- If the `[HttpGet]` attribute has a route template (such as `[HttpGet("/products")]`), append that to the path. This sample doesn't use a template. For more information, see [Attribute routing with Http\[Verb\] attributes](#).

In the following  `GetById` method, `"{id}"` is a placeholder variable for the unique identifier of the to-do item. When  `GetById` is invoked, it assigns the value of `"{id}"` in the URL to the method's `id` parameter.

```
[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}
```

```
[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}
```

`Name = "GetTodo"` creates a named route. Named routes:

- Enable the app to create an HTTP link using the route name.
- Are explained later in the tutorial.

## Return values

The  `GetAll` method returns a collection of  `TodoItem` objects. MVC automatically serializes the object to  `JSON` and writes the JSON into the body of the response message. The response code for this method is 200, assuming there are no unhandled exceptions. Unhandled exceptions are translated into 5xx errors.

In contrast, the  `GetById` method returns the more general `IActionResult type`, which represents a wide range of return types.  `GetById` has two different return types:

- If no item matches the requested ID, the method returns a 404 error. Returning `NotFound` returns an HTTP 404 response.
- Otherwise, the method returns 200 with a JSON response body. Returning `Ok` results in an HTTP 200 response.

In contrast, the  `GetById` method returns the `ActionResult<T> type`, which represents a wide range of return types.  `GetById` has two different return types:

- If no item matches the requested ID, the method returns a 404 error. Returning `NotFound` returns an HTTP 404 response.
- Otherwise, the method returns 200 with a JSON response body. Returning  `item` results in an HTTP 200 response.

## Launch the app

In VS Code, press F5 to launch the app. Navigate to <http://localhost:5000/api/todo> (the  `Todo` controller we created).

## Call the Web API with jQuery

In this section, an HTML page is added that uses jQuery to call the Web API. jQuery initiates the request and updates the page with the details from the API's response.

Configure the project to serve static files and to enable default file mapping. This is accomplished by invoking the [UseStaticFiles](#) and [UseDefaultFiles](#) extension methods in *Startup.Configure*. For more information, see [Static files](#).

```
public void Configure(IApplicationBuilder app)
{
    app.UseDefaultFiles();
    app.UseStaticFiles();
    app.UseMvc();
}
```

Add an HTML file, named *index.html*, to the project's *wwwroot* directory. Replace its contents with the following markup:

```
<!DOCTYPE html>
<html>
<head>
    <meta charset="UTF-8">
    <title>To-do CRUD</title>
    <style>
        input[type='submit'], button, [aria-label] {
            cursor: pointer;
        }

        #spoiler {
            display: none;
        }

        table {
            font-family: Arial, sans-serif;
            border: 1px solid;
            border-collapse: collapse;
        }

        th {
            background-color: #0066CC;
            color: white;
        }

        td {
            border: 1px solid;
            padding: 5px;
        }
    </style>
</head>
<body>
    <h1>To-do CRUD</h1>
    <h3>Add</h3>
    <form action="javascript:void(0);" method="POST" onsubmit="addItem()">
        <input type="text" id="add-name" placeholder="New to-do">
        <input type="submit" value="Add">
    </form>

    <div id="spoiler">
        <h3>Edit</h3>
        <form class="my-form">
            <input type="hidden" id="edit-id">
            <input type="checkbox" id="edit-isComplete">
            <input type="text" id="edit-name">
            <input type="submit" value="Edit">
        </form>
    </div>
</body>
```

```

        \a UNQUOTE- CLOSEINPUT()  DATA-TABSTOP- CLOSE /DATA0000,\a/
    </form>
</div>

<p id="counter"></p>

<table>
    <tr>
        <th>Is Complete</th>
        <th>Name</th>
        <th></th>
        <th></th>
    </tr>
    <tbody id="todos"></tbody>
</table>

<script src="https://code.jquery.com/jquery-3.3.1.min.js"
        integrity="sha256-FgpCb/KJQ1LNfOu91ta32o/NMZxltwRo8QtmkMRdAu8="
        crossorigin="anonymous"></script>
<script src="site.js"></script>
</body>
</html>

```

Add a JavaScript file, named *site.js*, to the project's *wwwroot* directory. Replace its contents with the following code:

```

const uri = 'api/todo';
let todos = null;
function getCount(data) {
    const el = $('#counter');
    let name = 'to-do';
    if (data) {
        if (data > 1) {
            name = 'to-dos';
        }
        el.text(data + ' ' + name);
    } else {
        el.html('No ' + name);
    }
}

$(document).ready(function () {
    getData();
});

function getData() {
    $.ajax({
        type: 'GET',
        url: uri,
        success: function (data) {
            $('#todos').empty();
            getCount(data.length);
            $.each(data, function (key, item) {
                const checked = item.isComplete ? 'checked' : '';

                $('<tr><td><input disabled="true" type="checkbox" ' + checked + '></td>' +
                    '<td>' + item.name + '</td>' +
                    '<td><button onclick="editItem(' + item.id + ')>Edit</button></td>' +
                    '<td><button onclick="deleteItem(' + item.id + ')>Delete</button></td>' +
                    '</tr>').appendTo($('#todos'));
            });
            todos = data;
        }
    });
}

function addItem() {
    const item = f

```

```

const item = {
  'name': $('#add-name').val(),
  'isComplete': false
};

$.ajax({
  type: 'POST',
  accepts: 'application/json',
  url: uri,
  contentType: 'application/json',
  data: JSON.stringify(item),
  error: function (jqXHR, textStatus, errorThrown) {
    alert('here');
  },
  success: function (result) {
    getData();
    $('#add-name').val('');
  }
});

function deleteItem(id) {
  $.ajax({
    url: uri + '/' + id,
    type: 'DELETE',
    success: function (result) {
      getData();
    }
  });
}

function editItem(id) {
  $.each(todos, function (key, item) {
    if (item.id === id) {
      $('#edit-name').val(item.name);
      $('#edit-id').val(item.id);
      $('#edit-isComplete').val(item.isComplete);
    }
  });
  $('#spoiler').css({ 'display': 'block' });
}

$('.my-form').on('submit', function () {
  const item = {
    'name': $('#edit-name').val(),
    'isComplete': $('#edit-isComplete').is(':checked'),
    'id': $('#edit-id').val()
  };

  $.ajax({
    url: uri + '/' + $('#edit-id').val(),
    type: 'PUT',
    accepts: 'application/json',
    contentType: 'application/json',
    data: JSON.stringify(item),
    success: function (result) {
      getData();
    }
  });

  closeInput();
  return false;
});

function closeInput() {
  $('#spoiler').css({ 'display': 'none' });
}

```

A change to the ASP.NET Core project's launch settings may be required to test the HTML page locally. Open `launchSettings.json` in the `Properties` directory of the project. Remove the `launchUrl` property to force the app to open at `index.html`—the project's default file.

There are several ways to get jQuery. In the preceding snippet, the library is loaded from a CDN. This sample is a complete CRUD example of calling the API with jQuery. There are additional features in this sample to make the experience richer. Below are explanations around the calls to the API.

## Get a list of to-do items

To get a list of to-do items, send an HTTP GET request to `/api/todo`.

The jQuery `ajax` function sends an AJAX request to the API, which returns JSON representing an object or array. This function can handle all forms of HTTP interaction, sending an HTTP request to the specified `url`. `GET` is used as the `type`. The `success` callback function is invoked if the request succeeds. In the callback, the DOM is updated with the to-do information.

```
$(document).ready(function () {
    getData();
});

function getData() {
    $.ajax({
        type: 'GET',
        url: uri,
        success: function (data) {
            $('#todos').empty();
            getCount(data.length);
            $.each(data, function (key, item) {
                const checked = item.isComplete ? 'checked' : '';

                $('<tr><td><input disabled="true" type="checkbox" ' + checked + '></td>' +
                    '<td>' + item.name + '</td>' +
                    '<td><button onclick="editItem(' + item.id + ')>Edit</button></td>' +
                    '<td><button onclick="deleteItem(' + item.id + ')>Delete</button></td>' +
                    '</tr>').appendTo($('#todos'));
            });
            todos = data;
        }
    });
}
```

## Add a to-do item

To add a to-do item, send an HTTP POST request to `/api/todo/`. The request body should contain a to-do object. The `ajax` function is using `POST` to call the API. For `POST` and `PUT` requests, the request body represents the data sent to the API. The API is expecting a JSON request body. The `accepts` and `contentType` options are set to `application/json` to classify the media type being received and sent, respectively. The data is converted to a JSON object using `JSON.stringify`. When the API returns a successful status code, the `getData` function is invoked to update the HTML table.

```

function addItem() {
  const item = {
    'name': $('#add-name').val(),
    'isComplete': false
  };

  $.ajax({
    type: 'POST',
    accepts: 'application/json',
    url: uri,
    contentType: 'application/json',
    data: JSON.stringify(item),
    error: function (jqXHR, textStatus, errorThrown) {
      alert('here');
    },
    success: function (result) {
      getData();
      $('#add-name').val('');
    }
  });
}

```

## Update a to-do item

Updating a to-do item is very similar to adding one, since both rely on a request body. The only real difference between the two in this case is that the `url` changes to add the unique identifier of the item, and the `type` is `PUT`.

```

$.ajax({
  url: uri + '/' + $('#edit-id').val(),
  type: 'PUT',
  accepts: 'application/json',
  contentType: 'application/json',
  data: JSON.stringify(item),
  success: function (result) {
    getData();
  }
});

```

## Delete a to-do item

Deleting a to-do item is accomplished by setting the `type` on the AJAX call to `DELETE` and specifying the item's unique identifier in the URL.

```

$.ajax({
  url: uri + '/' + id,
  type: 'DELETE',
  success: function (result) {
    getData();
  }
});

```

## Implement the other CRUD operations

In the following sections, `Create`, `Update`, and `Delete` methods are added to the controller.

### Create

Add the following `Create` method:

```

[HttpPost]
public IActionResult Create([FromBody] TodoItem item)
{
    if (item == null)
    {
        return BadRequest();
    }

    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}

```

The preceding code is an HTTP POST method, as indicated by the `[HttpPost]` attribute. The `[FromBody]` attribute tells MVC to get the value of the to-do item from the body of the HTTP request.

```

[HttpPost]
public IActionResult Create(TodoItem item)
{
    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}

```

The preceding code is an HTTP POST method, as indicated by the `[HttpPost]` attribute. MVC gets the value of the to-do item from the body of the HTTP request.

The `CreatedAtRoute` method:

- Returns a 201 response. HTTP 201 is the standard response for an HTTP POST method that creates a new resource on the server.
- Adds a Location header to the response. The Location header specifies the URI of the newly created to-do item. See [10.2.2 201 Created](#).
- Uses the "GetTodo" named route to create the URL. The "GetTodo" named route is defined in  `GetById`:

```

[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}

```

```

[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}

```

## Use Postman to send a Create request

- Start the app.
- Open Postman.

The screenshot shows the Postman interface with a red box highlighting the 'POST' method in the top bar. Another red box highlights the 'Body' tab in the navigation bar. A third red box highlights the 'raw' radio button under the body type dropdown. A fourth red box highlights the JSON (application/json) option in the dropdown. The request URL is https://localhost:44375/api/todo. The response pane shows a status of 201 Created and the JSON response: { "id": 6, "name": "walk dog", "isComplete": true }.

- Update the port number in the localhost URL.
- Set the HTTP method to *POST*.
- Click the **Body** tab.
- Select the **raw** radio button.
- Set the type to *JSON (application/json)*.
- Enter a request body with a to-do item resembling the following JSON:

```
{  
  "name": "walk dog",  
  "isComplete": true  
}
```

- Click the **Send** button.

### TIP

If no response displays after clicking **Send**, disable the **SSL certification verification** option. This is found under **File > Settings**. Click the **Send** button again after disabling the setting.

Click the **Headers** tab in the **Response** pane and copy the **Location** header value:

The screenshot shows the Postman application interface. At the top, there's a navigation bar with File, Edit, View, Help, and a workspace dropdown labeled "My Workspace". Below the header are buttons for New, Import, Runner, and a plus sign. To the right of the workspace are icons for sync status ("IN SYNC") and notifications.

The main area shows a request configuration for a POST method to the URL <https://localhost:44375/api/todo>. The "Body" tab is selected, showing a JSON payload:

```
1 [{}  
2   "name": "walk dog",  
3   "isComplete": true  
4 }]
```

Below the body, the "Headers" tab is highlighted with a red box, showing seven headers: Content-Type → application/json; charset=utf-8, Date → Fri, 27 Apr 2018 18:32:32 GMT, and Location → <https://localhost/api/Todo/6>.

The status bar at the bottom indicates a 201 Created response and a time of 148 ms.

The Location header URI can be used to access the new item.

## Update

Add the following `Update` method:

```
[HttpPut("{id}")]  
public IActionResult Update(long id, [FromBody] TodoItem item)  
{  
    if (item == null || item.Id != id)  
    {  
        return BadRequest();  
    }  
  
    var todo = _context.TodoItems.Find(id);  
    if (todo == null)  
    {  
        return NotFound();  
    }  
  
    todo.IsComplete = item.IsComplete;  
    todo.Name = item.Name;  
  
    _context.TodoItems.Update(todo);  
    _context.SaveChanges();  
    return NoContent();  
}
```

```
[HttpPut("{id}")]
public IActionResult Update(long id, TodoItem item)
{
    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    todo.IsComplete = item.IsComplete;
    todo.Name = item.Name;

    _context.TodoItems.Update(todo);
    _context.SaveChanges();
    return NoContent();
}
```

`Update` is similar to `Create`, except it uses HTTP PUT. The response is [204 \(No Content\)](#). According to the HTTP specification, a PUT request requires the client to send the entire updated entity, not just the deltas. To support partial updates, use HTTP PATCH.

Use Postman to update the to-do item's name to "walk cat":

The screenshot shows the Postman application interface. The request URL is `https://localhost:44375/api/todo/1`. The method is set to `PUT`. The `Body` tab is selected, and the `raw` option is chosen. The JSON payload is:

```
1 {  
2     "name": "walk cat",  
3     "isComplete": true  
4 }
```

The response status is `204 No Content` and the time taken is `70 ms`.

## Delete

Add the following `Delete` method:

```
[HttpDelete("{id}")]
public IActionResult Delete(long id)
{
    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    _context.TodoItems.Remove(todo);
    _context.SaveChanges();
    return NoContent();
}
```

The `Delete` response is [204 \(No Content\)](#).

Use Postman to delete the to-do item:

The screenshot shows the Postman application window. The top navigation bar includes File, Edit, View, Help, New, Import, Runner, My Workspace (with three environments listed), and various status indicators like IN SYNC and notifications.

The main interface shows a request configuration for a DELETE method directed at <https://localhost:44375/api/todo/1>. The 'Authorization' tab is selected, showing 'No Auth' selected from a dropdown. A note states: "The authorization header will be automatically generated when you send the request. [Learn more about authorization](#)". The 'Headers' tab shows four headers: 'Content-Type: application/json', 'Accept: application/json', 'Cache-Control: no-cache', and 'Postman-Token: 1234567890'. The 'Body' tab is currently active, showing a JSON object with a single key '1':

```
{
  "1": {}
}
```

The bottom status bar indicates the request was successful with a status of 204 No Content and a time of 735 ms.

## Visual Studio Code help

- [Getting started](#)
- [Debugging](#)
- [Integrated terminal](#)
- [Keyboard shortcuts](#)
  - [macOS keyboard shortcuts](#)

- [Linux keyboard shortcuts](#)
- [Windows keyboard shortcuts](#)

## Next steps

- For information on using a persistent database, see:
  - [Create a Razor Pages web app with ASP.NET Core](#)
  - [Work with data in ASP.NET Core](#)
- [ASP.NET Core Web API help pages using Swagger](#)
- [Routing to controller actions](#)
- [Build web APIs with ASP.NET Core](#)
- [Controller action return types](#)
- For information about deploying an API, including to Azure App Service, see [Host and deploy](#).
- [View or download sample code](#). See [how to download](#).

# Create a Web API with ASP.NET Core and Visual Studio for Mac

6/21/2018 • 15 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Mike Wasson](#)

In this tutorial, build a web API for managing a list of "to-do" items. The UI isn't constructed.

There are three versions of this tutorial:

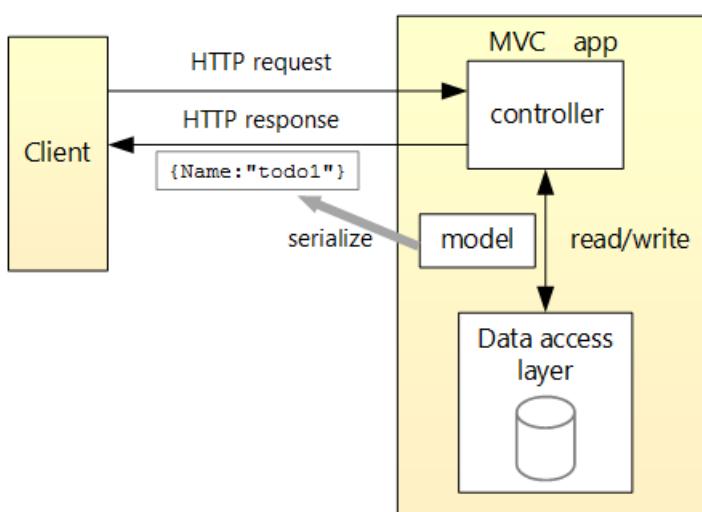
- macOS: Web API with Visual Studio for Mac (This tutorial)
- Windows: [Web API with Visual Studio for Windows](#)
- macOS, Linux, Windows: [Web API with Visual Studio Code](#)

## Overview

This tutorial creates the following API:

API	DESCRIPTION	REQUEST BODY	RESPONSE BODY
GET /api/todo	Get all to-do items	None	Array of to-do items
GET /api/todo/{id}	Get an item by ID	None	To-do item
POST /api/todo	Add a new item	To-do item	To-do item
PUT /api/todo/{id}	Update an existing item	To-do item	None
DELETE /api/todo/{id}	Delete an item	None	None

The following diagram shows the basic design of the app.



- The client is whatever consumes the web API (mobile app, browser, etc.). This tutorial doesn't create a client. [Postman](#) or [curl](#) is used as the client to test the app.
- A *model* is an object that represents the data in the app. In this case, the only model is a to-do item. Models are represented as C# classes, also known as **Plain Old ClR Object** (POCOs).

- A *controller* is an object that handles HTTP requests and creates the HTTP response. This app has a single controller.
- To keep the tutorial simple, the app doesn't use a persistent database. The sample app stores to-do items in an in-memory database.

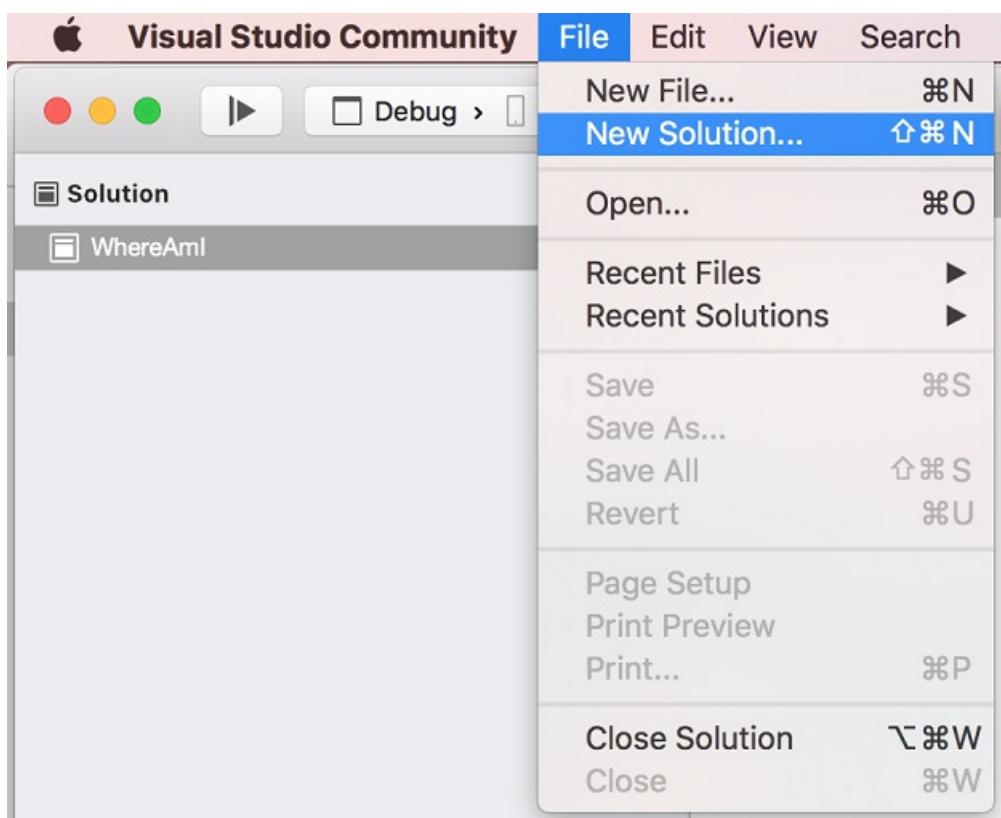
See [Introduction to ASP.NET Core MVC on macOS or Linux](#) for an example that uses a persistent database.

## Prerequisites

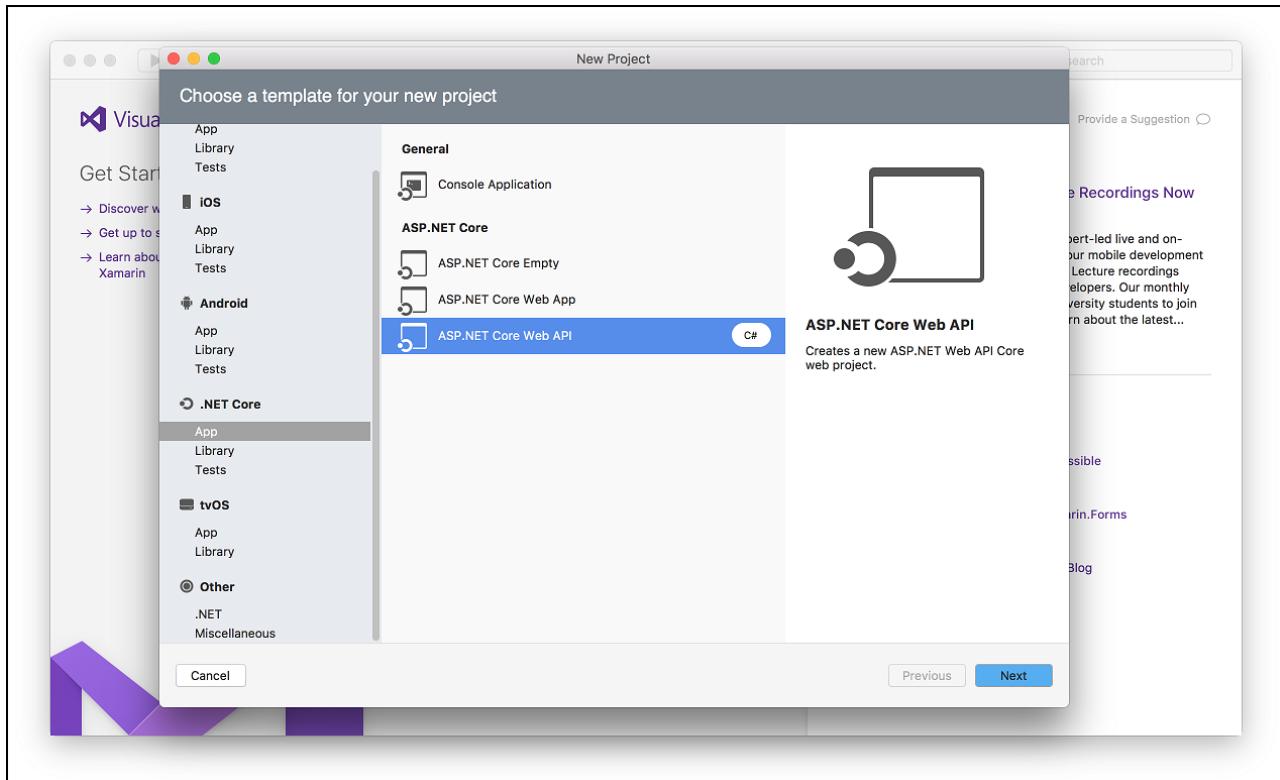
[Visual Studio for Mac](#)

## Create the project

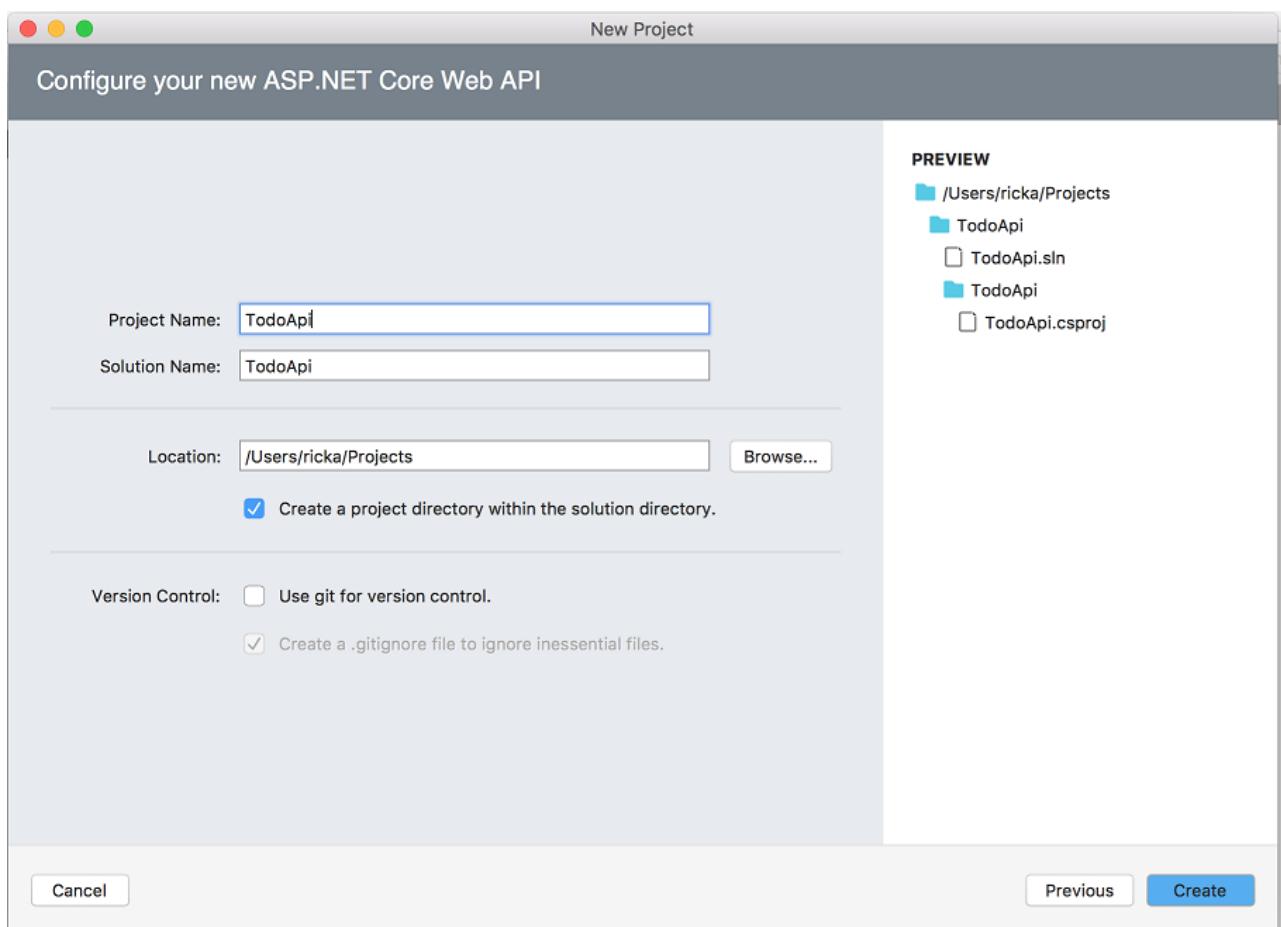
From Visual Studio, select **File > New Solution**.



Select **.NET Core App > ASP.NET Core Web API > Next**.



Enter *TodoApi* for the **Project Name**, and then click **Create**.



## Launch the app

In Visual Studio, select **Run > Start With Debugging** to launch the app. Visual Studio launches a browser and navigates to `http://localhost:5000`. You get an HTTP 404 (Not Found) error. Change the URL to `http://localhost:<port>/api/values`. The `ValuesController` data is displayed:

```
["value1","value2"]
```

## Add support for Entity Framework Core

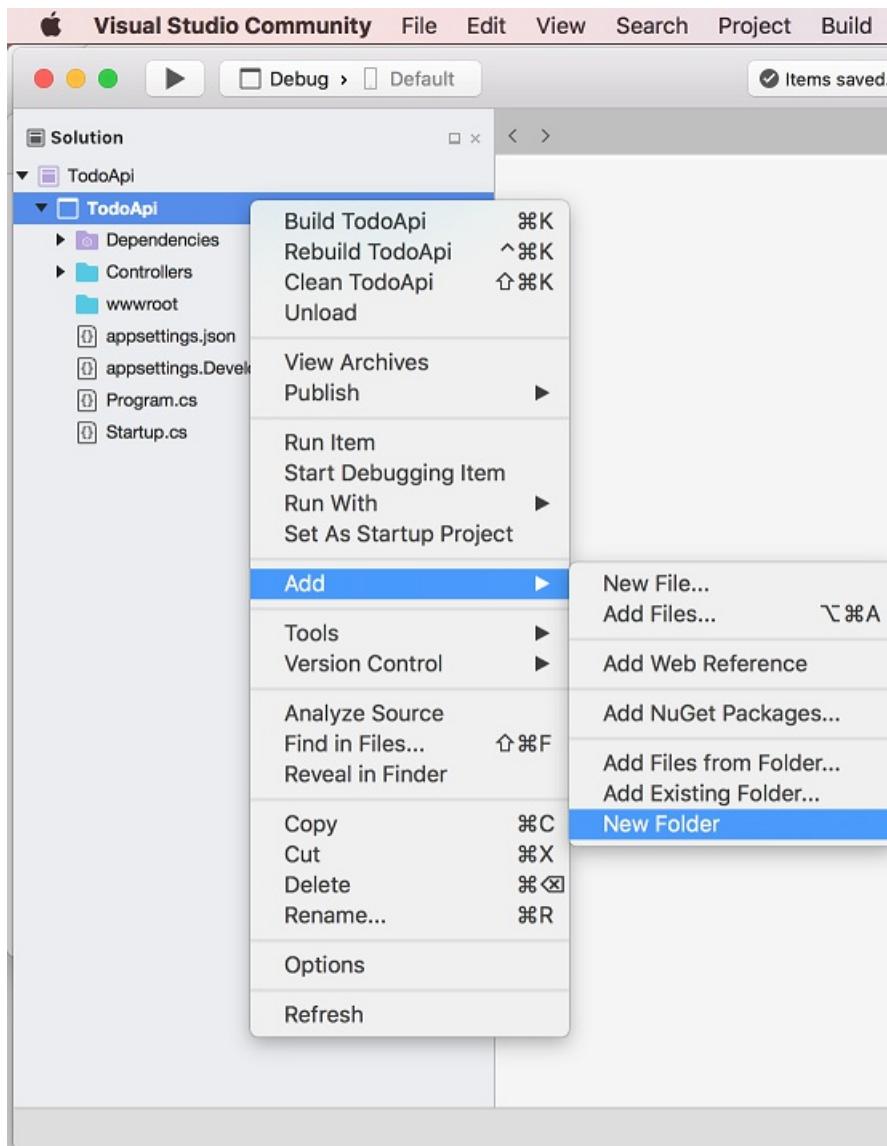
Install the [Entity Framework Core InMemory](#) database provider. This database provider allows Entity Framework Core to be used with an in-memory database.

- From the **Project** menu, select **Add NuGet Packages**.
  - Alternatively, you can right-click **Dependencies**, and then select **Add Packages**.
- Enter `EntityFrameworkCore.InMemory` in the search box.
- Select `Microsoft.EntityFrameworkCore.InMemory`, and then select **Add Package**.

## Add a model class

A model is an object representing the data in your app. In this case, the only model is a to-do item.

In Solution Explorer, right-click the project. Select **Add > New Folder**. Name the folder *Models*.



### NOTE

You can put model classes anywhere in your project, but the *Models* folder is used by convention.

Right-click the *Models* folder, and select **Add > New File > General > Empty Class**. Name the class *TodoItem*,

and then click **New**.

Replace the generated code with:

```
namespace TodoApi.Models
{
    public class TodoItem
    {
        public long Id { get; set; }
        public string Name { get; set; }
        public bool IsComplete { get; set; }
    }
}
```

The database generates the `Id` when a `TodoItem` is created.

### Create the database context

The *database context* is the main class that coordinates Entity Framework functionality for a given data model. You create this class by deriving from the `Microsoft.EntityFrameworkCore.DbContext` class.

Add a `TodoContext` class to the *Models* folder.

```
using Microsoft.EntityFrameworkCore;

namespace TodoApi.Models
{
    public class TodoContext : DbContext
    {
        public TodoContext(DbContextOptions<TodoContext> options)
            : base(options)
        {

        }

        public DbSet<TodoItem> TodoItems { get; set; }
    }
}
```

### Register the database context

In this step, the database context is registered with the [dependency injection](#) container. Services (such as the DB context) that are registered with the dependency injection (DI) container are available to the controllers.

Register the DB context with the service container using the built-in support for [dependency injection](#). Replace the contents of the *Startup.cs* file with the following code:

```

using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Mvc;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using TodoApi.Models;

namespace TodoApi
{
    public class Startup
    {
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<TodoContext>(opt =>
                opt.UseInMemoryDatabase("TodoList"));
            services.AddMvc()
                .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
        }

        public void Configure(IApplicationBuilder app)
        {
            app.UseMvc();
        }
    }
}

```

```

using Microsoft.AspNetCore.Builder;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using TodoApi.Models;

namespace TodoApi
{
    public class Startup
    {
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<TodoContext>(opt =>
                opt.UseInMemoryDatabase("TodoList"));
            services.AddMvc();
        }

        public void Configure(IApplicationBuilder app)
        {
            app.UseMvc();
        }
    }
}

```

The preceding code:

- Removes the unused code.
- Specifies an in-memory database is injected into the service container.

## Add a controller

In Solution Explorer, in the *Controllers* folder, add the class `TodoController`.

Replace the generated code with the following:

```

using Microsoft.AspNetCore.Mvc;
using System.Collections.Generic;
using System.Linq;
using TodoApi.Models;

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

        public TodoController(TodoContext context)
        {
            _context = context;

            if (_context.TodoItems.Count() == 0)
            {
                _context.TodoItems.Add(new TodoItem { Name = "Item1" });
                _context.SaveChanges();
            }
        }
    }
}

```

The preceding code defines an API controller class without methods. In the next sections, methods are added to implement the API.

```

using Microsoft.AspNetCore.Mvc;
using System.Collections.Generic;
using System.Linq;
using TodoApi.Models;

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    [ApiController]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

        public TodoController(TodoContext context)
        {
            _context = context;

            if (_context.TodoItems.Count() == 0)
            {
                _context.TodoItems.Add(new TodoItem { Name = "Item1" });
                _context.SaveChanges();
            }
        }
    }
}

```

The preceding code defines an API controller class without methods. In the next sections, methods are added to implement the API. The class is annotated with an `[ApiController]` attribute to enable some convenient features. For information on features enabled by the attribute, see [Annotate class with ApiControllerAttribute](#).

The controller's constructor uses [Dependency Injection](#) to inject the database context (`TodoContext`) into the controller. The database context is used in each of the [CRUD](#) methods in the controller. The constructor adds an item to the in-memory database if one doesn't exist.

## Get to-do items

To get to-do items, add the following methods to the `TodoController` class:

```
[HttpGet]
public List<TodoItem> GetAll()
{
    return _context.TodoItems.ToList();
}

[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}
```

```
[HttpGet]
public ActionResult<List<TodoItem>> GetAll()
{
    return _context.TodoItems.ToList();
}

[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}
```

These methods implement the two GET methods:

- `GET /api/todo`
- `GET /api/todo/{id}`

Here's a sample HTTP response for the `GetAll` method:

```
[
{
    "id": 1,
    "name": "Item1",
    "isComplete": false
}]
```

Later in the tutorial, I'll show how the HTTP response can be viewed with [Postman](#) or [curl](#).

### Routing and URL paths

The `[HttpGet]` attribute denotes a method that responds to an HTTP GET request. The URL path for each method is constructed as follows:

- Take the template string in the controller's `Route` attribute:

```

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

```

```

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    [ApiController]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

```

- Replace `[controller]` with the name of the controller, which is the controller class name minus the "Controller" suffix. For this sample, the controller class name is **TodoController** and the root name is "todo". ASP.NET Core [routing](#) is case insensitive.
- If the `[HttpGet]` attribute has a route template (such as `[HttpGet("/products")]`), append that to the path. This sample doesn't use a template. For more information, see [Attribute routing with Http\[Verb\] attributes](#).

In the following  `GetById` method, `"{id}"` is a placeholder variable for the unique identifier of the to-do item. When  `GetById` is invoked, it assigns the value of `"{id}"` in the URL to the method's `id` parameter.

```

[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}

```

```

[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}

```

`Name = "GetTodo"` creates a named route. Named routes:

- Enable the app to create an HTTP link using the route name.
- Are explained later in the tutorial.

## Return values

The  `GetAll` method returns a collection of `TodoItem` objects. MVC automatically serializes the object to [JSON](#) and writes the JSON into the body of the response message. The response code for this method is 200, assuming there are no unhandled exceptions. Unhandled exceptions are translated into 5xx errors.

In contrast, the  `GetById` method returns the more general [IActionResult type](#), which represents a wide range of

return types.  `GetById` has two different return types:

- If no item matches the requested ID, the method returns a 404 error. Returning `NotFound` returns an HTTP 404 response.
- Otherwise, the method returns 200 with a JSON response body. Returning `Ok` results in an HTTP 200 response.

In contrast, the  `GetById` method returns the `ActionResult<T>` type, which represents a wide range of return types.  `GetById` has two different return types:

- If no item matches the requested ID, the method returns a 404 error. Returning `NotFound` returns an HTTP 404 response.
- Otherwise, the method returns 200 with a JSON response body. Returning `item` results in an HTTP 200 response.

## Launch the app

In Visual Studio, select **Run > Start With Debugging** to launch the app. Visual Studio launches a browser and navigates to `http://localhost:<port>`, where `<port>` is a randomly chosen port number. You get an HTTP 404 (Not Found) error. Change the URL to `http://localhost:<port>/api/values`. The `ValuesController` data is displayed:

```
["value1","value2"]
```

Navigate to the `Todo` controller at `http://localhost:<port>/api/todo`. The following JSON is returned:

```
[{"key":1,"name":"Item1","isComplete":false}]
```

## Implement the other CRUD operations

We'll add `Create`, `Update`, and `Delete` methods to the controller. These methods are variations on a theme, so I'll just show the code and highlight the main differences. Build the project after adding or changing code.

### Create

```
[HttpPost]
public IActionResult Create([FromBody] TodoItem item)
{
    if (item == null)
    {
        return BadRequest();
    }

    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}
```

The preceding method responds to an HTTP POST, as indicated by the `[HttpPost]` attribute. The `[FromBody]` attribute tells MVC to get the value of the to-do item from the body of the HTTP request.

```
[HttpPost]
public IActionResult Create(TodoItem item)
{
    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}
```

The preceding method responds to an HTTP POST, as indicated by the `[HttpPost]` attribute. MVC gets the value of the to-do item from the body of the HTTP request.

The `CreatedAtRoute` method returns a 201 response. It's the standard response for an HTTP POST method that creates a new resource on the server. `CreatedAtRoute` also adds a Location header to the response. The Location header specifies the URI of the newly created to-do item. See [10.2.2 201 Created](#).

### Use Postman to send a Create request

- Start the app ([Run > Start With Debugging](#)).
- Open Postman.

The screenshot shows the Postman application interface. The top navigation bar includes File, Edit, View, Help, New, Import, Runner, My Workspace (IN SYNC), and environment dropdown. The main area shows a POST request to `https://localhost:44375/api/todo`. The Body tab is selected, showing a raw JSON payload:

```
1 [ {
2     "name": "walk dog",
3     "isComplete": true
4 } ]
```

The Headers tab shows three entries: form-data, x-www-form-urlencoded, and raw (selected). The Content-Type is set to `JSON (application/json)`. The response section shows a status of `201 Created` and a time of `148 ms`. The Body tab displays the response JSON:

```
1 { "id": 6, "name": "walk dog", "isComplete": true }
```

- Update the port number in the localhost URL.
- Set the HTTP method to *POST*.
- Click the **Body** tab.
- Select the **raw** radio button.
- Set the type to *JSON (application/json)*.
- Enter a request body with a to-do item resembling the following JSON:

```
{  
    "name": "walk dog",  
    "isComplete": true  
}
```

- Click the **Send** button.

#### TIP

If no response displays after clicking **Send**, disable the **SSL certification verification** option. This is found under **File > Settings**. Click the **Send** button again after disabling the setting.

Click the **Headers** tab in the **Response** pane and copy the **Location** header value:

The screenshot shows the Postman application interface. A POST request is being made to `https://localhost:44375/api/todo`. The request body is set to `JSON (application/json)` and contains the following JSON payload:

```
1 [ {  
2     "name": "walk dog",  
3     "isComplete": true  
4 }]
```

The **Headers** tab is highlighted with a red box. The `Content-Type` header is listed as `application/json; charset=utf-8`. The `Location` header is listed as `https://localhost/api/Todo/6`, which is also highlighted with a red box. The status bar at the bottom right indicates `Status: 201 Created Time: 148 ms`.

You can use the **Location** header URI to access the resource you created. The `Create` method returns `CreatedAtRoute`. The first parameter passed to `CreatedAtRoute` represents the named route to use for generating the URL. Recall that the  `GetById` method created the `"GetTodo"` named route:

```
[HttpGet("{id}", Name = "GetTodo")]
```

## Update

```
[HttpPut("{id}")]
public IActionResult Update(long id, [FromBody] TodoItem item)
{
    if (item == null || item.Id != id)
    {
        return BadRequest();
    }

    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    todo.IsComplete = item.IsComplete;
    todo.Name = item.Name;

    _context.TodoItems.Update(todo);
    _context.SaveChanges();
    return NoContent();
}
```

```
[HttpPut("{id}")]
public IActionResult Update(long id, TodoItem item)
{
    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    todo.IsComplete = item.IsComplete;
    todo.Name = item.Name;

    _context.TodoItems.Update(todo);
    _context.SaveChanges();
    return NoContent();
}
```

`Update` is similar to `Create`, but uses HTTP PUT. The response is [204 \(No Content\)](#). According to the HTTP spec, a PUT request requires the client to send the entire updated entity, not just the deltas. To support partial updates, use HTTP PATCH.

```
{
  "key": 1,
  "name": "walk dog",
  "isComplete": true
}
```

The screenshot shows the Postman application interface. At the top, there are tabs for 'File', 'Edit', 'View', and 'Help'. Below the tabs are buttons for 'New', 'Import', 'Runner', and 'My Workspace'. The 'My Workspace' button has a status indicator 'IN SYNC'. On the right side of the header are icons for environment management, sync, and notifications.

The main workspace shows a request configuration. The method is set to 'PUT' (highlighted with a red box), the URL is 'https://localhost:44375/api/todo/1', and the 'Body' tab is selected (also highlighted with a red box). The 'Body' type is set to 'raw' (highlighted with a red box) and the content type is 'JSON (application/json)' (highlighted with a red box). The JSON payload is:

```
1 {  
2   "name": "walk cat",  
3   "isComplete": true  
4 }
```

Below the request configuration, the response section is visible. It shows the status as 'Status: 204 No Content' and the time taken as 'Time: 70 ms'. The 'Body' tab is selected, showing an empty response body. Other tabs like 'Cookies', 'Headers', and 'Test Results' are also present.

## Delete

```
[HttpDelete("{id}")]
public IActionResult Delete(long id)
{
    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    _context.TodoItems.Remove(todo);
    _context.SaveChanges();
    return NoContent();
}
```

The response is [204 \(No Content\)](#).

The screenshot shows the Postman application interface. At the top, there are tabs for 'File', 'Edit', 'View', and 'Help'. Below the tabs are buttons for 'New', 'Import', 'Runner', and a workspace dropdown labeled 'My Workspace IN SYNC'. There are also icons for environment management and notifications.

In the main area, there are three tabs for environments: 'https://localhost:4437' (red dot), 'https://localhost:4437' (red dot), and 'https://localhost:4437' (red dot). A '+' button and an '...' button are available for creating new environments. To the right, it says 'No Environment'.

The request details are shown in a red-bordered box:

- Method: **DELETE**
- URL: <https://localhost:44375/api/todo/1>
- Params: None
- Send: Blue button

Below the request details, there are tabs for 'Authorization', 'Headers', 'Body', 'Pre-request Script', and 'Tests'. The 'Authorization' tab is selected, showing 'TYPE' set to 'No Auth'. A note states: 'The authorization header will be automatically generated when you send the request. [Learn more about authorization](#)'.

The 'Body' tab is selected, showing 'Status: 204 No Content' and 'Time: 735 ms'. It has options for 'Pretty', 'Raw', 'Preview', 'Text' (with a dropdown arrow), and a copy icon. The preview area is empty, showing only the number '1'.

## Call the Web API with jQuery

In this section, an HTML page is added that uses jQuery to call the Web API. jQuery initiates the request and updates the page with the details from the API's response.

Configure the project to serve static files and to enable default file mapping. This is accomplished by invoking the `UseStaticFiles` and `UseDefaultFiles` extension methods in `Startup.Configure`. For more information, see [Static files](#).

```
public void Configure(IApplicationBuilder app)
{
    app.UseDefaultFiles();
    app.UseStaticFiles();
    app.UseMvc();
}
```

Add an HTML file, named `index.html`, to the project's `wwwroot` directory. Replace its contents with the following markup:

```
<!DOCTYPE html>
<html>
<head>
    <meta charset="UTF-8">
    <title>To-do CRUD</title>
    <style>
        input[type='submit'], button, [aria-label] {
            cursor: pointer;
        }
    </style>

```

```

#spoiler {
    display: none;
}

table {
    font-family: Arial, sans-serif;
    border: 1px solid;
    border-collapse: collapse;
}

th {
    background-color: #0066CC;
    color: white;
}

td {
    border: 1px solid;
    padding: 5px;
}

```

</style>

</head>

<body>

<h1>To-do CRUD</h1>

<h3>Add</h3>

<form action="javascript:void(0);" method="POST" onsubmit="addItem()">

<input type="text" id="add-name" placeholder="New to-do">

<input type="submit" value="Add">

</form>

<div id="spoiler">

<h3>Edit</h3>

<form class="my-form">

<input type="hidden" id="edit-id">

<input type="checkbox" id="edit-isComplete">

<input type="text" id="edit-name">

<input type="submit" value="Edit">

<a onclick="closeInput()" aria-label="Close">Close</a>

</form>

</div>

<p id="counter"></p>

<table>

<tr>

<th>Is Complete</th>

<th>Name</th>

<th></th>

<th></th>

</tr>

<tbody id="todos"></tbody>

</table>

<script src="https://code.jquery.com/jquery-3.3.1.min.js"
 integrity="sha256-FgpCb/KJQlLNfOu91ta32o/NMZxltwRo8QtmkMRdAu8="
 crossorigin="anonymous"></script>

<script src="site.js"></script>

</body>

</html>

Add a JavaScript file, named *site.js*, to the project's *wwwroot* directory. Replace its contents with the following code:

```

const uri = 'api/todo';
let todos = null;
function getCount(data) {
    const el = $('#counter');
    let name = 'to-do';
    if (data) {

```

```

        if (data > 1) {
            name = 'to-dos';
        }
        el.text(data + ' ' + name);
    } else {
        el.html('No ' + name);
    }
}

$(document).ready(function () {
    getData();
});

function getData() {
    $.ajax({
        type: 'GET',
        url: uri,
        success: function (data) {
            $('#todos').empty();
            getCount(data.length);
            $.each(data, function (key, item) {
                const checked = item.isComplete ? 'checked' : '';

                $('<tr><td><input disabled="true" type="checkbox" ' + checked + '></td>' +
                    '<td>' + item.name + '</td>' +
                    '<td><button onclick="editItem(' + item.id + ')>Edit</button></td>' +
                    '<td><button onclick="deleteItem(' + item.id + ')>Delete</button></td>' +
                    '</tr>').appendTo($('#todos'));
            });
        }
    });
}

function addItem() {
    const item = {
        'name': $('#add-name').val(),
        'isComplete': false
    };

    $.ajax({
        type: 'POST',
        accepts: 'application/json',
        url: uri,
        contentType: 'application/json',
        data: JSON.stringify(item),
        error: function (jqXHR, textStatus, errorThrown) {
            alert('here');
        },
        success: function (result) {
            getData();
            $('#add-name').val('');
        }
    });
}

function deleteItem(id) {
    $.ajax({
        url: uri + '/' + id,
        type: 'DELETE',
        success: function (result) {
            getData();
        }
    });
}

function editItem(id) {
    $.each(todos, function (key, item) {

```

```

        if (item.id === id) {
            $('#edit-name').val(item.name);
            $('#edit-id').val(item.id);
            $('#edit-isComplete').val(item.isComplete);
        }
    });
    $('#spoiler').css({ 'display': 'block' });
}

$('.my-form').on('submit', function () {
    const item = {
        'name': $('#edit-name').val(),
        'isComplete': $('#edit-isComplete').is(':checked'),
        'id': $('#edit-id').val()
    };

    $.ajax({
        url: uri + '/' + $('#edit-id').val(),
        type: 'PUT',
        accepts: 'application/json',
        contentType: 'application/json',
        data: JSON.stringify(item),
        success: function (result) {
            getData();
        }
    });

    closeInput();
    return false;
});

function closeInput() {
    $('#spoiler').css({ 'display': 'none' });
}

```

A change to the ASP.NET Core project's launch settings may be required to test the HTML page locally. Open `launchSettings.json` in the *Properties* directory of the project. Remove the `launchUrl` property to force the app to open at `index.html`—the project's default file.

There are several ways to get jQuery. In the preceding snippet, the library is loaded from a CDN. This sample is a complete CRUD example of calling the API with jQuery. There are additional features in this sample to make the experience richer. Below are explanations around the calls to the API.

### Get a list of to-do items

To get a list of to-do items, send an HTTP GET request to `/api/todo`.

The jQuery `ajax` function sends an AJAX request to the API, which returns JSON representing an object or array. This function can handle all forms of HTTP interaction, sending an HTTP request to the specified `url`. `GET` is used as the `type`. The `success` callback function is invoked if the request succeeds. In the callback, the DOM is updated with the to-do information.

```

$(document).ready(function () {
    getData();
});

function getData() {
    $.ajax({
        type: 'GET',
        url: uri,
        success: function (data) {
            $('#todos').empty();
            getCount(data.length);
            $.each(data, function (key, item) {
                const checked = item.isComplete ? 'checked' : '';

                $('<tr><td><input disabled="true" type="checkbox" ' + checked + '></td>' +
                    '<td>' + item.name + '</td>' +
                    '<td><button onclick="editItem(' + item.id + ')>Edit</button></td>' +
                    '<td><button onclick="deleteItem(' + item.id + ')>Delete</button></td>' +
                    '</tr>').appendTo($('#todos'));
            });
        }
    });
}

```

## Add a to-do item

To add a to-do item, send an HTTP POST request to `/api/todo/`. The request body should contain a to-do object. The `ajax` function is using `POST` to call the API. For `POST` and `PUT` requests, the request body represents the data sent to the API. The API is expecting a JSON request body. The `accepts` and `contentType` options are set to `application/json` to classify the media type being received and sent, respectively. The data is converted to a JSON object using `JSON.stringify`. When the API returns a successful status code, the `getData` function is invoked to update the HTML table.

```

function addItem() {
    const item = {
        'name': $('#add-name').val(),
        'isComplete': false
    };

    $.ajax({
        type: 'POST',
        accepts: 'application/json',
        url: uri,
        contentType: 'application/json',
        data: JSON.stringify(item),
        error: function (jqXHR, textStatus, errorThrown) {
            alert('here');
        },
        success: function (result) {
            getData();
            $('#add-name').val('');
        }
    });
}

```

## Update a to-do item

Updating a to-do item is very similar to adding one, since both rely on a request body. The only real difference between the two in this case is that the `url` changes to add the unique identifier of the item, and the `type` is `PUT`.

```
$.ajax({
    url: uri + '/' + $('#edit-id').val(),
    type: 'PUT',
    accepts: 'application/json',
    contentType: 'application/json',
    data: JSON.stringify(item),
    success: function (result) {
        getData();
    }
});
```

## Delete a to-do item

Deleting a to-do item is accomplished by setting the `type` on the AJAX call to `DELETE` and specifying the item's unique identifier in the URL.

```
$.ajax({
    url: uri + '/' + id,
    type: 'DELETE',
    success: function (result) {
        getData();
    }
});
```

## Next steps

- For information on using a persistent database, see:
  - [Create a Razor Pages web app with ASP.NET Core](#)
  - [Work with data in ASP.NET Core](#)
- [ASP.NET Core Web API help pages using Swagger](#)
- [Routing to controller actions](#)
- [Build web APIs with ASP.NET Core](#)
- [Controller action return types](#)
- For information about deploying an API, including to Azure App Service, see [Host and deploy](#).
- [View or download sample code](#). See [how to download](#).

# Create a Web API with ASP.NET Core and Visual Studio for Windows

6/21/2018 • 15 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Mike Wasson](#)

This tutorial builds a web API for managing a list of "to-do" items. A user interface (UI) isn't created.

There are three versions of this tutorial:

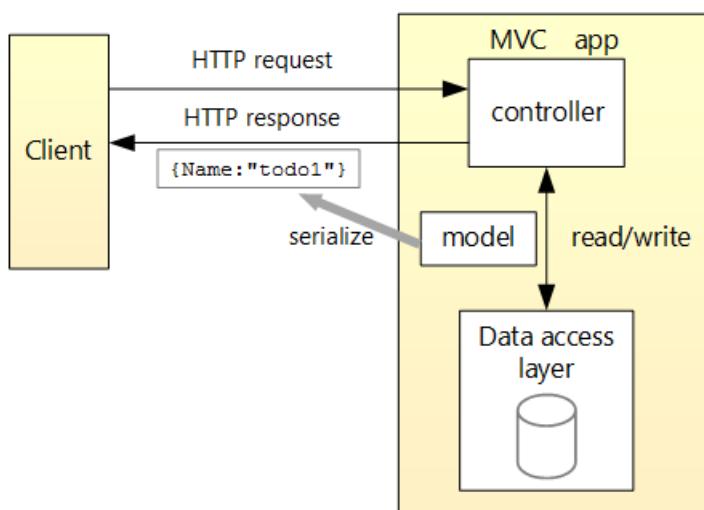
- Windows: Web API with Visual Studio for Windows (This tutorial)
- macOS: [Web API with Visual Studio for Mac](#)
- macOS, Linux, Windows: [Web API with Visual Studio Code](#)

## Overview

This tutorial creates the following API:

API	DESCRIPTION	REQUEST BODY	RESPONSE BODY
GET /api/todo	Get all to-do items	None	Array of to-do items
GET /api/todo/{id}	Get an item by ID	None	To-do item
POST /api/todo	Add a new item	To-do item	To-do item
PUT /api/todo/{id}	Update an existing item	To-do item	None
DELETE /api/todo/{id}	Delete an item	None	None

The following diagram shows the basic design of the app.



- The client is whatever consumes the web API (mobile app, browser, etc.). This tutorial doesn't create a client. [Postman](#) or [curl](#) is used as the client to test the app.
- A *model* is an object that represents the data in the app. In this case, the only model is a to-do item. Models are represented as C# classes, also known as **Plain Old CLR Object** (POCOs).

- A *controller* is an object that handles HTTP requests and creates the HTTP response. This app has a single controller.
- To keep the tutorial simple, the app doesn't use a persistent database. The sample app stores to-do items in an in-memory database.

## Prerequisites

Visual Studio 2017 version 15.7.3 or later with the following workloads:

- **ASP.NET and web development**
- **.NET Core cross-platform development**

.NET Core 2.1 SDK or later

## Create the project

Follow these steps in Visual Studio:

- From the **File** menu, select **New > Project**.
- Select the **ASP.NET Core Web Application** template. Name the project *TodoApi* and click **OK**.
- In the **New ASP.NET Core Web Application - TodoApi** dialog, choose the ASP.NET Core version. Select the **API** template and click **OK**. Do **not** select **Enable Docker Support**.

### Launch the app

In Visual Studio, press CTRL+F5 to launch the app. Visual Studio launches a browser and navigates to `http://localhost:<port>/api/values`, where `<port>` is a randomly chosen port number. Chrome, Microsoft Edge, and Firefox display the following output:

```
[ "value1", "value2" ]
```

If using Internet Explorer, you'll be prompted to save a *values.json* file.

### Add a model class

A model is an object representing the data in the app. In this case, the only model is a to-do item.

In Solution Explorer, right-click the project. Select **Add > New Folder**. Name the folder *Models*.

#### NOTE

The model classes can go anywhere in the project. The *Models* folder is used by convention for model classes.

In Solution Explorer, right-click the *Models* folder and select **Add > Class**. Name the class *TodoItem* and click **Add**.

Update the `TodoItem` class with the following code:

```
namespace TodoApi.Models
{
    public class TodoItem
    {
        public long Id { get; set; }
        public string Name { get; set; }
        public bool IsComplete { get; set; }
    }
}
```

The database generates the `Id` when a `TodoItem` is created.

## Create the database context

The *database context* is the main class that coordinates Entity Framework functionality for a given data model. This class is created by deriving from the `Microsoft.EntityFrameworkCore.DbContext` class.

In Solution Explorer, right-click the *Models* folder and select **Add > Class**. Name the class *TodoContext* and click **Add**.

Replace the class with the following code:

```
using Microsoft.EntityFrameworkCore;

namespace TodoApi.Models
{
    public class TodoContext : DbContext
    {
        public TodoContext(DbContextOptions<TodoContext> options)
            : base(options)
        {
        }

        public DbSet<TodoItem> TodoItems { get; set; }
    }
}
```

## Register the database context

In this step, the database context is registered with the [dependency injection](#) container. Services (such as the DB context) that are registered with the dependency injection (DI) container are available to the controllers.

Register the DB context with the service container using the built-in support for [dependency injection](#). Replace the contents of the *Startup.cs* file with the following code:

```

using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Mvc;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using TodoApi.Models;

namespace TodoApi
{
    public class Startup
    {
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<TodoContext>(opt =>
                opt.UseInMemoryDatabase("TodoList"));
            services.AddMvc()
                .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
        }

        public void Configure(IApplicationBuilder app)
        {
            app.UseMvc();
        }
    }
}

```

```

using Microsoft.AspNetCore.Builder;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using TodoApi.Models;

namespace TodoApi
{
    public class Startup
    {
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<TodoContext>(opt =>
                opt.UseInMemoryDatabase("TodoList"));
            services.AddMvc();
        }

        public void Configure(IApplicationBuilder app)
        {
            app.UseMvc();
        }
    }
}

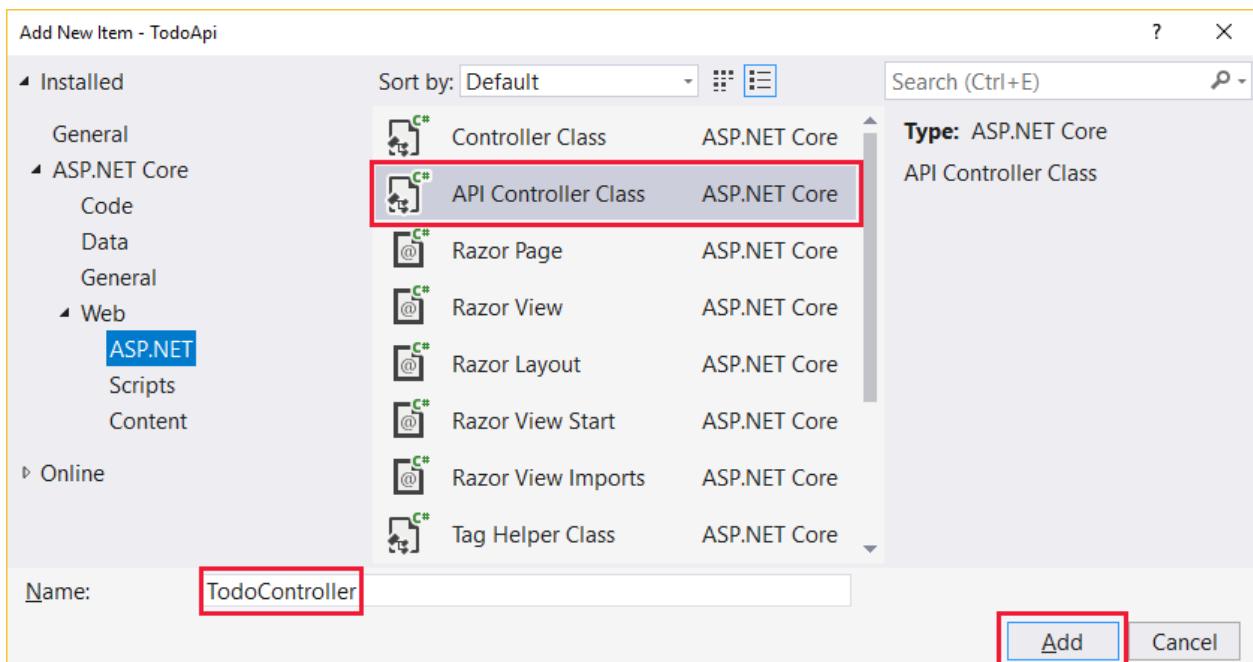
```

The preceding code:

- Removes the unused code.
- Specifies an in-memory database is injected into the service container.

## Add a controller

In Solution Explorer, right-click the *Controllers* folder. Select **Add > New Item**. In the **Add New Item** dialog, select the **API Controller Class** template. Name the class *TodoController*, and click **Add**.



Replace the class with the following code:

```
using Microsoft.AspNetCore.Mvc;
using System.Collections.Generic;
using System.Linq;
using TodoApi.Models;

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

        public TodoController(TodoContext context)
        {
            _context = context;

            if (_context.TodoItems.Count() == 0)
            {
                _context.TodoItems.Add(new TodoItem { Name = "Item1" });
                _context.SaveChanges();
            }
        }
    }
}
```

The preceding code defines an API controller class without methods. In the next sections, methods are added to implement the API.

```

using Microsoft.AspNetCore.Mvc;
using System.Collections.Generic;
using System.Linq;
using TodoApi.Models;

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    [ApiController]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

        public TodoController(TodoContext context)
        {
            _context = context;

            if (_context.TodoItems.Count() == 0)
            {
                _context.TodoItems.Add(new TodoItem { Name = "Item1" });
                _context.SaveChanges();
            }
        }
    }
}

```

The preceding code defines an API controller class without methods. In the next sections, methods are added to implement the API. The class is annotated with an `[ApiController]` attribute to enable some convenient features. For information on features enabled by the attribute, see [Annotate class with ApiControllerAttribute](#).

The controller's constructor uses [Dependency Injection](#) to inject the database context (`TodoContext`) into the controller. The database context is used in each of the [CRUD](#) methods in the controller. The constructor adds an item to the in-memory database if one doesn't exist.

## Get to-do items

To get to-do items, add the following methods to the `TodoController` class:

```

[HttpGet]
public List<TodoItem> GetAll()
{
    return _context.TodoItems.ToList();
}

[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}

```

```

[HttpGet]
public ActionResult<List<TodoItem>> GetAll()
{
    return _context.TodoItems.ToList();
}

[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}

```

These methods implement the two GET methods:

- `GET /api/todo`
- `GET /api/todo/{id}`

Here's a sample HTTP response for the `GetAll` method:

```
[
{
    "id": 1,
    "name": "Item1",
    "isComplete": false
}
]
```

Later in the tutorial, I'll show how the HTTP response can be viewed with [Postman](#) or [curl](#).

## Routing and URL paths

The `[HttpGet]` attribute denotes a method that responds to an HTTP GET request. The URL path for each method is constructed as follows:

- Take the template string in the controller's `Route` attribute:

```

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;
    }
}
```

```

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    [ApiController]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;
    }
}
```

- Replace `[controller]` with the name of the controller, which is the controller class name minus the "Controller" suffix. For this sample, the controller class name is **TodoController** and the root name is "todo". ASP.NET Core [routing](#) is case insensitive.

- If the `[HttpGet]` attribute has a route template (such as `[HttpGet("/products")]`), append that to the path. This sample doesn't use a template. For more information, see [Attribute routing with Http\[Verb\] attributes](#).

In the following  `GetById` method, `"{id}"` is a placeholder variable for the unique identifier of the to-do item. When  `GetById` is invoked, it assigns the value of `"{id}"` in the URL to the method's `id` parameter.

```
[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}
```

```
[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}
```

`Name = "GetTodo"` creates a named route. Named routes:

- Enable the app to create an HTTP link using the route name.
- Are explained later in the tutorial.

## Return values

The  `GetAll` method returns a collection of  `TodoItem` objects. MVC automatically serializes the object to [JSON](#) and writes the JSON into the body of the response message. The response code for this method is 200, assuming there are no unhandled exceptions. Unhandled exceptions are translated into 5xx errors.

In contrast, the  `GetById` method returns the more general [IActionResult type](#), which represents a wide range of return types.  `GetById` has two different return types:

- If no item matches the requested ID, the method returns a 404 error. Returning `NotFound` returns an HTTP 404 response.
- Otherwise, the method returns 200 with a JSON response body. Returning `Ok` results in an HTTP 200 response.

In contrast, the  `GetById` method returns the [ActionResult<T> type](#), which represents a wide range of return types.  `GetById` has two different return types:

- If no item matches the requested ID, the method returns a 404 error. Returning `NotFound` returns an HTTP 404 response.
- Otherwise, the method returns 200 with a JSON response body. Returning `item` results in an HTTP 200 response.

## Launch the app

In Visual Studio, press CTRL+F5 to launch the app. Visual Studio launches a browser and navigates to `http://localhost:<port>/api/values`, where `<port>` is a randomly chosen port number. Navigate to the  `Todo`

controller at `http://localhost:<port>/api/todo`.

## Implement the other CRUD operations

In the following sections, `Create`, `Update`, and `Delete` methods are added to the controller.

### Create

Add the following `Create` method:

```
[HttpPost]
public IActionResult Create([FromBody] TodoItem item)
{
    if (item == null)
    {
        return BadRequest();
    }

    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}
```

The preceding code is an HTTP POST method, as indicated by the `[HttpPost]` attribute. The `[FromBody]` attribute tells MVC to get the value of the to-do item from the body of the HTTP request.

```
[HttpPost]
public IActionResult Create(TodoItem item)
{
    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}
```

The preceding code is an HTTP POST method, as indicated by the `[HttpPost]` attribute. MVC gets the value of the to-do item from the body of the HTTP request.

The `CreatedAtRoute` method:

- Returns a 201 response. HTTP 201 is the standard response for an HTTP POST method that creates a new resource on the server.
- Adds a Location header to the response. The Location header specifies the URI of the newly created to-do item. See [10.2.2 201 Created](#).
- Uses the "GetTodo" named route to create the URL. The "GetTodo" named route is defined in  `GetById`:

```
[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}
```

```
[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}
```

### Use Postman to send a Create request

- Start the app.
- Open Postman.

The screenshot shows the Postman application window. At the top, the URL is set to `https://localhost:44375/api/todo`. The method dropdown is set to `POST`. The `Body` tab is selected, and the type is set to `raw` with `JSON (application/json)` selected. The request body contains the following JSON:

```
1 {{"name": "walk dog", "isComplete": true}}
```

In the bottom section, the `Body` tab is active, showing the response body which is identical to the request body. The status is listed as `Status: 201 Created Time: 148 ms`.

- Update the port number in the localhost URL.
- Set the HTTP method to `POST`.
- Click the **Body** tab.
- Select the **raw** radio button.
- Set the type to `JSON (application/json)`.
- Enter a request body with a to-do item resembling the following JSON:

```
{  
  "name": "walk dog",  
  "isComplete": true  
}
```

- Click the **Send** button.

#### TIP

If no response displays after clicking **Send**, disable the **SSL certification verification** option. This is found under **File > Settings**. Click the **Send** button again after disabling the setting.

Click the **Headers** tab in the **Response** pane and copy the **Location** header value:

The screenshot shows the Postman application interface. At the top, there's a navigation bar with File, Edit, View, Help, and a workspace dropdown set to My Workspace. Below the bar, a search bar contains the URL https://localhost:4437. To the right of the search bar are three buttons: a plus sign, a three-dot ellipsis, and a refresh icon. On the far right of the bar, it says 'No Environment' with a dropdown arrow. The main workspace has a 'POST' method selected and the URL https://localhost:44375/api/todo. To the right of the URL are Params and Send buttons. Below the URL, tabs for Authorization, Headers (3), Body (selected), Pre-request Script, and Tests are visible. Under the Body tab, there's a JSON editor with the following content:

```
1 [{}  
2   "name": "walk dog",  
3   "isComplete": true  
4 ]
```

Below the JSON editor, the Headers tab is highlighted with a red box. It shows seven headers: Content-Type → application/json; charset=utf-8, Date → Fri, 27 Apr 2018 18:32:32 GMT, and Location → https://localhost/api/Todo/6. The Location header is also highlighted with a red box. At the bottom of the interface, there are icons for refresh, search, and file operations, along with a BUILD dropdown and a lightbulb icon.

The Location header URI can be used to access the new item.

#### Update

Add the following **Update** method:

```
[HttpPut("{id}")]
public IActionResult Update(long id, [FromBody] TodoItem item)
{
    if (item == null || item.Id != id)
    {
        return BadRequest();
    }

    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    todo.IsComplete = item.IsComplete;
    todo.Name = item.Name;

    _context.TodoItems.Update(todo);
    _context.SaveChanges();
    return NoContent();
}
```

```
[HttpPut("{id}")]
public IActionResult Update(long id, TodoItem item)
{
    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    todo.IsComplete = item.IsComplete;
    todo.Name = item.Name;

    _context.TodoItems.Update(todo);
    _context.SaveChanges();
    return NoContent();
}
```

`Update` is similar to `Create`, except it uses HTTP PUT. The response is [204 \(No Content\)](#). According to the HTTP specification, a PUT request requires the client to send the entire updated entity, not just the deltas. To support partial updates, use HTTP PATCH.

Use Postman to update the to-do item's name to "walk cat":

The screenshot shows the Postman application interface. At the top, there are tabs for 'File', 'Edit', 'View', and 'Help'. Below the tabs, there are buttons for 'New', 'Import', 'Runner', and 'My Workspace'. The 'My Workspace' button has a dropdown arrow. To the right of the workspace button are icons for 'IN SYNC', a globe, a user profile, and notifications. The main workspace shows two tabs: 'https://localhost:4437' and 'https://localhost:4437'. There are buttons for '+', '...', and 'No Environment'. Below the tabs, a red box highlights the 'PUT' method dropdown. The URL 'https://localhost:44375/api/todo/1' is entered. To the right are buttons for 'Params' and 'Send'. Underneath the URL, there are tabs for 'Authorization', 'Headers (3)', 'Body (●)', 'Pre-request Script', and 'Tests'. A red box highlights the 'Body' tab. Below the tabs, there are four radio buttons: 'form-data', 'x-www-form-urlencoded', 'raw' (which is selected and highlighted with a red box), and 'binary'. A red box also highlights the 'JSON (application/json)' dropdown. The 'Body' section contains a code editor with the following JSON:

```
1 {  
2   "name": "walk cat",  
3   "isComplete": true  
4 }
```

## Delete

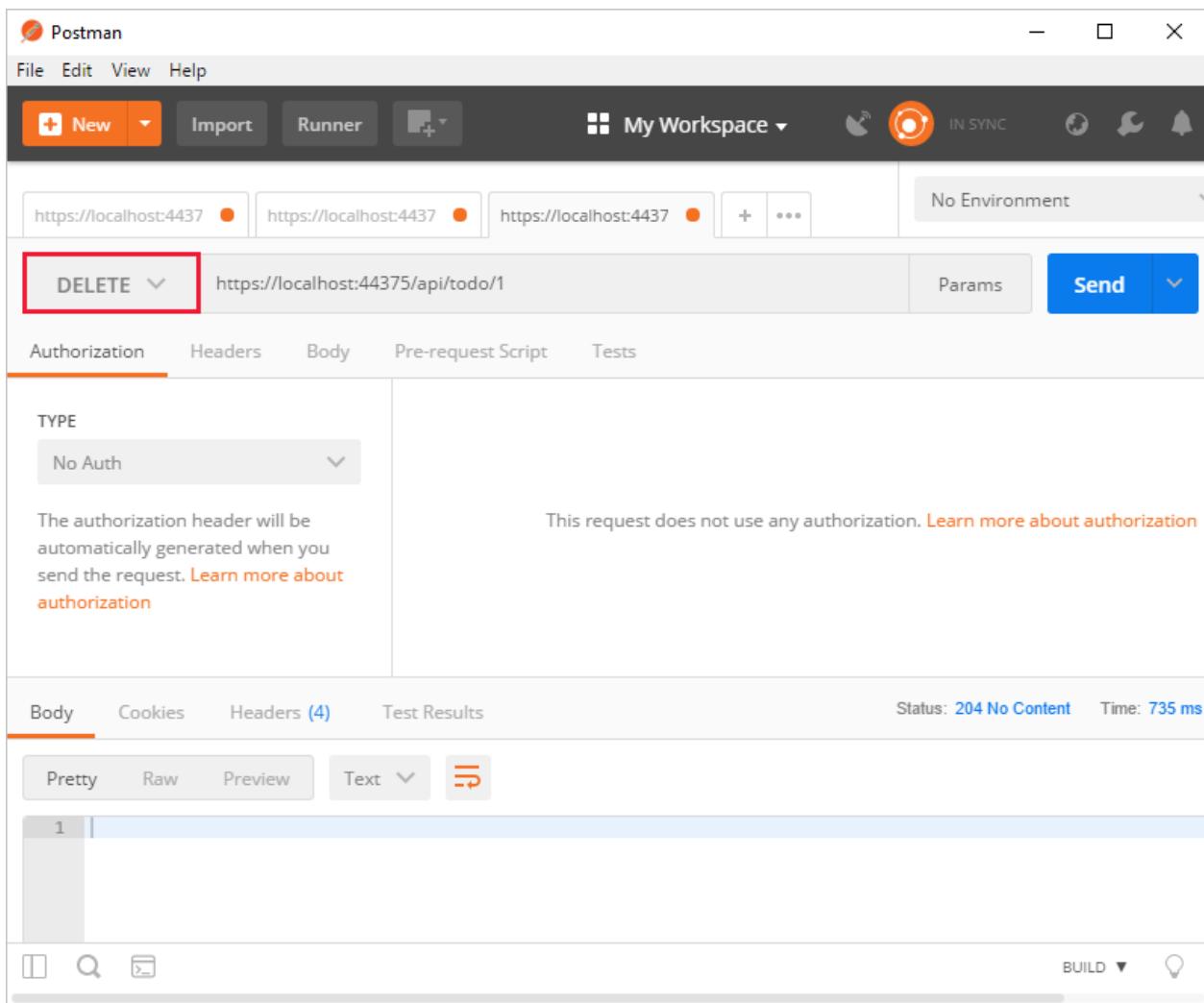
Add the following `Delete` method:

```
[HttpDelete("{id}")]
public IActionResult Delete(long id)
{
    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    _context.TodoItems.Remove(todo);
    _context.SaveChanges();
    return NoContent();
}
```

The `Delete` response is [204 \(No Content\)](#).

Use Postman to delete the to-do item:



## Call the Web API with jQuery

In this section, an HTML page is added that uses jQuery to call the Web API. jQuery initiates the request and updates the page with the details from the API's response.

Configure the project to serve static files and to enable default file mapping. This is accomplished by invoking the [UseStaticFiles](#) and [UseDefaultFiles](#) extension methods in *Startup.Configure*. For more information, see [Static files](#).

```
public void Configure(IApplicationBuilder app)
{
    app.UseDefaultFiles();
    app.UseStaticFiles();
    app.UseMvc();
}
```

Add an HTML file, named *index.html*, to the project's *wwwroot* directory. Replace its contents with the following markup:

```
<!DOCTYPE html>
<html>
<head>
    <meta charset="UTF-8">
    <title>To-do CRUD</title>
    <style>
        input[type='submit'], button, [aria-label] {
            cursor: pointer;
        }
    </style>

```

```

#spoiler {
    display: none;
}

table {
    font-family: Arial, sans-serif;
    border: 1px solid;
    border-collapse: collapse;
}

th {
    background-color: #0066CC;
    color: white;
}

td {
    border: 1px solid;
    padding: 5px;
}

```

</style>

</head>

<body>

<h1>To-do CRUD</h1>

<h3>Add</h3>

<form action="javascript:void(0);" method="POST" onsubmit="addItem()">

<input type="text" id="add-name" placeholder="New to-do">

<input type="submit" value="Add">

</form>

<div id="spoiler">

<h3>Edit</h3>

<form class="my-form">

<input type="hidden" id="edit-id">

<input type="checkbox" id="edit-isComplete">

<input type="text" id="edit-name">

<input type="submit" value="Edit">

<a onclick="closeInput()" aria-label="Close">#10006;</a>

</form>

</div>

<p id="counter"></p>

<table>

<tr>

<th>Is Complete</th>

<th>Name</th>

<th></th>

<th></th>

</tr>

<tbody id="todos"></tbody>

</table>

<script src="https://code.jquery.com/jquery-3.3.1.min.js"
 integrity="sha256-FgpCb/KJQlLNf0u91ta32o/NMZxltwRo8QtmkMRdAu8="
 crossorigin="anonymous"></script>

<script src="site.js"></script>

</body>

</html>

Add a JavaScript file, named *site.js*, to the project's *wwwroot* directory. Replace its contents with the following code:

```

const uri = 'api/todo';
let todos = null;
function getCount(data) {
    const el = $('#counter');

```

```

let name = 'to-do';
if (data) {
    if (data > 1) {
        name = 'to-dos';
    }
    el.text(data + ' ' + name);
} else {
    el.html('No ' + name);
}
}

$(document).ready(function () {
    getData();
});

function getData() {
$.ajax({
    type: 'GET',
    url: uri,
    success: function (data) {
        $('#todos').empty();
        getCount(data.length);
        $.each(data, function (key, item) {
            const checked = item.isComplete ? 'checked' : '';
            $('<tr><td><input disabled="true" type="checkbox" ' + checked + '></td>' +
                '<td>' + item.name + '</td>' +
                '<td><button onclick="editItem(' + item.id + ')">Edit</button></td>' +
                '<td><button onclick="deleteItem(' + item.id + ')">Delete</button></td>' +
                '</tr>').appendTo($('#todos'));
        });
        todos = data;
    }
});
}

function addItem() {
const item = {
    'name': $('#add-name').val(),
    'isComplete': false
};

$.ajax({
    type: 'POST',
    accepts: 'application/json',
    url: uri,
    contentType: 'application/json',
    data: JSON.stringify(item),
    error: function (jqXHR, textStatus, errorThrown) {
        alert('here');
    },
    success: function (result) {
        getData();
        $('#add-name').val('');
    }
});
}

function deleteItem(id) {
$.ajax({
    url: uri + '/' + id,
    type: 'DELETE',
    success: function (result) {
        getData();
    }
});
}

```

```

function editItem(id) {
    $.each(todos, function (key, item) {
        if (item.id === id) {
            $('#edit-name').val(item.name);
            $('#edit-id').val(item.id);
            $('#edit-isComplete').val(item.isComplete);
        }
    });
    $('#spoiler').css({ 'display': 'block' });
}

$('.my-form').on('submit', function () {
    const item = {
        'name': $('#edit-name').val(),
        'isComplete': $('#edit-isComplete').is(':checked'),
        'id': $('#edit-id').val()
    };

    $.ajax({
        url: uri + '/' + $('#edit-id').val(),
        type: 'PUT',
        accepts: 'application/json',
        contentType: 'application/json',
        data: JSON.stringify(item),
        success: function (result) {
            getData();
        }
    });

    closeInput();
    return false;
});

function closeInput() {
    $('#spoiler').css({ 'display': 'none' });
}

```

A change to the ASP.NET Core project's launch settings may be required to test the HTML page locally. Open *launchSettings.json* in the *Properties* directory of the project. Remove the `launchUrl` property to force the app to open at *index.html*—the project's default file.

There are several ways to get jQuery. In the preceding snippet, the library is loaded from a CDN. This sample is a complete CRUD example of calling the API with jQuery. There are additional features in this sample to make the experience richer. Below are explanations around the calls to the API.

### Get a list of to-do items

To get a list of to-do items, send an HTTP GET request to `/api/todo`.

The jQuery `ajax` function sends an AJAX request to the API, which returns JSON representing an object or array. This function can handle all forms of HTTP interaction, sending an HTTP request to the specified `url`. `GET` is used as the `type`. The `success` callback function is invoked if the request succeeds. In the callback, the DOM is updated with the to-do information.

```

$(document).ready(function () {
    getData();
});

function getData() {
    $.ajax({
        type: 'GET',
        url: uri,
        success: function (data) {
            $('#todos').empty();
            getCount(data.length);
            $.each(data, function (key, item) {
                const checked = item.isComplete ? 'checked' : '';

                $('<tr><td><input disabled="true" type="checkbox" ' + checked + '></td>' +
                    '<td>' + item.name + '</td>' +
                    '<td><button onclick="editItem(' + item.id + ')>Edit</button></td>' +
                    '<td><button onclick="deleteItem(' + item.id + ')>Delete</button></td>' +
                    '</tr>').appendTo($('#todos'));
            });
        }
    });

    todos = data;
}
});

```

## Add a to-do item

To add a to-do item, send an HTTP POST request to `/api/todo/`. The request body should contain a to-do object. The `ajax` function is using `POST` to call the API. For `POST` and `PUT` requests, the request body represents the data sent to the API. The API is expecting a JSON request body. The `accepts` and `contentType` options are set to `application/json` to classify the media type being received and sent, respectively. The data is converted to a JSON object using `JSON.stringify`. When the API returns a successful status code, the `getData` function is invoked to update the HTML table.

```

function addItem() {
    const item = {
        'name': $('#add-name').val(),
        'isComplete': false
    };

    $.ajax({
        type: 'POST',
        accepts: 'application/json',
        url: uri,
        contentType: 'application/json',
        data: JSON.stringify(item),
        error: function (jqXHR, textStatus, errorThrown) {
            alert('here');
        },
        success: function (result) {
            getData();
            $('#add-name').val('');
        }
    });
}

```

## Update a to-do item

Updating a to-do item is very similar to adding one, since both rely on a request body. The only real difference between the two in this case is that the `url` changes to add the unique identifier of the item, and the `type` is `PUT`.

```
$.ajax({
    url: uri + '/' + $('#edit-id').val(),
    type: 'PUT',
    accepts: 'application/json',
    contentType: 'application/json',
    data: JSON.stringify(item),
    success: function (result) {
        getData();
    }
});
```

## Delete a to-do item

Deleting a to-do item is accomplished by setting the `type` on the AJAX call to `DELETE` and specifying the item's unique identifier in the URL.

```
$.ajax({
    url: uri + '/' + id,
    type: 'DELETE',
    success: function (result) {
        getData();
    }
});
```

## Next steps

- For information on using a persistent database, see:
  - [Create a Razor Pages web app with ASP.NET Core](#)
  - [Work with data in ASP.NET Core](#)
- [ASP.NET Core Web API help pages using Swagger](#)
- [Routing to controller actions](#)
- [Build web APIs with ASP.NET Core](#)
- [Controller action return types](#)
- For information about deploying an API, including to Azure App Service, see [Host and deploy](#).
- [View or download sample code](#). See [how to download](#).

# Create backend services for native mobile apps with ASP.NET Core

6/21/2018 • 7 minutes to read • [Edit Online](#)

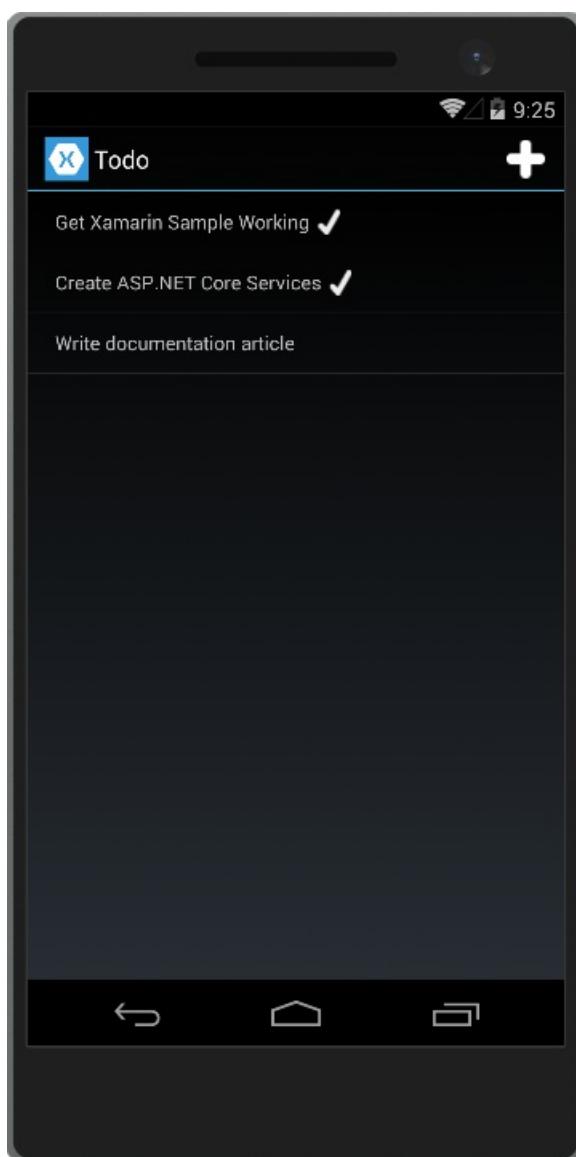
By [Steve Smith](#)

Mobile apps can easily communicate with ASP.NET Core backend services.

[View or download sample backend services code](#)

## The Sample Native Mobile App

This tutorial demonstrates how to create backend services using ASP.NET Core MVC to support native mobile apps. It uses the [Xamarin Forms ToDoRest app](#) as its native client, which includes separate native clients for Android, iOS, Windows Universal, and Window Phone devices. You can follow the linked tutorial to create the native app (and install the necessary free Xamarin tools), as well as download the Xamarin sample solution. The Xamarin sample includes an ASP.NET Web API 2 services project, which this article's ASP.NET Core app replaces (with no changes required by the client).

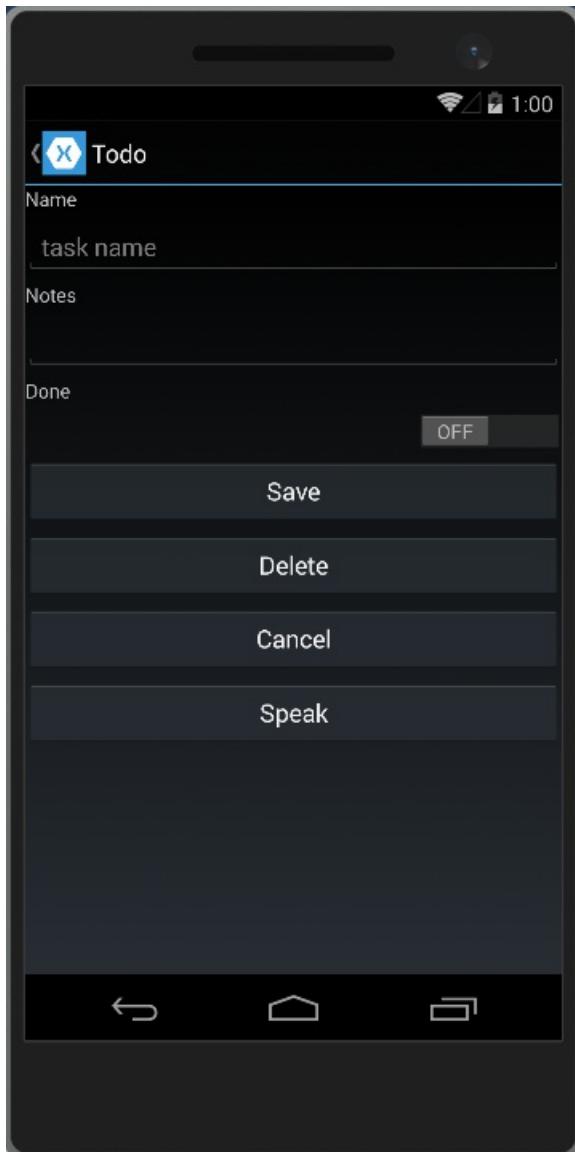


### Features

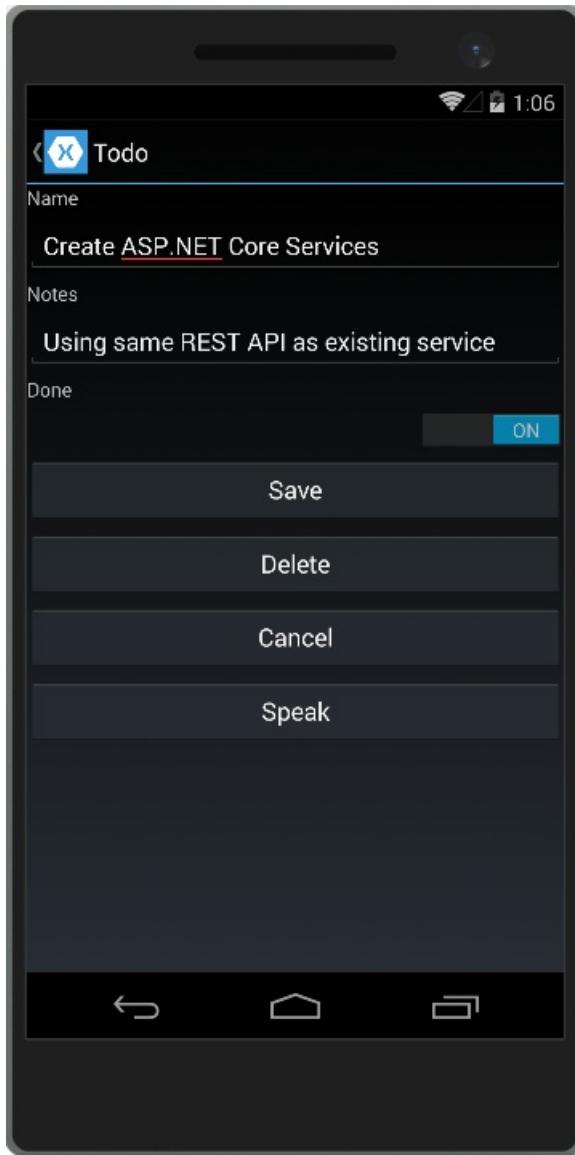
The ToDoRest app supports listing, adding, deleting, and updating To-Do items. Each item has an ID, a Name, Notes, and a property indicating whether it's been Done yet.

The main view of the items, as shown above, lists each item's name and indicates if it's done with a checkmark.

Tapping the  icon opens an add item dialog:



Tapping an item on the main list screen opens up an edit dialog where the item's Name, Notes, and Done settings can be modified, or the item can be deleted:



This sample is configured by default to use backend services hosted at developer.xamarin.com, which allow read-only operations. To test it out yourself against the ASP.NET Core app created in the next section running on your computer, you'll need to update the app's `RestUrl` constant. Navigate to the `ToDoREST` project and open the `Constants.cs` file. Replace the `RestUrl` with a URL that includes your machine's IP address (not localhost or 127.0.0.1, since this address is used from the device emulator, not from your machine). Include the port number as well (5000). In order to test that your services work with a device, ensure you don't have an active firewall blocking access to this port.

```
// URL of REST service (Xamarin ReadOnly Service)
//public static string RestUrl = "http://developer.xamarin.com:8081/api/todoitems{0}";

// use your machine's IP address
public static string RestUrl = "http://192.168.1.207:5000/api/todoitems/{0}";
```

## Creating the ASP.NET Core Project

Create a new ASP.NET Core Web Application in Visual Studio. Choose the Web API template and No Authentication. Name the project `ToDoApi`.

Select a template:

**ASP.NET Core Templates**

Empty



Web API



Web Application

A project template for creating an ASP.NET Core application with an example Controller for a RESTful HTTP service. This template can also be used for ASP.NET MVC Views and Controllers.

[Learn more](#)[Change Authentication](#)Authentication: **No Authentication**

Microsoft Azure

 Host in the cloud

App Service ▾

[OK](#)[Cancel](#)

The application should respond to all requests made to port 5000. Update *Program.cs* to include

```
.UseUrls("http://*:5000")
```

 to achieve this:

```
var host = new WebHostBuilder()
    .UseKestrel()
    .UseUrls("http://*:5000")
    .UseContentRoot(Directory.GetCurrentDirectory())
    .UseIISIntegration()
    .UseStartup<Startup>()
    .Build();
```

**NOTE**

Make sure you run the application directly, rather than behind IIS Express, which ignores non-local requests by default. Run [dotnet run](#) from a command prompt, or choose the application name profile from the Debug Target dropdown in the Visual Studio toolbar.

Add a model class to represent To-Do items. Mark required fields using the `[Required]` attribute:

```

using System.ComponentModel.DataAnnotations;

namespace ToDoApi.Models
{
    public class ToDoItem
    {
        [Required]
        public string ID { get; set; }

        [Required]
        public string Name { get; set; }

        [Required]
        public string Notes { get; set; }

        public bool Done { get; set; }
    }
}

```

The API methods require some way to work with data. Use the same `IToDoRepository` interface the original Xamarin sample uses:

```

using System.Collections.Generic;
using ToDoApi.Models;

namespace ToDoApi.Interfaces
{
    public interface IToDoRepository
    {
        bool DoesItemExist(string id);
        IEnumerable<ToDoItem> All { get; }
        ToDoItem Find(string id);
        void Insert(ToDoItem item);
        void Update(ToDoItem item);
        void Delete(string id);
    }
}

```

For this sample, the implementation just uses a private collection of items:

```

using System.Collections.Generic;
using System.Linq;
using ToDoApi.Interfaces;
using ToDoApi.Models;

namespace ToDoApi.Services
{
    public class ToDoRepository : IToDoRepository
    {
        private List<ToDoItem> _ToDoList;

        public ToDoRepository()
        {
            InitializeData();
        }

        public IEnumerable<ToDoItem> All
        {
            get { return _ToDoList; }
        }

        public bool DoesItemExist(string id)
        {
            return _ToDoList.Any(item => item.ID == id);
        }
    }
}

```

```

        }

        public ToDoItem Find(string id)
        {
            return _toDoList.FirstOrDefault(item => item.ID == id);
        }

        public void Insert(ToDoItem item)
        {
            _toDoList.Add(item);
        }

        public void Update(ToDoItem item)
        {
            var todoItem = this.Find(item.ID);
            var index = _toDoList.IndexOf(todoItem);
            _toDoList.RemoveAt(index);
            _toDoList.Insert(index, item);
        }

        public void Delete(string id)
        {
            _toDoList.Remove(this.Find(id));
        }

        private void InitializeData()
        {
            _toDoList = new List<ToDoItem>();

            var todoItem1 = new ToDoItem
            {
                ID = "6bb8a868-dba1-4f1a-93b7-24ebce87e243",
                Name = "Learn app development",
                Notes = "Attend Xamarin University",
                Done = true
            };

            var todoItem2 = new ToDoItem
            {
                ID = "b94afb54-a1cb-4313-8af3-b7511551b33b",
                Name = "Develop apps",
                Notes = "Use Xamarin Studio/Visual Studio",
                Done = false
            };

            var todoItem3 = new ToDoItem
            {
                ID = "ecfa6f80-3671-4911-aabe-63cc442c1ecf",
                Name = "Publish apps",
                Notes = "All app stores",
                Done = false,
            };

            _toDoList.Add(todoItem1);
            _toDoList.Add(todoItem2);
            _toDoList.Add(todoItem3);
        }
    }
}

```

Configure the implementation in *Startup.cs*:

```
public void ConfigureServices(IServiceCollection services)
{
    // Add framework services.
    services.AddMvc();

    services.AddSingleton<IToDoRepository, ToDoRepository>();
}
```

At this point, you're ready to create the *ToDoItemsController*.

**TIP**

Learn more about creating web APIs in [Build your first Web API with ASP.NET Core MVC and Visual Studio](#).

## Creating the Controller

Add a new controller to the project, *ToDoItemsController*. It should inherit from `Microsoft.AspNetCore.Mvc.Controller`. Add a `[Route]` attribute to indicate that the controller will handle requests made to paths starting with `api/todoitems`. The `[controller]` token in the route is replaced by the name of the controller (omitting the `Controller` suffix), and is especially helpful for global routes. Learn more about [routing](#).

The controller requires an `IToDoRepository` to function; request an instance of this type through the controller's constructor. At runtime, this instance will be provided using the framework's support for [dependency injection](#).

```
using System;
using Microsoft.AspNetCore.Http;
using Microsoft.AspNetCore.Mvc;
using ToDoApi.Interfaces;
using ToDoApi.Models;

namespace ToDoApi.Controllers
{
    [Route("api/[controller]")]
    public class ToDoItemsController : Controller
    {
        private readonly IToDoRepository _ToDoRepository;

        public ToDoItemsController(IToDoRepository ToDoRepository)
        {
            _ToDoRepository = ToDoRepository;
        }
    }
}
```

This API supports four different HTTP verbs to perform CRUD (Create, Read, Update, Delete) operations on the data source. The simplest of these is the Read operation, which corresponds to an HTTP GET request.

### Reading Items

Requesting a list of items is done with a GET request to the `List` method. The `[HttpGet]` attribute on the `List` method indicates that this action should only handle GET requests. The route for this action is the route specified on the controller. You don't necessarily need to use the action name as part of the route. You just need to ensure each action has a unique and unambiguous route. Routing attributes can be applied at both the controller and method levels to build up specific routes.

```
[HttpGet]
public IActionResult List()
{
    return Ok(_todoRepository.All);
}
```

The `List` method returns a 200 OK response code and all of the ToDo items, serialized as JSON.

You can test your new API method using a variety of tools, such as [Postman](#), shown here:

The screenshot shows the Postman application interface. At the top, there are tabs for Runner, Import, Builder, Team Library, and a sync status indicator. Below the header, the URL is set to `http://192.168.1.207:5000/api/todoitems`. The main interface shows a `GET` request has been sent, and the response body displays a JSON array of three todo items:

```
[{"id": "6bb8a868-dba1-4f1a-93b7-24ebce87e243", "name": "Learn app development", "notes": "Attend Xamarin University", "done": true}, {"id": "b94afb54-a1cb-4313-8af3-b7511551b33b", "name": "Develop apps", "notes": "Use Xamarin Studio/Visual Studio", "done": false}, {"id": "ecfa6f80-3671-4911-aabe-63cc442c1ecf", "name": "Publish apps", "notes": "All app stores", "done": false}]
```

## Creating Items

By convention, creating new data items is mapped to the HTTP POST verb. The `Create` method has an `[HttpPost]` attribute applied to it, and accepts a `ToDoItem` instance. Since the `item` argument will be passed in the body of the POST, this parameter is decorated with the `[FromBody]` attribute.

Inside the method, the item is checked for validity and prior existence in the data store, and if no issues occur, it's added using the repository. Checking `ModelState.IsValid` performs [model validation](#), and should be done in every API method that accepts user input.

```
[HttpPost]
public IActionResult Create([FromBody] ToDoItem item)
{
    try
    {
        if (item == null || !ModelState.IsValid)
        {
            return BadRequest(ErrorCode.TodoItemNameAndNotesRequired.ToString());
        }
        bool itemExists = _ToDoRepository.DoesItemExist(item.ID);
        if (itemExists)
        {
            return StatusCode(StatusCodes.Status409Conflict, ErrorCode.TodoItemIDInUse.ToString());
        }
        _ToDoRepository.Insert(item);
    }
    catch (Exception)
    {
        return BadRequest(ErrorCode.CouldNotCreateItem.ToString());
    }
    return Ok(item);
}
```

The sample uses an enum containing error codes that are passed to the mobile client:

```
public enum ErrorCode
{
    TodoItemNameAndNotesRequired,
    TodoItemIDInUse,
    RecordNotFound,
    CouldNotCreateItem,
    CouldNotUpdateItem,
    CouldNotDeleteItem
}
```

Test adding new items using Postman by choosing the POST verb providing the new object in JSON format in the Body of the request. You should also add a request header specifying a Content-Type of application/json.

The method returns the newly created item in the response.

## Updating Items

Modifying records is done using HTTP PUT requests. Other than this change, the `Edit` method is almost identical to `Create`. Note that if the record isn't found, the `Edit` action will return a `NotFound` (404) response.

```
[HttpPut]
public IActionResult Edit([FromBody] ToDoItem item)
{
    try
    {
        if (item == null || !ModelState.IsValid)
        {
            return BadRequest(ErrorCode.TodoItemNameAndNotesRequired.ToString());
        }
        var existingItem = _todoRepository.Find(item.ID);
        if (existingItem == null)
        {
            return NotFound(ErrorCode.RecordNotFound.ToString());
        }
        _todoRepository.Update(item);
    }
    catch (Exception)
    {
        return BadRequest(ErrorCode.CouldNotUpdateItem.ToString());
    }
    return NoContent();
}
```

To test with Postman, change the verb to PUT. Specify the updated object data in the Body of the request.

The screenshot shows the Postman application interface. The top navigation bar includes 'Runner', 'Import', 'Builder' (which is selected), 'Team Library', and various status indicators like 'SYNC OFF'. Below the header, the URL is set to `http://192.168.1.207:5000/a`. The main area shows a 'PUT' request to `http://192.168.1.207:5000/api/todoitems`. The 'Body' tab is active, showing a raw JSON payload:

```
1 {  
2     "ID": "6bb8b868-dba1-4f1a-93b7-24ebce87243",  
3     "Name": "An UPDATED Test Item",  
4     "Notes": "Some updated notes",  
5     "Done": true  
6 }
```

The 'Headers' section contains two entries: 'Content-Type: application/json' and 'Accept: application/json'. The 'Body' section is set to 'raw' and 'JSON (application/json)'. The response section shows a successful `204 No Content` response with a time of `91 ms`.

This method returns a `NoContent` (204) response when successful, for consistency with the pre-existing API.

## Deleting Items

Deleting records is accomplished by making DELETE requests to the service, and passing the ID of the item to be deleted. As with updates, requests for items that don't exist will receive `NotFound` responses. Otherwise, a successful request will get a `NoContent` (204) response.

```
[HttpDelete("{id}")]
public IActionResult Delete(string id)
{
    try
    {
        var item = _todoRepository.Find(id);
        if (item == null)
        {
            return NotFound(ErrorCode.RecordNotFound.ToString());
        }
        _todoRepository.Delete(id);
    }
    catch (Exception)
    {
        return BadRequest(ErrorCode.CouldNotDeleteItem.ToString());
    }
    return NoContent();
}
```

Note that when testing the delete functionality, nothing is required in the Body of the request.

The screenshot shows the Postman application interface. At the top, there are tabs for Runner, Import, Builder (which is selected), and Team Library. On the right side of the header, there are icons for a gear (Sync Off), a bell, and a dropdown menu. Below the header, the URL `http://192.168.1.207:5000/a` is entered in the address bar, along with a plus sign icon for creating new requests. To the right of the URL, it says "No environment" with a dropdown arrow and an eye icon. The main workspace shows a **DELETE** request to `http://192.168.1.207:5000/api/todoitems/6bb8b8`. The "Body" tab is selected, showing options for form-data, x-www-form-urlencoded, raw, and binary, with "raw" selected and "JSON (application/json)" chosen. A large text area for the request body is present but empty. Other tabs include Headers (2), Pre-request Script, Tests, and Generate Code. Below the request area, the response section is shown with "Body" selected. It displays the status `204 No Content` and time `91 ms`. It includes Pretty, Raw, Preview, and HTML buttons, and a search icon. A large text area for the response body is also empty.

## Common Web API Conventions

As you develop the backend services for your app, you will want to come up with a consistent set of conventions or policies for handling cross-cutting concerns. For example, in the service shown above, requests for specific records that weren't found received a `NotFound` response, rather than a `BadRequest` response. Similarly, commands made to this service that passed in model bound types always checked `ModelState.IsValid` and returned a `BadRequest` for invalid model types.

Once you've identified a common policy for your APIs, you can usually encapsulate it in a [filter](#). Learn more about [how to encapsulate common API policies in ASP.NET Core MVC applications](#).

# ASP.NET Core Web API help pages with Swagger / Open API

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Christoph Nienaber](#) and [Rico Suter](#)

When consuming a Web API, understanding its various methods can be challenging for a developer. [Swagger](#), also known as Open API, solves the problem of generating useful documentation and help pages for Web APIs. It provides benefits such as interactive documentation, client SDK generation, and API discoverability.

In this article, the [Swashbuckle.AspNetCore](#) and [NSwag](#) .NET Swagger implementations are showcased:

- **Swashbuckle.AspNetCore** is an open source project for generating Swagger documents for ASP.NET Core Web APIs.
- **NSwag** is another open source project for integrating [Swagger UI](#) or [ReDoc](#) into ASP.NET Core Web APIs. It offers approaches to generate C# and TypeScript client code for your API.

## What is Swagger / Open API?

Swagger is a language-agnostic specification for describing REST APIs. The Swagger project was donated to the [OpenAPI Initiative](#), where it's now referred to as Open API. Both names are used interchangeably; however, Open API is preferred. It allows both computers and humans to understand the capabilities of a service without any direct access to the implementation (source code, network access, documentation). One goal is to minimize the amount of work needed to connect disassociated services. Another goal is to reduce the amount of time needed to accurately document a service.

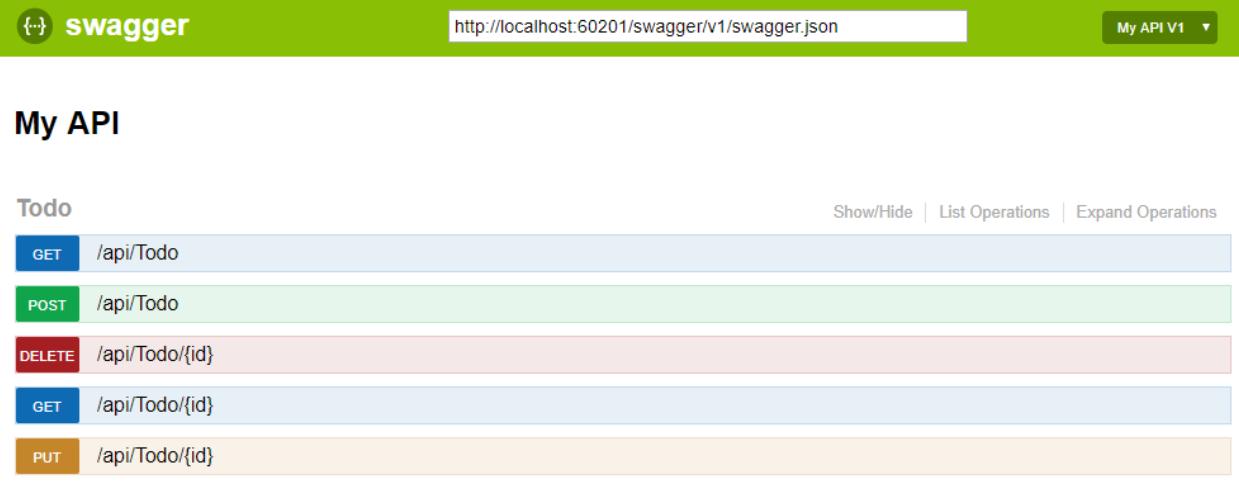
## Swagger specification (`swagger.json`)

The core to the Swagger flow is the Swagger specification—by default, a document named `swagger.json`. It's generated by the Swagger tool chain (or third-party implementations of it) based on your service. It describes the capabilities of your API and how to access it with HTTP. It drives the Swagger UI and is used by the tool chain to enable discovery and client code generation. Here's an example of a Swagger specification, reduced for brevity:

```
{
    "swagger": "2.0",
    "info": {
        "version": "v1",
        "title": "API V1"
    },
    "basePath": "/",
    "paths": {
        "/api/Todo": {
            "get": {
                "tags": [
                    "Todo"
                ],
                "operationId": "ApiTodoGet",
                "consumes": [],
                "produces": [
                    "text/plain",
                    "application/json",
                    "text/json"
                ],
                "responses": {
                    "200": {
                        "description": "Success",
                        "schema": {
                            "type": "array",
                            "items": {
                                "$ref": "#/definitions/TodoItem"
                            }
                        }
                    }
                }
            },
            "post": {
                ...
            }
        },
        "/api/Todo/{id)": {
            "get": {
                ...
            },
            "put": {
                ...
            },
            "delete": {
                ...
            },
            "definitions": {
                "TodoItem": {
                    "type": "object",
                    "properties": {
                        "id": {
                            "format": "int64",
                            "type": "integer"
                        },
                        "name": {
                            "type": "string"
                        },
                        "isComplete": {
                            "default": false,
                            "type": "boolean"
                        }
                    }
                }
            }
        },
        "securityDefinitions": {}
    }
}
```

# Swagger UI

Swagger UI offers a web-based UI that provides information about the service, using the generated Swagger specification. Both Swashbuckle and NSwag include an embedded version of Swagger UI, so that it can be hosted in your ASP.NET Core app using a middleware registration call. The web UI looks like this:



The screenshot shows the Swagger UI interface for a Todo API. At the top, there's a green header bar with the title "swagger" and a URL input field containing "http://localhost:60201/swagger/v1/swagger.json". A dropdown menu "My API V1" is also visible. Below the header, the main content area has a title "Todo" and a "My API" heading. On the right side of the main content, there are three buttons: "Show/Hide", "List Operations", and "Expand Operations". The main content area lists five API operations under the "Todo" category:

- GET /api/Todo** (blue button)
- POST /api/Todo** (green button)
- DELETE /api/Todo/{id}** (red button)
- GET /api/Todo/{id}** (blue button)
- PUT /api/Todo/{id}** (orange button)

At the bottom left, there's a note: "[ BASE URL: / , API VERSION: V1 ]".

Each public action method in your controllers can be tested from the UI. Click a method name to expand the section. Add any necessary parameters, and click **Try it out!**.

**GET** /api/Todo

## Response Class (Status 200)

Success

[Model](#) [Example Value](#)

```
[  
  {  
    "id": 0,  
    "name": "string",  
    "isComplete": false  
  }  
]
```

Response Content Type [text/plain](#)[Try it out!](#) [Hide Response](#)

## Curl

```
curl -X GET --header 'Accept: application/json' 'http://localhost:60201/api/Todo'
```

## Request URL

<http://localhost:60201/api/Todo>

## Response Body

```
[  
  {  
    "id": 1,  
    "name": "Item1",  
    "isComplete": false  
  }  
]
```

## Response Code

200

## Response Headers

```
{  
  "date": "Thu, 31 Aug 2017 17:29:04 GMT",  
  "server": "Kestrel",  
  "transfer-encoding": "chunked",  
  "content-type": "application/json; charset=utf-8"  
}
```

**NOTE**

The Swagger UI version used for the screenshots is version 2. For a version 3 example, see [Petstore example](#).

## Next steps

- [Get started with Swashbuckle](#)
- [Get started with NSwag](#)

# Get started with NSwag and ASP.NET Core

6/29/2018 • 6 minutes to read • [Edit Online](#)

By [Christoph Nienaber](#) and [Rico Suter](#)

[View or download sample code](#) ([how to download](#))

[View or download sample code](#) ([how to download](#))

Using [NSwag](#) with ASP.NET Core middleware requires the [NSwag.AspNetCore](#) NuGet package. The package consists of a Swagger generator, Swagger UI (v2 and v3), and [ReDoc UI](#).

It's highly recommended to make use of NSwag's code generation capabilities. Choose one of the following options for code generation:

- Use [NSwagStudio](#), a Windows desktop app for generating client code in C# and TypeScript for your API.
- Use the [NSwag.CodeGeneration.CSharp](#) or [NSwag.CodeGeneration.TypeScript](#) NuGet packages to do code generation inside your project.
- Use NSwag from the [command line](#).
- Use the [NSwag.MSBuild](#) NuGet package.

## Features

The main reason to use NSwag is the ability to not only introduce the Swagger UI and Swagger generator, but to make use of the flexible code generation capabilities. You don't need an existing API—you can use third-party APIs that incorporate Swagger and let NSwag generate a client implementation. Either way, the development cycle is expedited and you can more easily adapt to API changes.

## Package installation

The NSwag NuGet package can be added with the following approaches:

- [Visual Studio](#)
- [Visual Studio for Mac](#)
- [Visual Studio Code](#)
- [.NET Core CLI](#)
- From the **Package Manager Console** window:
  - Go to **View > Other Windows > Package Manager Console**
  - Navigate to the directory in which the *TodoApi.csproj* file exists
  - Execute the following command:

```
Install-Package NSwag.AspNetCore
```

- From the **Manage NuGet Packages** dialog:
  - Right-click the project in **Solution Explorer > Manage NuGet Packages**
  - Set the **Package source** to "nuget.org"
  - Enter "NSwag.AspNetCore" in the search box

- Select the "NSwag.AspNetCore" package from the **Browse** tab and click **Install**

## Add and configure Swagger middleware

Import the following namespaces in the `Startup` class:

```
using NJsonSchema;
using NSwag.AspNetCore;
using System.Reflection;
```

In the `Startup.Configure` method, enable the middleware for serving the generated Swagger specification and the Swagger UI:

```
public void Configure(IApplicationBuilder app)
{
    app.UseStaticFiles();

    // Enable the Swagger UI middleware and the Swagger generator
    app.UseSwaggerUi(typeof(Startup).GetTypeInfo().Assembly, settings =>
    {
        settings.GeneratorSettings.DefaultPropertyNameHandling =
            PropertyNameHandling.CamelCase;
    });

    app.UseMvc();
}
```

Launch the app. Navigate to `http://localhost:<port>/swagger` to view the Swagger UI. Navigate to `http://localhost:<port>/swagger/v1/swagger.json` to view the Swagger specification.

## Code generation

### Via NSwagStudio

- Install NSwagStudio from the official [GitHub repository](#).
- Launch NSwagStudio. Enter the `swagger.json` file URL in the **Swagger Specification URL** textbox, and click the **Create local Copy** button.
- Select the **CSharp Client** client output type. Other options include **TypeScript Client** and **CSharp Web API Controller**. Using a Web API Controller is basically a reverse generation. It uses a specification of a service to rebuild the service.
- Click the **Generate Outputs** button. A complete C# client implementation of the `TodoApi.NSwag` project is produced. Click the **CSharp Client** tab of the **Outputs** section to see the generated client code:

```

//-----
// <auto-generated>
//   Generated using the NSwag toolchain v11.17.3.0 (NJsonSchema v9.10.46.0 (Newtonsoft.Json v9.0.0.0))
//   (http://NSwag.org)
// </auto-generated>
//-----

namespace MyNamespace
{
    #pragma warning disable // Disable all warnings

    [System.CodeDom.Compiler.GeneratedCode("NSwag",
        "11.17.3.0 (NJsonSchema v9.10.46.0 (Newtonsoft.Json v9.0.0.0))")]
    public partial class TodoClient
    {
        private string _baseUrl = "http://localhost:50499";
        private System.Lazy<Newtonsoft.Json.JsonSerializerSettings> _settings;

        public TodoClient()
        {
            _settings = new System.Lazy<Newtonsoft.Json.JsonSerializerSettings>(() =>
            {
                var settings = new Newtonsoft.Json.JsonSerializerSettings();
                UpdateJsonSerializerSettings(settings);
                return settings;
            });
        }

        public string BaseUrl
        {
            get { return _baseUrl; }
            set { _baseUrl = value; }
        }

        // code omitted for brevity
    }
}

```

#### TIP

The C# client code is generated based on settings defined in the **Settings** tab of the **CSharp Client** tab. Modify the settings to perform tasks such as default namespace renaming and synchronous method generation.

- Copy the generated C# code into a file in a client project (for example, a [Xamarin.Forms](#) app).
- Start consuming the web API:

```

var todoClient = new TodoClient();

// Gets all to-dos from the API
var allTodos = await todoClient.GetAllAsync();

// Create a new TodoItem, and save it in the API
var createdTodo = await todoClient.CreateAsync(new TodoItem());

// Get a single to-do by ID
var foundTodo = await todoClient.GetByIdAsync(1);

```

#### NOTE

You can inject a base URL and/or a HTTP client into the API client. The best practice is to always [reuse the HttpClient](#).

## Other ways to generate client code

You can generate the client code in other ways, more suited to your workflow:

- [MSBuild](#)
- [In code](#)
- [T4 templates](#)

## Customize

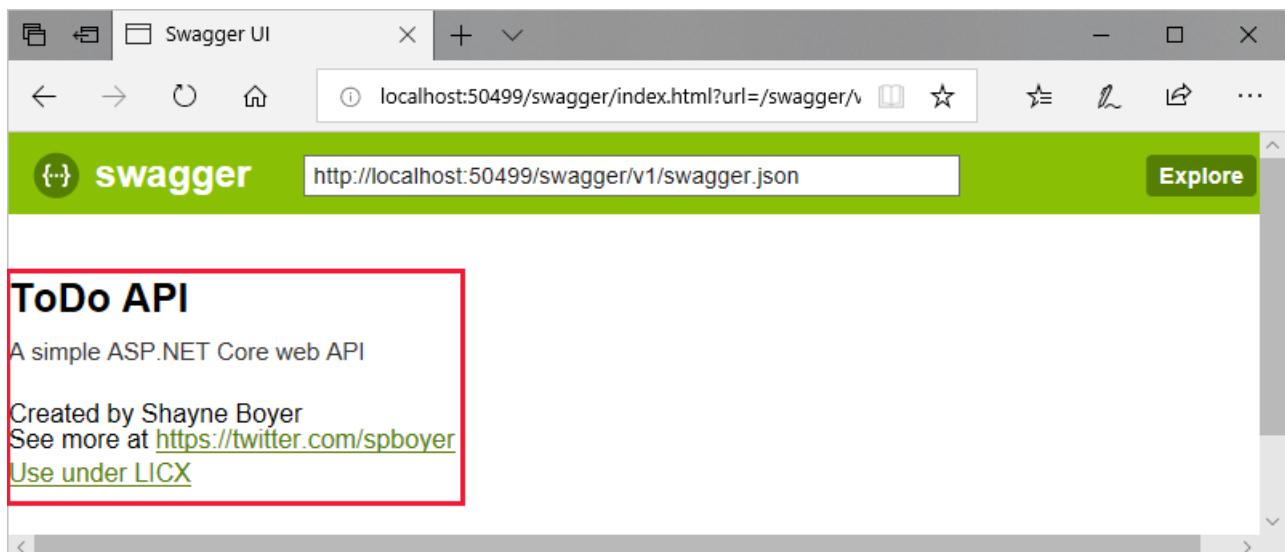
Swagger provides options for documenting the object model to ease consumption of the web API.

### API info and description

In the `Startup.Configure` method, a configuration action passed to the `UseSwagger` method adds information such as the author, license, and description:

```
// Register the Swagger generator
app.UseSwagger(typeof(Startup).Assembly, settings =>
{
    settings.PostProcess = document =>
    {
        document.Info.Version = "v1";
        document.Info.Title = "ToDo API";
        document.Info.Description = "A simple ASP.NET Core web API";
        document.Info.TermsOfService = "None";
        document.Info.Contact = new NSwag.SwaggerContact
        {
            Name = "Shayne Boyer",
            Email = string.Empty,
            Url = "https://twitter.com/spboyer"
        };
        document.Info.License = new NSwag.SwaggerLicense
        {
            Name = "Use under LICX",
            Url = "https://example.com/license"
        };
    };
});
```

The Swagger UI displays the version's information:



## XML comments

XML comments are enabled with the following approaches:

- [Visual Studio](#)
- [Visual Studio for Mac](#)
- [Visual Studio Code](#)
- Right-click the project in **Solution Explorer** and select **Edit <project\_name>.csproj**.
- Manually add the highlighted lines to the .csproj file:

```
<PropertyGroup>
  <GenerateDocumentationFile>true</GenerateDocumentationFile>
  <NoWarn>$(NoWarn);1591</NoWarn>
</PropertyGroup>
```

- Right-click the project in **Solution Explorer** and select **Properties**
- Check the **XML documentation file** box under the **Output** section of the **Build** tab

## Data annotations

NSwag uses [Reflection](#), and the recommended return type for web API actions is [IActionResult](#). Consequently, NSwag can't infer what your action is doing and what it returns. Consider the following example:

```
[HttpPost]
public IActionResult Create([FromBody] TodoItem item)
{
    if (item == null)
    {
        return BadRequest();
    }

    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}
```

The preceding action returns `IActionResult`, but inside the action it's returning either `CreatedAtRoute` or `BadRequest`. Data annotations are used to tell clients which HTTP status codes this action is known to return. Decorate the action with the following attributes:

```
[ProducesResponseType(typeof(TodoItem), 201)] // Created
[ProducesResponseType(400)] // BadRequest
```

NSwag uses [Reflection](#), and the recommended return type for web API actions is [ActionResult<T>](#). Consequently, NSwag can only infer the return type defined by `T`. Other possible return types in the action cannot be inferred. Consider the following example:

```
[HttpPost]
public ActionResult<TodoItem> Create(TodoItem item)
{
    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}
```

The preceding action returns `ActionResult<T>`, but inside the action it's returning either `CreatedAtRoute`. Since the controller is decorated with the [\[ApiController\]](#) attribute, a `BadRequest` response is possible too. See [Automatic HTTP 400 responses](#) for more info. Data annotations are used to tell clients which HTTP status codes this action is

known to return. Decorate the action with the following attributes:

```
[ProducesResponseType(201)]      // Created  
[ProducesResponseType(400)]      // BadRequest
```

The Swagger generator can now accurately describe this action, and generated clients know what they receive when calling the endpoint. Decorating all actions with these attributes is highly recommended. For guidelines on what HTTP responses your API actions should return, see the [RFC 7231 specification](#).

# Get started with Swashbuckle and ASP.NET Core

6/29/2018 • 11 minutes to read • [Edit Online](#)

By [Shayne Boyer](#) and [Scott Addie](#)

[View or download sample code](#) ([how to download](#))

There are three main components to Swashbuckle:

- [Swashbuckle.AspNetCore.Swagger](#): a Swagger object model and middleware to expose `SwaggerDocument` objects as JSON endpoints.
- [Swashbuckle.AspNetCore.SwaggerGen](#): a Swagger generator that builds `SwaggerDocument` objects directly from your routes, controllers, and models. It's typically combined with the Swagger endpoint middleware to automatically expose Swagger JSON.
- [Swashbuckle.AspNetCore.SwaggerUI](#): an embedded version of the Swagger UI tool. It interprets Swagger JSON to build a rich, customizable experience for describing the Web API functionality. It includes built-in test harnesses for the public methods.

## Package installation

Swashbuckle can be added with the following approaches:

- [Visual Studio](#)
- [Visual Studio for Mac](#)
- [Visual Studio Code](#)
- [.NET Core CLI](#)
- From the **Package Manager Console** window:
  - Go to **View > Other Windows > Package Manager Console**
  - Navigate to the directory in which the `TodoApi.csproj` file exists
  - Execute the following command:

```
Install-Package Swashbuckle.AspNetCore
```

- From the **Manage NuGet Packages** dialog:
  - Right-click the project in **Solution Explorer > Manage NuGet Packages**
  - Set the **Package source** to "nuget.org"
  - Enter "Swashbuckle.AspNetCore" in the search box
  - Select the "Swashbuckle.AspNetCore" package from the **Browse** tab and click **Install**

## Add and configure Swagger middleware

Add the Swagger generator to the services collection in the `Startup.ConfigureServices` method:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<TodoContext>(opt =>
        opt.UseInMemoryDatabase("TodoList"));
    services.AddMvc();

    // Register the Swagger generator, defining 1 or more Swagger documents
    services.AddSwaggerGen(c =>
    {
        c.SwaggerDoc("v1", new Info { Title = "My API", Version = "v1" });
    });
}
```

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<TodoContext>(opt =>
        opt.UseInMemoryDatabase("TodoList"));
    services.AddMvc()
        .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);

    // Register the Swagger generator, defining 1 or more Swagger documents
    services.AddSwaggerGen(c =>
    {
        c.SwaggerDoc("v1", new Info { Title = "My API", Version = "v1" });
    });
}
```

Import the following namespace to use the `Info` class:

```
using Swashbuckle.AspNetCore.Swagger;
```

In the `Startup.Configure` method, enable the middleware for serving the generated JSON document and the Swagger UI:

```
public void Configure(IApplicationBuilder app)
{
    // Enable middleware to serve generated Swagger as a JSON endpoint.
    app.UseSwagger();

    // Enable middleware to serve swagger-ui (HTML, JS, CSS, etc.),
    // specifying the Swagger JSON endpoint.
    app.UseSwaggerUI(c =>
    {
        c.SwaggerEndpoint("/swagger/v1/swagger.json", "My API V1");
    });

    app.UseMvc();
}
```

Launch the app, and navigate to `http://localhost:<port>/swagger/v1/swagger.json`. The generated document describing the endpoints appears as shown in [Swagger specification \(swagger.json\)](#).

The Swagger UI can be found at `http://localhost:<port>/swagger`. Explore the API via Swagger UI and incorporate it in other programs.

## TIP

To serve the Swagger UI at the app's root (`http://localhost:<port>/`), set the `RoutePrefix` property to an empty string:

```
app.UseSwaggerUI(c =>
{
    c.SwaggerEndpoint("/swagger/v1/swagger.json", "My API V1");
    c.RoutePrefix = string.Empty;
});
```

## Customize and extend

Swagger provides options for documenting the object model and customizing the UI to match your theme.

### API info and description

The configuration action passed to the `AddSwaggerGen` method adds information such as the author, license, and description:

```
// Register the Swagger generator, defining 1 or more Swagger documents
services.AddSwaggerGen(c =>
{
    c.SwaggerDoc("v1", new Info
    {
        Version = "v1",
        Title = "ToDo API",
        Description = "A simple example ASP.NET Core Web API",
        TermsOfService = "None",
        Contact = new Contact
        {
            Name = "Shayne Boyer",
            Email = string.Empty,
            Url = "https://twitter.com/spboyer"
        },
        License = new License
        {
            Name = "Use under LICX",
            Url = "https://example.com/license"
        }
    });
});
```

The Swagger UI displays the version's information:

The screenshot shows the Swagger UI interface for a 'ToDo API' at version v1. The main title 'ToDo API' is displayed with a red border around it. Below the title, there is a link to '/swagger/v1/swagger.json'. Underneath the link, the text 'A simple example ASP.NET Core Web API' is shown. At the bottom of this section, there are three links: 'Terms of service', 'Shayne Boyer - Website', and 'Use under LICX'. The top navigation bar includes tabs for 'Select a spec' (set to 'My API V1') and a dropdown menu.

## XML comments

XML comments can be enabled with the following approaches:

- [Visual Studio](#)
- [Visual Studio for Mac](#)
- [Visual Studio Code](#)
- Right-click the project in **Solution Explorer** and select **Edit <project\_name>.csproj**.
- Manually add the highlighted lines to the `.csproj` file:

```
<PropertyGroup>
  <GenerateDocumentationFile>true</GenerateDocumentationFile>
  <NoWarn>$(NoWarn);1591</NoWarn>
</PropertyGroup>
```

- Right-click the project in **Solution Explorer** and select **Properties**.
- Check the **XML documentation file** box under the **Output** section of the **Build** tab.

Enabling XML comments provides debug information for undocumented public types and members.

Undocumented types and members are indicated by the warning message. For example, the following message indicates a violation of warning code 1591:

```
warning CS1591: Missing XML comment for publicly visible type or member 'TodoController.GetAll()'
```

Suppress warnings by defining a semicolon-delimited list of warning codes to ignore in the `.csproj` file. Appending the warning codes to `$(NoWarn);` applies the C# default values too.

```
<PropertyGroup>
  <GenerateDocumentationFile>true</GenerateDocumentationFile>
  <NoWarn>$(NoWarn);1591</NoWarn>
</PropertyGroup>
```

```
<PropertyGroup>
  <DocumentationFile>bin\$(Configuration)\$(TargetFramework)\$(AssemblyName).xml</DocumentationFile>
  <NoWarn>$(NoWarn);1591</NoWarn>
</PropertyGroup>
```

Configure Swagger to use the generated XML file. For Linux or non-Windows operating systems, file names and paths can be case-sensitive. For example, a *TodoApi.XML* file is valid on Windows but not CentOS.

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<TodoContext>(opt =>
        opt.UseInMemoryDatabase("TodoList"));
    services.AddMvc()
        .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);

    // Register the Swagger generator, defining 1 or more Swagger documents
    services.AddSwaggerGen(c =>
    {
        c.SwaggerDoc("v1", new Info
        {
            Version = "v1",
            Title = "ToDo API",
            Description = "A simple example ASP.NET Core Web API",
            TermsOfService = "None",
            Contact = new Contact
            {
                Name = "Shayne Boyer",
                Email = string.Empty,
                Url = "https://twitter.com/spboyer"
            },
            License = new License
            {
                Name = "Use under LICX",
                Url = "https://example.com/license"
            }
        });
    });

    // Set the comments path for the Swagger JSON and UI.
    var xmlFile = $"{Assembly.GetExecutingAssembly().GetName().Name}.xml";
    var xmlPath = Path.Combine(AppContext.BaseDirectory, xmlFile);
    c.IncludeXmlComments(xmlPath);
});
```

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<TodoContext>(opt =>
        opt.UseInMemoryDatabase("TodoList"));
    services.AddMvc();

    // Register the Swagger generator, defining 1 or more Swagger documents
    services.AddSwaggerGen(c =>
    {
        c.SwaggerDoc("v1", new Info
        {
            Version = "v1",
            Title = "ToDo API",
            Description = "A simple example ASP.NET Core Web API",
            TermsOfService = "None",
            Contact = new Contact
            {
                Name = "Shayne Boyer",
                Email = string.Empty,
                Url = "https://twitter.com/spboyer"
            },
            License = new License
            {
                Name = "Use under LICX",
                Url = "https://example.com/license"
            }
        });
    });

    // Set the comments path for the Swagger JSON and UI.
    var xmlFile = $"{Assembly.GetExecutingAssembly().GetName().Name}.xml";
    var xmlPath = Path.Combine(AppContext.BaseDirectory, xmlFile);
    c.IncludeXmlComments(xmlPath);
});

}
```

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<TodoContext>(opt =>
        opt.UseInMemoryDatabase("TodoList"));
    services.AddMvc();

    // Register the Swagger generator, defining 1 or more Swagger documents
    services.AddSwaggerGen(c =>
    {
        c.SwaggerDoc("v1", new Info
        {
            Version = "v1",
            Title = "ToDo API",
            Description = "A simple example ASP.NET Core Web API",
            TermsOfService = "None",
            Contact = new Contact
            {
                Name = "Shayne Boyer",
                Email = string.Empty,
                Url = "https://twitter.com/spboyer"
            },
            License = new License
            {
                Name = "Use under LICX",
                Url = "https://example.com/license"
            }
        });
    });

    // Set the comments path for the Swagger JSON and UI.
    var xmlFile = $"{Assembly.GetEntryAssembly().GetName().Name}.xml";
    var xmlPath = Path.Combine(AppContext.BaseDirectory, xmlFile);
    c.IncludeXmlComments(xmlPath);
});
}

```

In the preceding code, [Reflection](#) is used to build an XML file name matching that of the Web API project. The [AppContext.BaseDirectory](#) property is used to construct a path to the XML file.

Adding triple-slash comments to an action enhances the Swagger UI by adding the description to the section header. Add a [`<summary>`](#) element above the [`Delete`](#) action:

```

/// <summary>
/// Deletes a specific TodoItem.
/// </summary>
/// <param name="id"></param>
[HttpDelete("{id}")]
public IActionResult Delete(long id)
{
    var todo = _context.TodoItems.Find(id);

    if (todo == null)
    {
        return NotFound();
    }

    _context.TodoItems.Remove(todo);
    _context.SaveChanges();

    return NoContent();
}

```

The Swagger UI displays the inner text of the preceding code's [`<summary>`](#) element:

The screenshot shows the Swagger UI interface for a DELETE operation. At the top left is a red button labeled "DELETE". To its right is the endpoint path "/api/Todo/{id}" in a blue box, with a description "Deletes a specific TodoItem." below it. In the top right corner is a "Try it out" button. Below the header, there's a section titled "Parameters" with a table. The first parameter is "id \* required" (type: integer, path). There's also a "Responses" section with a table for the 200 status code, which has a "Success" description. The "Code" column lists the HTTP status code, and the "Description" column lists the response message.

Name	Description
<b>id</b> * required integer (path)	

Responses	Response content type
	application/json

Code	Description
200	<i>Success</i>

The UI is driven by the generated JSON schema:

```

"delete": {
    "tags": [
        "Todo"
    ],
    "summary": "Deletes a specific TodoItem.",
    "operationId": "ApiTodoByIdDelete",
    "consumes": [],
    "produces": [],
    "parameters": [
        {
            "name": "id",
            "in": "path",
            "description": "",
            "required": true,
            "type": "integer",
            "format": "int64"
        }
    ],
    "responses": {
        "200": {
            "description": "Success"
        }
    }
}

```

Add a `<remarks>` element to the `Create` action method documentation. It supplements information specified in the `<summary>` element and provides a more robust Swagger UI. The `<remarks>` element content can consist of text, JSON, or XML.

```

/// <summary>
/// Creates a TodoItem.
/// </summary>
/// <remarks>
/// Sample request:
///
///     POST /Todo
/// {
///     "id": 1,
///     "name": "Item1",
///     "isComplete": true
/// }
///
/// </remarks>
/// <param name="item"></param>
/// <returns>A newly created TodoItem</returns>
/// <response code="201">Returns the newly created item</response>
/// <response code="400">If the item is null</response>
[HttpPost]
[ProducesResponseType(typeof(TodoItem), 201)]
[ProducesResponseType(400)]
public IActionResult Create([FromBody] TodoItem item)
{
    if (item == null)
    {
        return BadRequest();
    }

    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}

```

```

/// <summary>
/// Creates a TodoItem.
/// </summary>
/// <remarks>
/// Sample request:
///
///     POST /Todo
/// {
///     "id": 1,
///     "name": "Item1",
///     "isComplete": true
/// }
///
/// </remarks>
/// <param name="item"></param>
/// <returns>A newly created TodoItem</returns>
/// <response code="201">Returns the newly created item</response>
/// <response code="400">If the item is null</response>
[HttpPost]
[ProducesResponseType(201)]
[ProducesResponseType(400)]
public ActionResult<TodoItem> Create(TodoItem item)
{
    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}

```

Notice the UI enhancements with these additional comments:

**POST**

/api/Todo Creates a TodoItem.

Sample request:

```
POST /Todo
{
    "id": 1,
    "name": "Item1",
    "isComplete": true
}
```

## Data annotations

Decorate the model with attributes, found in the [System.ComponentModel.DataAnnotations](#) namespace, to help drive the Swagger UI components.

Add the `[Required]` attribute to the `Name` property of the `TodoItem` class:

```
using System.ComponentModel;
using System.ComponentModel.DataAnnotations;

namespace TodoApi.Models
{
    public class TodoItem
    {
        public long Id { get; set; }

        [Required]
        public string Name { get; set; }

        [DefaultValue(false)]
        public bool IsComplete { get; set; }
    }
}
```

The presence of this attribute changes the UI behavior and alters the underlying JSON schema:

```
"definitions": {
    "TodoItem": {
        "required": [
            "name"
        ],
        "type": "object",
        "properties": {
            "id": {
                "format": "int64",
                "type": "integer"
            },
            "name": {
                "type": "string"
            },
            "isComplete": {
                "default": false,
                "type": "boolean"
            }
        }
    }
},
```

Add the `[Produces("application/json")]` attribute to the API controller. Its purpose is to declare that the controller's actions support a response content type of *application/json*:

```
[Produces("application/json")]
[Route("api/[controller]")]
public class TodoController : ControllerBase
{
    private readonly TodoContext _context;
```

```
[Produces("application/json")]
[Route("api/[controller]")]
[ApiController]
public class TodoController : ControllerBase
{
    private readonly TodoContext _context;
```

The **Response Content Type** drop-down selects this content type as the default for the controller's GET actions:

The screenshot shows the Swagger UI interface for a `GET /api/Todo` endpoint. The top navigation bar has a blue button for `GET` and the URL `/api/Todo`. Below it, there's a **Parameters** section with a note "No parameters". On the right, there's a **Try it out** button. In the bottom right corner of the main content area, there's a **Responses** section. Within this section, there's a **Response content type** dropdown menu. The menu is open, showing the value `application/json`, which is highlighted with a red rectangular border.

As the usage of data annotations in the Web API increases, the UI and API help pages become more descriptive and useful.

### Describe response types

Consuming developers are most concerned with what's returned—specifically response types and error codes (if not standard). The response types and error codes are denoted in the XML comments and data annotations.

The `Create` action returns an HTTP 201 status code on success. An HTTP 400 status code is returned when the posted request body is null. Without proper documentation in the Swagger UI, the consumer lacks knowledge of these expected outcomes. Fix that problem by adding the highlighted lines in the following example:

```

/// <summary>
/// Creates a TodoItem.
/// </summary>
/// <remarks>
/// Sample request:
///
///     POST /Todo
///     {
///         "id": 1,
///         "name": "Item1",
///         "isComplete": true
///     }
///
/// </remarks>
/// <param name="item"></param>
/// <returns>A newly created TodoItem</returns>
/// <response code="201">Returns the newly created item</response>
/// <response code="400">If the item is null</response>
[HttpPost]
[ProducesResponseType(typeof(TodoItem), 201)]
[ProducesResponseType(400)]
public IActionResult Create([FromBody] TodoItem item)
{
    if (item == null)
    {
        return BadRequest();
    }

    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}

```

```

/// <summary>
/// Creates a TodoItem.
/// </summary>
/// <remarks>
/// Sample request:
///
///     POST /Todo
///     {
///         "id": 1,
///         "name": "Item1",
///         "isComplete": true
///     }
///
/// </remarks>
/// <param name="item"></param>
/// <returns>A newly created TodoItem</returns>
/// <response code="201">Returns the newly created item</response>
/// <response code="400">If the item is null</response>
[HttpPost]
[ProducesResponseType(201)]
[ProducesResponseType(400)]
public ActionResult<TodoItem> Create(TodoItem item)
{
    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}

```

The Swagger UI now clearly documents the expected HTTP response codes:

The screenshot shows the 'Responses' section of the Swagger UI. At the top, it says 'Response content type application/json'. Below that, there's a table with two columns: 'Code' and 'Description'. The first row shows '201' and 'Returns the newly created item'. A red box highlights this row. Below it, there's a 'Example Value' button and a 'Model' link. The model is shown as a JSON object: { "id": 0, "name": "string", "isComplete": false }. The second row shows '400' and 'If the item is null'.

## Customize the UI

The stock UI is both functional and presentable. However, API documentation pages should represent your brand or theme. Branding the Swashbuckle components requires adding the resources to serve static files and building the folder structure to host those files.

If targeting .NET Framework or .NET Core 1.x, add the [Microsoft.AspNetCore.StaticFiles](#) NuGet package to the project:

```
<PackageReference Include="Microsoft.AspNetCore.StaticFiles" Version="2.0.0" />
```

The preceding NuGet package is already installed if targeting .NET Core 2.x and using the [metapackage](#).

Enable the static files middleware:

```
public void Configure(IApplicationBuilder app)
{
    app.UseStaticFiles();

    // Enable middleware to serve generated Swagger as a JSON endpoint.
    app.UseSwagger();

    // Enable middleware to serve swagger-ui (HTML, JS, CSS, etc.),
    // specifying the Swagger JSON endpoint.
    app.UseSwaggerUI(c =>
    {
        c.SwaggerEndpoint("/swagger/v1/swagger.json", "My API V1");
    });

    app.UseMvc();
}
```

Acquire the contents of the *dist* folder from the [Swagger UI GitHub repository](#). This folder contains the necessary assets for the Swagger UI page.

Create a *wwwroot/swagger/ui* folder, and copy into it the contents of the *dist* folder.

Create a *custom.css* file, in *wwwroot/swagger/ui*, with the following CSS to customize the page header:

```
.swagger-ui .topbar {  
    background-color: #000;  
    border-bottom: 3px solid #547f00;  
}
```

Reference *custom.css* in the *index.html* file, after any other CSS files:

```
<link href="https://fonts.googleapis.com/css?  
family=Open+Sans:400,700|Source+Code+Pro:300,600|Titillium+Web:400,600,700" rel="stylesheet">  
<link rel="stylesheet" type="text/css" href="/swagger-ui.css">  
<link rel="stylesheet" type="text/css" href="custom.css">
```

Browse to the *index.html* page at `http://localhost:<port>/swagger/ui/index.html`. Enter `http://localhost:<port>/swagger/v1/swagger.json` in the header's textbox, and click the **Explore** button. The resulting page looks as follows:

The screenshot shows the Swagger UI interface for a Todo API. At the top, there is a navigation bar with the Swagger logo, the URL `http://localhost:49253/swagger/v1/swagger.json`, and an **Explore** button. Below the navigation bar, the title "ToDo API" is displayed with a "v1" badge. A link to the API documentation at `http://localhost:49253/swagger/v1/swagger.json` is provided. Below the title, there are links for "Terms of service", "Shayne Boyer - Website", and "Use under LICX".

The main content area is titled "Todo". It lists five API endpoints:

- GET** `/api/Todo`
- POST** `/api/Todo` Creates a Todolitem.
- GET** `/api/Todo/{id}`
- PUT** `/api/Todo/{id}`
- DELETE** `/api/Todo/{id}` Deletes a specific Todolitem.

Below the endpoints, there is a section titled "Models" which contains a link to "Todolitem".

There's much more you can do with the page. See the full capabilities for the UI resources at the [Swagger UI GitHub repository](#).

# Work with data in ASP.NET Core

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# ASP.NET Core Razor Pages with EF Core - tutorial series

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This series of tutorials teaches how to create ASP.NET Core Razor Pages web apps that use Entity Framework (EF) Core for data access.

1. [Get started](#)
2. [Create, Read, Update, and Delete operations](#)
3. [Sorting, filtering, paging, and grouping](#)
4. [Migrations](#)
5. [Create a complex data model](#)
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8. [Handle concurrency conflicts](#)

# Razor Pages with Entity Framework Core in ASP.NET Core - Tutorial 1 of 8

7/10/2018 • 15 minutes to read • [Edit Online](#)

The ASP.NET Core 2.0 version of this tutorial can be found in [this PDF file](#).

The ASP.NET Core 2.1 version of this tutorial has many improvements over the 2.0 version.

By [Tom Dykstra](#) and [Rick Anderson](#)

The Contoso University sample web app demonstrates how to create an ASP.NET Core Razor Pages app using Entity Framework (EF) Core.

The sample app is a web site for a fictional Contoso University. It includes functionality such as student admission, course creation, and instructor assignments. This page is the first in a series of tutorials that explain how to build the Contoso University sample app.

[Download or view the completed app.](#) [Download instructions.](#)

## Prerequisites

- [Visual Studio](#)
- [.NET Core CLI](#)

[Visual Studio 2017 version 15.7.3 or later](#) with the following workloads:

- **ASP.NET and web development**
- **.NET Core cross-platform development**

[.NET Core 2.1 SDK or later](#)

Familiarity with [Razor Pages](#). New programmers should complete [Get started with Razor Pages](#) before starting this series.

## Troubleshooting

If you run into a problem you can't resolve, you can generally find the solution by comparing your code to the [completed project](#). A good way to get help is by posting a question to [StackOverflow.com](#) for [ASP.NET Core](#) or [EF Core](#).

## The Contoso University web app

The app built in these tutorials is a basic university web site.

Users can view and update student, course, and instructor information. Here are a few of the screens created in the tutorial.

The screenshot shows a web browser window titled "Index - Contoso University". The address bar displays "localhost:1234/Students". The page header "Contoso University" has a three-line menu icon. The main content area is titled "Index" with a "Create New" link. A search bar with placeholder "Find by name:" and a "Search" button is present. Below is a table with columns "Last Name", "First Name", and "Enrollment Date". Three rows of student data are listed:

Last Name	First Name	Enrollment Date	
Smith	Joe	2017-10-31	Edit   Details   Delete
Alexander	Carson	2010-09-01	Edit   Details   Delete
Alonso	Meredith	2012-09-01	Edit   Details   Delete

Navigation buttons "Previous" and "Next" are at the bottom, along with a copyright notice: "© 2017 - Contoso University".

The screenshot shows a web browser window titled "Edit - Contoso University". The address bar displays "localhost:1234/Students/Edit/1". The page header "Contoso University" has a three-line menu icon. The main content area is titled "Edit" with a "Student" subtitle. It contains three input fields: "Last Name" (Alexander), "First Name" (Carson), and "Enrollment Date" (09/01/2010). A "Save" button is below the date field. Navigation links "Back to List" and "© 2017 - Contoso University" are at the bottom.

The UI style of this site is close to what's generated by the built-in templates. The tutorial focus is on EF Core with

Razor Pages, not the UI.

## Create the ContosoUniversity Razor Pages web app

- [Visual Studio](#)
  - [.NET Core CLI](#)
- From the Visual Studio **File** menu, select **New > Project**.
  - Create a new ASP.NET Core Web Application. Name the project **ContosoUniversity**. It's important to name the project *ContosoUniversity* so the namespaces match when code is copy/pasted.
  - Select **ASP.NET Core 2.1** in the dropdown, and then select **Web Application**.

For images of the preceding steps, see [Create a Razor web app](#). Run the app.

## Set up the site style

A few changes set up the site menu, layout, and home page. Update *Pages/Shared/\_Layout.cshtml* with the following changes:

- Change each occurrence of "ContosoUniversity" to "Contoso University". There are three occurrences.
- Add menu entries for **Students**, **Courses**, **Instructors**, and **Departments**, and delete the **Contact** menu entry.

The changes are highlighted. (All the markup is *not* displayed.)

```

<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>@ViewData["Title"] : Contoso University</title>

    <environment include="Development">
        <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />
        <link rel="stylesheet" href("~/css/site.css" />
    </environment>
    <environment exclude="Development">
        <link rel="stylesheet" href="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/css/bootstrap.min.css"
              asp-fallback-href="~/lib/bootstrap/dist/css/bootstrap.min.css"
              asp-fallback-test-class="sr-only" asp-fallback-test-property="position" asp-fallback-test-
              value="absolute" />
        <link rel="stylesheet" href "~/css/site.min.css" asp-append-version="true" />
    </environment>
</head>
<body>
    <nav class="navbar navbar-inverse navbar-fixed-top">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-
collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a asp-page="/Index" class="navbar-brand">Contoso University</a>
            </div>
            <div class="navbar-collapse collapse">
                <ul class="nav navbar-nav">
                    <li><a asp-page="/Index">Home</a></li>
                    <li><a asp-page="/About">About</a></li>
                    <li><a asp-page="/Students/Index">Students</a></li>
                    <li><a asp-page="/Courses/Index">Courses</a></li>
                    <li><a asp-page="/Instructors/Index">Instructors</a></li>
                    <li><a asp-page="/Departments/Index">Departments</a></li>
                </ul>
            </div>
        </div>
    </nav>

    <partial name="_CookieConsentPartial" />

    <div class="container body-content">
        @RenderBody()
        <hr />
        <footer>
            <p>&copy; 2018 : Contoso University</p>
        </footer>
    </div>

    @*Remaining markup not shown for brevity.*@

```

In *Pages/Index.cshtml*, replace the contents of the file with the following code to replace the text about ASP.NET and MVC with text about this app:

```

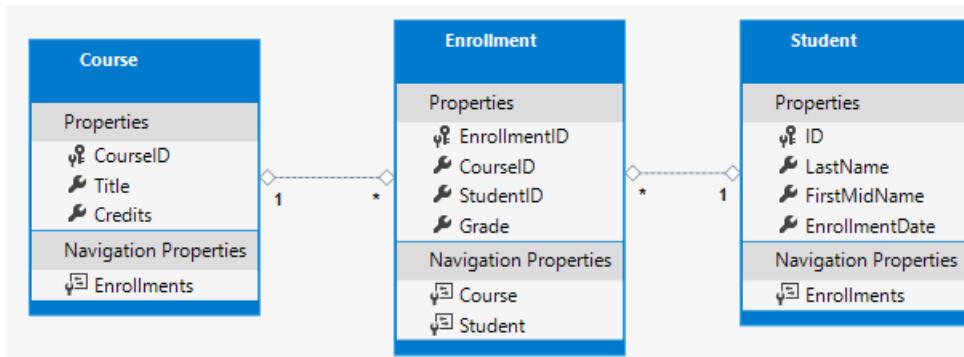
@page
@model IndexModel
 @{
     ViewData["Title"] = "Home page";
 }

<div class="jumbotron">
    <h1>Contoso University</h1>
</div>
<div class="row">
    <div class="col-md-4">
        <h2>Welcome to Contoso University</h2>
        <p>
            Contoso University is a sample application that
            demonstrates how to use Entity Framework Core in an
            ASP.NET Core Razor Pages web app.
        </p>
    </div>
    <div class="col-md-4">
        <h2>Build it from scratch</h2>
        <p>You can build the application by following the steps in a series of tutorials.</p>
        <p>
            <a class="btn btn-default"
                href="https://docs.microsoft.com/aspnet/core/data/ef-rp/intro">
                See the tutorial &raquo;
            </a>
        </p>
    </div>
    <div class="col-md-4">
        <h2>Download it</h2>
        <p>You can download the completed project from GitHub.</p>
        <p>
            <a class="btn btn-default"
                href="https://github.com/aspnet/Docs/tree/master/aspnetcore/data/ef-rp/intro/samples/cu-final">
                See project source code &raquo;
            </a>
        </p>
    </div>
</div>

```

## Create the data model

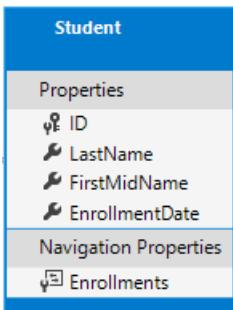
Create entity classes for the Contoso University app. Start with the following three entities:



There's a one-to-many relationship between `Student` and `Enrollment` entities. There's a one-to-many relationship between `Course` and `Enrollment` entities. A student can enroll in any number of courses. A course can have any number of students enrolled in it.

In the following sections, a class for each one of these entities is created.

### The Student entity



Create a *Models* folder. In the *Models* folder, create a class file named *Student.cs* with the following code:

```
using System;
using System.Collections.Generic;

namespace ContosoUniversity.Models
{
    public class Student
    {
        public int ID { get; set; }
        public string LastName { get; set; }
        public string FirstMidName { get; set; }
        public DateTime EnrollmentDate { get; set; }

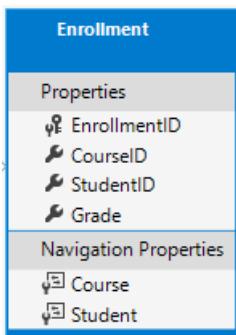
        public ICollection<Enrollment> Enrollments { get; set; }
    }
}
```

The `ID` property becomes the primary key column of the database (DB) table that corresponds to this class. By default, EF Core interprets a property that's named `ID` or `classnameID` as the primary key. In `classnameID`, `classname` is the name of the class. The alternative automatically recognized primary key is `StudentID` in the preceding example.

The `Enrollments` property is a navigation property. Navigation properties link to other entities that are related to this entity. In this case, the `Enrollments` property of a `Student` entity holds all of the `Enrollment` entities that are related to that `Student`. For example, if a `Student` row in the DB has two related `Enrollment` rows, the `Enrollments` navigation property contains those two `Enrollment` entities. A related `Enrollment` row is a row that contains that student's primary key value in the `StudentID` column. For example, suppose the student with `ID=1` has two rows in the `Enrollment` table. The `Enrollment` table has two rows with `StudentID = 1`. `StudentID` is a foreign key in the `Enrollment` table that specifies the student in the `Student` table.

If a navigation property can hold multiple entities, the navigation property must be a list type, such as `ICollection<T>`. `ICollection<T>` can be specified, or a type such as `List<T>` or `HashSet<T>`. When `ICollection<T>` is used, EF Core creates a `HashSet<T>` collection by default. Navigation properties that hold multiple entities come from many-to-many and one-to-many relationships.

## The Enrollment entity



In the *Models* folder, create *Enrollment.cs* with the following code:

```

namespace ContosoUniversity.Models
{
    public enum Grade
    {
        A, B, C, D, F
    }

    public class Enrollment
    {
        public int EnrollmentID { get; set; }
        public int CourseID { get; set; }
        public int StudentID { get; set; }
        public Grade? Grade { get; set; }

        public Course Course { get; set; }
        public Student Student { get; set; }
    }
}

```

The `EnrollmentID` property is the primary key. This entity uses the `classnameID` pattern instead of `ID` like the `Student` entity. Typically developers choose one pattern and use it throughout the data model. In a later tutorial, using ID without classname is shown to make it easier to implement inheritance in the data model.

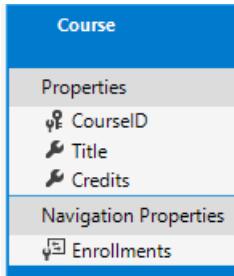
The `Grade` property is an `enum`. The question mark after the `Grade` type declaration indicates that the `Grade` property is nullable. A grade that's null is different from a zero grade -- null means a grade isn't known or hasn't been assigned yet.

The `StudentID` property is a foreign key, and the corresponding navigation property is `Student`. An `Enrollment` entity is associated with one `Student` entity, so the property contains a single `Student` entity. The `Student` entity differs from the `student.Enrollments` navigation property, which contains multiple `Enrollment` entities.

The `CourseID` property is a foreign key, and the corresponding navigation property is `course`. An `Enrollment` entity is associated with one `Course` entity.

EF Core interprets a property as a foreign key if it's named `<navigation property name><primary key property name>`. For example, `StudentID` for the `Student` navigation property, since the `Student` entity's primary key is `ID`. Foreign key properties can also be named `<primary key property name>`. For example, `CourseID` since the `Course` entity's primary key is `CourseID`.

## The Course entity



In the `Models` folder, create `Course.cs` with the following code:

```

using System.Collections.Generic;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Course
    {
        [DatabaseGenerated(DatabaseGeneratedOption.None)]
        public int CourseID { get; set; }
        public string Title { get; set; }
        public int Credits { get; set; }

        public ICollection<Enrollment> Enrollments { get; set; }
    }
}

```

The `Enrollments` property is a navigation property. A `Course` entity can be related to any number of `Enrollment` entities.

The `DatabaseGenerated` attribute allows the app to specify the primary key rather than having the DB generate it.

## Scaffold the student model

In this section, the student model is scaffolded. That is, the scaffolding tool produces pages for Create, Read, Update, and Delete (CRUD) operations for the student model.

- Build the project.
- Create the *Pages/Students* folder.
- [Visual Studio](#)
- [.NET Core CLI](#)
- In **Solution Explorer**, right click on the *Pages/Students* folder > **Add > New Scaffolded Item**.
- In the **Add Scaffold** dialog, select **Razor Pages using Entity Framework (CRUD)** > **ADD**.

Complete the **Add Razor Pages using Entity Framework (CRUD)** dialog:

- In the **Model class** drop-down, select **Student (ContosoUniversity.Models)**.
- In the **Data context class** row, select the + (plus) sign and change the generated name to **ContosoUniversity.Models.SchoolContext**.
- In the **Data context class** drop-down, select **ContosoUniversity.Models.SchoolContext**
- Select **Add**.

## Add Razor Pages using Entity Framework (CRUD)

X

Generates Razor Pages using Entity Framework for; Create, Delete, Details, Edit and List operations for the selected model.

Model class:

Data context class:  - +

Options:

- Create as a partial view
- Reference script libraries
- Use a layout page:

...

(Leave empty if it is set in a Razor \_viewstart file)

Add

Cancel

See [Scaffold the movie model](#) if you have a problem with the preceding step.

The scaffold process created and changed the following files:

### Files created

- Pages/Students Create, Delete, Details, Edit, Index.
- Data/ContosoUniversityContext.cs

### Files updates

- Startup.cs : Changes to this file are detailed the next section.
- appsettings.json : The connection string used to connect to a local database is added.

## Examine the context registered with dependency injection

ASP.NET Core is built with [dependency injection](#). Services (such as the EF Core DB context) are registered with dependency injection during application startup. Components that require these services (such as Razor Pages) are provided these services via constructor parameters. The constructor code that gets a db context instance is shown later in the tutorial.

The scaffolding tool automatically created a DB Context and registered it with the dependency injection container.

Examine the `ConfigureServices` method in `Startup.cs`. The highlighted line was added by the scaffolder:

```
public void ConfigureServices(IServiceCollection services)
{
    services.Configure<CookiePolicyOptions>(options =>
    {
        // This lambda determines whether user consent for
        // non-essential cookies is needed for a given request.
        options.CheckConsentNeeded = context => true;
        options.MinimumSameSitePolicy = SameSiteMode.None;
    });

    services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1);

    services.AddDbContext<SchoolContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("SchoolContext")));
}
```

The name of the connection string is passed in to the context by calling a method on a [DbContextOptions](#) object. For local development, the [ASP.NET Core configuration system](#) reads the connection string from the *appsettings.json* file.

## Update main

In *Program.cs*, modify the `Main` method to do the following:

- Get a DB context instance from the dependency injection container.
- Call the [EnsureCreated](#).
- Dispose the context when the `EnsureCreated` method completes.

The following code shows the updated *Program.cs* file.

```

using ContosoUniversity.Models; // SchoolContext
using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.DependencyInjection; // CreateScope
using Microsoft.Extensions.Logging;
using System;

namespace ContosoUniversity
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = CreateWebHostBuilder(args).Build();

            using (var scope = host.Services.CreateScope())
            {
                var services = scope.ServiceProvider;

                try
                {
                    var context = services.GetRequiredService<SchoolContext>();
                    context.Database.EnsureCreated();
                }
                catch (Exception ex)
                {
                    var logger = services.GetRequiredService<ILogger<Program>>();
                    logger.LogError(ex, "An error occurred creating the DB.");
                }
            }

            host.Run();
        }

        public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>();
    }
}

```

`EnsureCreated` ensures that the database for the context exists. If it exists, no action is taken. If it does not exist, then the database and all its schema are created. `EnsureCreated` does not use migrations to create the database. A database that is created with `EnsureCreated` cannot be later updated using migrations.

`EnsureCreated` is called on app start, which allows the following work flow:

- Delete the DB.
- Change the DB schema (for example, add an `EmailAddress` field).
- Run the app.
- `EnsureCreated` creates a DB with the `EmailAddress` column.

`EnsureCreated` is convenient early in development when the schema is rapidly evolving. Later in the tutorial the DB is deleted and migrations are used.

## Test the app

Run the app and accept the cookie policy. This app doesn't keep personal information. You can read about the cookie policy at [EU General Data Protection Regulation \(GDPR\) support](#).

- Select the **Students** link and then **Create New**.
- Test the Edit, Details, and Delete links.

## Examine the SchoolContext DB context

The main class that coordinates EF Core functionality for a given data model is the DB context class. The data context is derived from [Microsoft.EntityFrameworkCore.DbContext](#). The data context specifies which entities are included in the data model. In this project, the class is named `SchoolContext`.

Update `SchoolContext.cs` with the following code:

```
using Microsoft.EntityFrameworkCore;

namespace ContosoUniversity.Models
{
    public class SchoolContext : DbContext
    {
        public SchoolContext(DbContextOptions<SchoolContext> options)
            : base(options)
        {
        }

        public DbSet<Student> Student { get; set; }
        public DbSet<Enrollment> Enrollment { get; set; }
        public DbSet<Course> Course { get; set; }
    }
}
```

The highlighted code creates a `DbSet< TEntity >` property for each entity set. In EF Core terminology:

- An entity set typically corresponds to a DB table.
- An entity corresponds to a row in the table.

`DbSet<Enrollment>` and `DbSet<Course>` could be omitted. EF Core includes them implicitly because the `Student` entity references the `Enrollment` entity, and the `Enrollment` entity references the `Course` entity. For this tutorial, keep `DbSet<Enrollment>` and `DbSet<Course>` in the `SchoolContext`.

## SQL Server Express LocalDB

The connection string specifies [SQL Server LocalDB](#). LocalDB is a lightweight version of the SQL Server Express Database Engine and is intended for app development, not production use. LocalDB starts on demand and runs in user mode, so there's no complex configuration. By default, LocalDB creates `.mdf` DB files in the `c:/Users/<user>` directory.

## Add code to initialize the DB with test data

EF Core creates an empty DB. In this section, an `Initialize` method is written to populate it with test data.

In the `Data` folder, create a new class file named `DbInitializer.cs` and add the following code:

```
using ContosoUniversity.Models;
using System;
using System.Linq;

namespace ContosoUniversity.Data
{
    public static class DbInitializer
    {
        public static void Initialize(SchoolContext context)
        {
            // context.Database.EnsureCreated();

            // Look for any students.
            if (context.Student.Any())
            {
                // Add some sample data.
            }
        }
    }
}
```

```

        return; // DB has been seeded
    }

    var students = new Student[]
    {
        new Student{FirstMidName="Carson", LastName="Alexander", EnrollmentDate=DateTime.Parse("2005-09-01")},
        new Student{FirstMidName="Meredith", LastName="Alonso", EnrollmentDate=DateTime.Parse("2002-09-01")},
        new Student{FirstMidName="Arturo", LastName="Anand", EnrollmentDate=DateTime.Parse("2003-09-01")},
        new Student{FirstMidName="Gytis", LastName="Barzdukas", EnrollmentDate=DateTime.Parse("2002-09-01")},
        new Student{FirstMidName="Yan", LastName="Li", EnrollmentDate=DateTime.Parse("2002-09-01")},
        new Student{FirstMidName="Peggy", LastName="Justice", EnrollmentDate=DateTime.Parse("2001-09-01")},
        new Student{FirstMidName="Laura", LastName="Norman", EnrollmentDate=DateTime.Parse("2003-09-01")},
        new Student{FirstMidName="Nino", LastName="Olivetto", EnrollmentDate=DateTime.Parse("2005-09-01")}
    };
    foreach (Student s in students)
    {
        context.Student.Add(s);
    }
    context.SaveChanges();

    var courses = new Course[]
    {
        new Course{CourseID=1050, Title="Chemistry", Credits=3},
        new Course{CourseID=4022, Title="Microeconomics", Credits=3},
        new Course{CourseID=4041, Title="Macroeconomics", Credits=3},
        new Course{CourseID=1045, Title="Calculus", Credits=4},
        new Course{CourseID=3141, Title="Trigonometry", Credits=4},
        new Course{CourseID=2021, Title="Composition", Credits=3},
        new Course{CourseID=2042, Title="Literature", Credits=4}
    };
    foreach (Course c in courses)
    {
        context.Course.Add(c);
    }
    context.SaveChanges();

    var enrollments = new Enrollment[]
    {
        new Enrollment{StudentID=1, CourseID=1050, Grade=Grade.A},
        new Enrollment{StudentID=1, CourseID=4022, Grade=Grade.C},
        new Enrollment{StudentID=1, CourseID=4041, Grade=Grade.B},
        new Enrollment{StudentID=2, CourseID=1045, Grade=Grade.B},
        new Enrollment{StudentID=2, CourseID=3141, Grade=Grade.F},
        new Enrollment{StudentID=2, CourseID=2021, Grade=Grade.F},
        new Enrollment{StudentID=3, CourseID=1050},
        new Enrollment{StudentID=4, CourseID=1050},
        new Enrollment{StudentID=4, CourseID=4022, Grade=Grade.F},
        new Enrollment{StudentID=5, CourseID=4041, Grade=Grade.C},
        new Enrollment{StudentID=6, CourseID=1045},
        new Enrollment{StudentID=7, CourseID=3141, Grade=Grade.A},
    };
    foreach (Enrollment e in enrollments)
    {
        context.Enrollment.Add(e);
    }
    context.SaveChanges();
}
}

```

The code checks if there are any students in the DB. If there are no students in the DB, the DB is initialized with test data. It loads test data into arrays rather than `List<T>` collections to optimize performance.

The `EnsureCreated` method automatically creates the DB for the DB context. If the DB exists, `EnsureCreated` returns without modifying the DB.

In `Program.cs`, modify the `Main` method to call `Initialize`:

```
public class Program
{
    public static void Main(string[] args)
    {
        var host = CreateWebHostBuilder(args).Build();

        using (var scope = host.Services.CreateScope())
        {
            var services = scope.ServiceProvider;

            try
            {
                var context = services.GetRequiredService<SchoolContext>();
                // using ContosoUniversity.Data;
                DbInitializer.Initialize(context);
            }
            catch (Exception ex)
            {
                var logger = services.GetRequiredService<ILogger<Program>>();
                logger.LogError(ex, "An error occurred creating the DB.");
            }
        }

        host.Run();
    }

    public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
        WebHost.CreateDefaultBuilder(args)
            .UseStartup<Startup>();
}
```

Delete any student records and restart the app. If the DB is not initialized, set a break point in `Initialize` to diagnose the problem.

## View the DB

Open **SQL Server Object Explorer** (SSOX) from the **View** menu in Visual Studio. In SSOX, click **(localdb)\MSSQLLocalDB > Databases > ContosoUniversity1**.

Expand the **Tables** node.

Right-click the **Student** table and click **View Data** to see the columns created and the rows inserted into the table.

## Asynchronous code

Asynchronous programming is the default mode for ASP.NET Core and EF Core.

A web server has a limited number of threads available, and in high load situations all of the available threads might be in use. When that happens, the server can't process new requests until the threads are freed up. With synchronous code, many threads may be tied up while they aren't actually doing any work because they're waiting for I/O to complete. With asynchronous code, when a process is waiting for I/O to complete, its thread is freed up for the server to use for processing other requests. As a result, asynchronous code enables server resources to be used more efficiently, and the server is enabled to handle more traffic without delays.

Asynchronous code does introduce a small amount of overhead at run time. For low traffic situations, the performance hit is negligible, while for high traffic situations, the potential performance improvement is substantial.

In the following code, the `async` keyword, `Task<T>` return value, `await` keyword, and `ToListAsync` method make the code execute asynchronously.

```
public async Task OnGetAsync()
{
    Student = await _context.Student.ToListAsync();
}
```

- The `async` keyword tells the compiler to:
- Generate callbacks for parts of the method body.
- Automatically create the `Task` object that's returned. For more information, see [Task Return Type](#).
- The implicit return type `Task` represents ongoing work.
- The `await` keyword causes the compiler to split the method into two parts. The first part ends with the operation that's started asynchronously. The second part is put into a callback method that's called when the operation completes.
- `ToToListAsync` is the asynchronous version of the `ToList` extension method.

Some things to be aware of when writing asynchronous code that uses EF Core:

- Only statements that cause queries or commands to be sent to the DB are executed asynchronously. That includes, `ToToListAsync`, `SingleOrDefaultAsync`, `FirstOrDefaultAsync`, and `SaveChangesAsync`. It doesn't include statements that just change an `IQueryable`, such as  
`var students = context.Students.Where(s => s.LastName == "Davolio")`.
- An EF Core context isn't thread safe: don't try to do multiple operations in parallel.
- To take advantage of the performance benefits of async code, verify that library packages (such as for paging) use async if they call EF Core methods that send queries to the DB.

For more information about asynchronous programming in .NET, see [Async Overview](#) and [Asynchronous programming with async and await](#).

In the next tutorial, basic CRUD (create, read, update, delete) operations are examined.

[NEXT](#)

# Razor Pages with EF Core in ASP.NET Core - CRUD - 2 of 8

7/14/2018 • 11 minutes to read • [Edit Online](#)

The ASP.NET Core 2.0 version of this tutorial can be found in [this PDF file](#).

The ASP.NET Core 2.1 version of this tutorial has many improvements over the 2.0 version.

By [Tom Dykstra](#), [Jon P Smith](#), and [Rick Anderson](#)

The Contoso University web app demonstrates how to create Razor Pages web apps using EF Core and Visual Studio. For information about the tutorial series, see [the first tutorial](#).

In this tutorial, the scaffolded CRUD (create, read, update, delete) code is reviewed and customized.

To minimize complexity and keep these tutorials focused on EF Core, EF Core code is used in the page models. Some developers use a service layer or repository pattern in to create an abstraction layer between the UI (Razor Pages) and the data access layer.

In this tutorial, the Create, Edit, Delete, and Details Razor Pages in the *Student* folder are examined.

The scaffolded code uses the following pattern for Create, Edit, and Delete pages:

- Get and display the requested data with the HTTP GET method `OnGetAsync`.
- Save changes to the data with the HTTP POST method `OnPostAsync`.

The Index and Details pages get and display the requested data with the HTTP GET method `OnGetAsync`

## SingleOrDefaultAsync vs FirstOrDefaultAsync

The generated code uses `FirstOrDefaultAsync`, which is generally preferred over `SingleOrDefaultAsync`.

`FirstOrDefaultAsync` is more efficient than `SingleOrDefaultAsync` at fetching one entity:

- Unless the code needs to verify that there's not more than one entity returned from the query.
- `SingleOrDefaultAsync` fetches more data and does unnecessary work.
- `SingleOrDefaultAsync` throws an exception if there's more than one entity that fits the filter part.
- `FirstOrDefaultAsync` doesn't throw if there's more than one entity that fits the filter part.

### FindAsync

In much of the scaffolded code, `FindAsync` can be used in place of `FirstOrDefaultAsync`.

`FindAsync`:

- Finds an entity with the primary key (PK). If an entity with the PK is being tracked by the context, it's returned without a request to the DB.
- Is simple and concise.
- Is optimized to look up a single entity.
- Can have perf benefits in some situations, but they rarely happens for typical web apps.
- Implicitly uses `FirstAsync` instead of `SingleAsync`.

But if you want to `Include` other entities, then `FindAsync` is no longer appropriate. This means that you may need to abandon `FindAsync` and move to a query as your app progresses.

## Customize the Details page

Browse to `Pages/Students` page. The **Edit**, **Details**, and **Delete** links are generated by the [Anchor Tag Helper](#) in the `Pages/Students/Index.cshtml` file.

```
<td>
    <a asp-page=".Edit" asp-route-id="@item.ID">Edit</a> |
    <a asp-page=".Details" asp-route-id="@item.ID">Details</a> |
    <a asp-page=".Delete" asp-route-id="@item.ID">Delete</a>
</td>
```

Run the app and select a **Details** link. The URL is of the form `http://localhost:5000/Students/Details?id=2`. The Student ID is passed using a query string (`?id=2`).

Update the Edit, Details, and Delete Razor Pages to use the `"{id:int}"` route template. Change the page directive for each of these pages from `@page` to `@page "{id:int}"`.

A request to the page with the `"{id:int}"` route template that does **not** include a integer route value returns an HTTP 404 (not found) error. For example, `http://localhost:5000/Students/Details` returns a 404 error. To make the ID optional, append `?` to the route constraint:

```
@page "{id:int?}"
```

Run the app, click on a Details link, and verify the URL is passing the ID as route data (`http://localhost:5000/Students/Details/2`).

Don't globally change `@page` to `@page "{id:int}"`, doing so breaks the links to the Home and Create pages.

### Add related data

The scaffolded code for the Students Index page doesn't include the `Enrollments` property. In this section, the contents of the `Enrollments` collection is displayed in the Details page.

The `OnGetAsync` method of `Pages/Students/Details.cshtml.cs` uses the `FirstOrDefaultAsync` method to retrieve a single `Student` entity. Add the following highlighted code:

```
public async Task<IActionResult> OnGetAsync(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    Student = await _context.Student
        .Include(s => s.Enrollments)
        .ThenInclude(e => e.Course)
        .AsNoTracking()
        .FirstOrDefaultAsync(m => m.ID == id);

    if (Student == null)
    {
        return NotFound();
    }
    return Page();
}
```

The `Include` and `ThenInclude` methods cause the context to load the `Student.Enrollments` navigation property, and within each enrollment the `Enrollment.Course` navigation property. These methods are examined in detail in the reading-related data tutorial.

The [AsNoTracking](#) method improves performance in scenarios when the entities returned are not updated in the current context. `AsNoTracking` is discussed later in this tutorial.

### Display related enrollments on the Details page

Open `Pages/Students/Details.cshtml`. Add the following highlighted code to display a list of enrollments:

```

@page "{id:int}"
@model ContosoUniversity.Pages.Students.DetailsModel

@{
    ViewData["Title"] = "Details";
}



## Details



#### Student



---


    <dl class="dl-horizontal">
        <dt>
            @Html.DisplayNameFor(model => model.Student.LastName)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Student.LastName)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Student.FirstMidName)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Student.FirstMidName)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Student.EnrollmentDate)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Student.EnrollmentDate)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Student.Enrollments)
        </dt>
        <dd>
            <table class="table">
                <tr>
                    <th>Course Title</th>
                    <th>Grade</th>
                </tr>
                @foreach (var item in Model.Student.Enrollments)
                {
                    <tr>
                        <td>
                            @Html.DisplayFor(modelItem => item.Course.Title)
                        </td>
                        <td>
                            @Html.DisplayFor(modelItem => item.Grade)
                        </td>
                    </tr>
                }
            </table>
        </dd>
    </dl>


<div>
    <a asp-page=".Edit" asp-route-id="@Model.Student.ID">Edit</a> |
    <a asp-page=".Index">Back to List</a>
</div>

```

If code indentation is wrong after the code is pasted, press CTRL-K-D to correct it.

The preceding code loops through the entities in the `Enrollments` navigation property. For each enrollment, it displays the course title and the grade. The course title is retrieved from the Course entity that's stored in the `Course` navigation property of the Enrollments entity.

Run the app, select the **Students** tab, and click the **Details** link for a student. The list of courses and grades for the selected student is displayed.

## Update the Create page

Update the `OnPostAsync` method in *Pages/Students/Create.cshtml.cs* with the following code:

```
public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    var emptyStudent = new Student();

    if (await TryUpdateModelAsync<Student>(
        emptyStudent,
        "student", // Prefix for form value.
        s => s.FirstMidName, s => s.LastName, s => s.EnrollmentDate))
    {
        _context.Student.Add(emptyStudent);
        await _context.SaveChangesAsync();
        return RedirectToPage("./Index");
    }

    return null;
}
```

### TryUpdateModelAsync

Examine the `TryUpdateModelAsync` code:

```
var emptyStudent = new Student();

if (await TryUpdateModelAsync<Student>(
    emptyStudent,
    "student", // Prefix for form value.
    s => s.FirstMidName, s => s.LastName, s => s.EnrollmentDate))
{
```

In the preceding code, `TryUpdateModelAsync<Student>` tries to update the `emptyStudent` object using the posted form values from the `PageContext` property in the `PageModel`. `TryUpdateModelAsync` only updates the properties listed (`s => s.FirstMidName, s => s.LastName, s => s.EnrollmentDate`).

In the preceding sample:

- The second argument (`"student", // Prefix`) is the prefix used to look up values. It's not case sensitive.
- The posted form values are converted to the types in the `Student` model using [model binding](#).

### Overposting

Using `TryUpdateModel` to update fields with posted values is a security best practice because it prevents overposting. For example, suppose the `Student` entity includes a `Secret` property that this web page shouldn't update or add:

```

public class Student
{
    public int ID { get; set; }
    public string LastName { get; set; }
    public string FirstMidName { get; set; }
    public DateTime EnrollmentDate { get; set; }
    public string Secret { get; set; }
}

```

Even if the app doesn't have a `Secret` field on the create/update Razor Page, a hacker could set the `Secret` value by overposting. A hacker could use a tool such as Fiddler, or write some JavaScript, to post a `Secret` form value. The original code doesn't limit the fields that the model binder uses when it creates a `Student` instance.

Whatever value the hacker specified for the `Secret` form field is updated in the DB. The following image shows the Fiddler tool adding the `Secret` field (with the value "OverPost") to the posted form values.

The screenshot shows the Fiddler interface with a red box highlighting the 'Execute' button. The 'Request Headers' section contains standard browser headers. The 'Request Body' section shows a URL-encoded form with the 'Secret' field explicitly added by the hacker.

The value "OverPost" is successfully added to the `Secret` property of the inserted row. The app designer never intended the `Secret` property to be set with the Create page.

### **View model**

A view model typically contains a subset of the properties included in the model used by the application. The application model is often called the domain model. The domain model typically contains all the properties required by the corresponding entity in the DB. The view model contains only the properties needed for the UI layer (for example, the Create page). In addition to the view model, some apps use a binding model or input model to pass data between the Razor Pages page model class and the browser. Consider the following `Student` view model:

```

using System;

namespace ContosoUniversity.Models
{
    public class StudentVM
    {
        public int ID { get; set; }
        public string LastName { get; set; }
        public string FirstMidName { get; set; }
        public DateTime EnrollmentDate { get; set; }
    }
}

```

View models provide an alternative way to prevent overposting. The view model contains only the properties to view (display) or update.

The following code uses the `StudentVM` view model to create a new student:

```

[BindProperty]
public StudentVM StudentVM { get; set; }

public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    var entry = _context.Add(new Student());
    entry.CurrentValues.SetValues(StudentVM);
    await _context.SaveChangesAsync();
    return RedirectToPage("./Index");
}

```

The `SetValues` method sets the values of this object by reading values from another `PropertyValues` object.

`SetValues` uses property name matching. The view model type doesn't need to be related to the model type, it just needs to have properties that match.

Using `StudentVM` requires `CreateVM.cshtml` be updated to use `StudentVM` rather than `Student`.

In Razor Pages, the `PageModel` derived class is the view model.

## Update the Edit page

Update the page model for the Edit page. The major changes are highlighted:

```

public class EditModel : PageModel
{
    private readonly SchoolContext _context;

    public EditModel(SchoolContext context)
    {
        _context = context;
    }

    [BindProperty]
    public Student Student { get; set; }

    public async Task<IActionResult> OnGetAsync(int? id)
    {
        if (id == null)
        {
            return NotFound();
        }

        Student = await _context.Student.FindAsync(id);

        if (Student == null)
        {
            return NotFound();
        }
        return Page();
    }

    public async Task<IActionResult> OnPostAsync(int? id)
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        var studentToUpdate = await _context.Student.FindAsync(id);

        if (await TryUpdateModelAsync<Student>(
            studentToUpdate,
            "student",
            s => s.FirstMidName, s => s.LastName, s => s.EnrollmentDate))
        {
            await _context.SaveChangesAsync();
            return RedirectToPage("./Index");
        }

        return Page();
    }
}

```

The code changes are similar to the Create page with a few exceptions:

- `OnPostAsync` has an optional `id` parameter.
- The current student is fetched from the DB, rather than creating an empty student.
- `FirstOrDefaultAsync` has been replaced with `FindAsync`. `FindAsync` is a good choice when selecting an entity from the primary key. See [FindAsync](#) for more information.

## Test the Edit and Create pages

Create and edit a few student entities.

## Entity States

The DB context keeps track of whether entities in memory are in sync with their corresponding rows in the DB.

The DB context sync information determines what happens when `SaveChangesAsync` is called. For example, when a new entity is passed to the `AddAsync` method, that entity's state is set to `Added`. When `SaveChangesAsync` is called, the DB context issues a SQL INSERT command.

An entity may be in one of the [following states](#):

- `Added`: The entity doesn't yet exist in the DB. The `SaveChanges` method issues an INSERT statement.
- `Unchanged`: No changes need to be saved with this entity. An entity has this status when it's read from the DB.
- `Modified`: Some or all of the entity's property values have been modified. The `SaveChanges` method issues an UPDATE statement.
- `Deleted`: The entity has been marked for deletion. The `SaveChanges` method issues a DELETE statement.
- `Detached`: The entity isn't being tracked by the DB context.

In a desktop app, state changes are typically set automatically. An entity is read, changes are made, and the entity state is automatically be changed to `Modified`. Calling `SaveChanges` generates a SQL UPDATE statement that updates only the changed properties.

In a web app, the `DbContext` that reads an entity and displays the data is disposed after a page is rendered. When a page's `OnPostAsync` method is called, a new web request is made and with a new instance of the `DbContext`. Re-reading the entity in that new context simulates desktop processing.

## Update the Delete page

In this section, code is added to implement a custom error message when the call to `SaveChanges` fails. Add a string to contain possible error messages:

```
public class DeleteModel : PageModel
{
    private readonly SchoolContext _context;

    public DeleteModel(SchoolContext context)
    {
        _context = context;
    }

    [BindProperty]
    public Student Student { get; set; }
    public string ErrorMessage { get; set; }
```

Replace the `OnGetAsync` method with the following code:

```

public async Task<IActionResult> OnGetAsync(int? id, bool? saveChangesError = false)
{
    if (id == null)
    {
        return NotFound();
    }

    Student = await _context.Student
        .AsNoTracking()
        .FirstOrDefaultAsync(m => m.ID == id);

    if (Student == null)
    {
        return NotFound();
    }

    if (saveChangesError.GetValueOrDefault())
    {
        ErrorMessage = "Delete failed. Try again";
    }

    return Page();
}

```

The preceding code contains the optional parameter `saveChangesError`. `saveChangesError` indicates whether the method was called after a failure to delete the student object. The delete operation might fail because of transient network problems. Transient network errors are more likely in the cloud. `saveChangesError` is false when the Delete page `OnGetAsync` is called from the UI. When `OnGetAsync` is called by `OnPostAsync` (because the delete operation failed), the `saveChangesError` parameter is true.

## The Delete pages `OnPostAsync` method

Replace the `OnPostAsync` with the following code:

```

public async Task<IActionResult> OnPostAsync(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var student = await _context.Student
        .AsNoTracking()
        .FirstOrDefaultAsync(m => m.ID == id);

    if (student == null)
    {
        return NotFound();
    }

    try
    {
        _context.Student.Remove(student);
        await _context.SaveChangesAsync();
        return RedirectToPage("./Index");
    }
    catch (DbUpdateException /* ex */)
    {
        //Log the error (uncomment ex variable name and write a log.)
        return RedirectToAction("./Delete",
            new { id, saveChangesError = true });
    }
}

```

The preceding code retrieves the selected entity, then calls the `Remove` method to set the entity's status to `Deleted`. When `SaveChanges` is called, a SQL DELETE command is generated. If `Remove` fails:

- The DB exception is caught.
- The Delete pages `OnGetAsync` method is called with `saveChangesError=true`.

## Update the Delete Razor Page

Add the following highlighted error message to the Delete Razor Page.

```
@page "{id:int}"
@model ContosoUniversity.Pages.Students.DeleteModel

@{
    ViewData["Title"] = "Delete";
}

<h2>Delete</h2>

<p class="text-danger">@Model.ErrorMessage</p>

<h3>Are you sure you want to delete this?</h3>
<div>
```

Test Delete.

## Common errors

Student/Index or other links don't work:

Verify the Razor Page contains the correct `@page` directive. For example, The Student/Index Razor Page should **not** contain a route template:

```
@page "{id:int}"
```

Each Razor Page must include the `@page` directive.

[PREVIOUS](#) [NEXT](#)

# Razor Pages with EF Core in ASP.NET Core - Sort, Filter, Paging - 3 of 8

6/28/2018 • 15 minutes to read • [Edit Online](#)

The ASP.NET Core 2.0 version of this tutorial can be found in [this PDF file](#).

The ASP.NET Core 2.1 version of this tutorial has many improvements over the 2.0 version.

By [Tom Dykstra](#), [Rick Anderson](#), and [Jon P Smith](#)

The Contoso University web app demonstrates how to create Razor Pages web apps using EF Core and Visual Studio. For information about the tutorial series, see [the first tutorial](#).

In this tutorial, sorting, filtering, grouping, and paging, functionality is added.

The following illustration shows a completed page. The column headings are clickable links to sort the column. Clicking a column heading repeatedly switches between ascending and descending sort order.

The screenshot shows a browser window for the 'Index - Contoso University' page. The URL is 'localhost:5813/Student'. The page title is 'Contoso University'. The main content area is titled 'Index' and contains a table of student data. At the top of the table, there are three column headers: 'Last Name', 'First Name', and 'Enrollment Date'. Below the table, there are two buttons: 'Previous' and 'Next'. The table data is as follows:

Last Name	First Name	Enrollment Date	Action
Alexander	Carson	9/1/2005 12:00:00 AM	Edit   Details   Delete
Alonso	Meredith	9/1/2002 12:00:00 AM	Edit   Details   Delete
Anand	Arturo	9/1/2003 12:00:00 AM	Edit   Details   Delete

If you run into problems you can't solve, download the [completed app](#).

## Add sorting to the Index page

Add strings to the `Students/Index.cshtml.cs` `PageModel` to contain the sorting parameters:

```

public class IndexModel : PageModel
{
    private readonly SchoolContext _context;

    public IndexModel(SchoolContext context)
    {
        _context = context;
    }

    public string NameSort { get; set; }
    public string DateSort { get; set; }
    public string CurrentFilter { get; set; }
    public string CurrentSort { get; set; }

```

Update the *Students/Index.cshtml.cs* `OnGetAsync` with the following code:

```

public async Task OnGetAsync(string sortOrder)
{
    NameSort = String.IsNullOrEmpty(sortOrder) ? "name_desc" : "";
    DateSort = sortOrder == "Date" ? "date_desc" : "Date";

    IQueryable<Student> studentIQ = from s in _context.Student
                                      select s;

    switch (sortOrder)
    {
        case "name_desc":
            studentIQ = studentIQ.OrderByDescending(s => s.LastName);
            break;
        case "Date":
            studentIQ = studentIQ.OrderBy(s => s.EnrollmentDate);
            break;
        case "date_desc":
            studentIQ = studentIQ.OrderByDescending(s => s.EnrollmentDate);
            break;
        default:
            studentIQ = studentIQ.OrderBy(s => s.LastName);
            break;
    }

    Student = await studentIQ.AsNoTracking().ToListAsync();
}

```

The preceding code receives a `sortOrder` parameter from the query string in the URL. The URL (including the query string) is generated by the [Anchor Tag Helper](#)

The `sortOrder` parameter is either "Name" or "Date." The `sortOrder` parameter is optionally followed by "\_desc" to specify descending order. The default sort order is ascending.

When the Index page is requested from the **Students** link, there's no query string. The students are displayed in ascending order by last name. Ascending order by last name is the default (fall-through case) in the `switch` statement. When the user clicks a column heading link, the appropriate `sortOrder` value is provided in the query string value.

`NameSort` and `DateSort` are used by the Razor Page to configure the column heading hyperlinks with the appropriate query string values:

```

public async Task OnGetAsync(string sortOrder)
{
    NameSort = String.IsNullOrEmpty(sortOrder) ? "name_desc" : "";
    DateSort = sortOrder == "Date" ? "date_desc" : "Date";

    IQueryable<Student> studentIQ = from s in _context.Student
                                      select s;

    switch (sortOrder)
    {
        case "name_desc":
            studentIQ = studentIQ.OrderByDescending(s => s.LastName);
            break;
        case "Date":
            studentIQ = studentIQ.OrderBy(s => s.EnrollmentDate);
            break;
        case "date_desc":
            studentIQ = studentIQ.OrderByDescending(s => s.EnrollmentDate);
            break;
        default:
            studentIQ = studentIQ.OrderBy(s => s.LastName);
            break;
    }

    Student = await studentIQ.AsNoTracking().ToListAsync();
}

```

The following code contains the C# conditional `?:` operator:

```

NameSort = String.IsNullOrEmpty(sortOrder) ? "name_desc" : "";
DateSort = sortOrder == "Date" ? "date_desc" : "Date";

```

The first line specifies that when `sortOrder` is null or empty, `NameSort` is set to "name\_desc." If `sortOrder` is **not** null or empty, `NameSort` is set to an empty string.

The `?:` operator is also known as the ternary operator.

These two statements enable the page to set the column heading hyperlinks as follows:

CURRENT SORT ORDER	LAST NAME HYPERLINK	DATE HYPERLINK
Last Name ascending	descending	ascending
Last Name descending	ascending	ascending
Date ascending	ascending	descending
Date descending	ascending	ascending

The method uses LINQ to Entities to specify the column to sort by. The code initializes an `IQueryable<Student>` before the switch statement, and modifies it in the switch statement:

```

public async Task OnGetAsync(string sortOrder)
{
    NameSort = String.IsNullOrEmpty(sortOrder) ? "name_desc" : "";
    DateSort = sortOrder == "Date" ? "date_desc" : "Date";

    IQueryable<Student> studentIQ = from s in _context.Student
                                      select s;

    switch (sortOrder)
    {
        case "name_desc":
            studentIQ = studentIQ.OrderByDescending(s => s.LastName);
            break;
        case "Date":
            studentIQ = studentIQ.OrderBy(s => s.EnrollmentDate);
            break;
        case "date_desc":
            studentIQ = studentIQ.OrderByDescending(s => s.EnrollmentDate);
            break;
        default:
            studentIQ = studentIQ.OrderBy(s => s.LastName);
            break;
    }

    Student = await studentIQ.AsNoTracking().ToListAsync();
}

```

When an `IQueryable` is created or modified, no query is sent to the database. The query isn't executed until the `IQueryable` object is converted into a collection. `IQueryable` are converted to a collection by calling a method such as `ToListAsync`. Therefore, the `IQueryable` code results in a single query that's not executed until the following statement:

```
Student = await studentIQ.AsNoTracking().ToListAsync();
```

`OnGetAsync` could get verbose with a large number of sortable columns.

### Add column heading hyperlinks to the Student Index page

Replace the code in `Students/Index.cshtml`, with the following highlighted code:

```

@page
@model ContosoUniversity.Pages.Students.IndexModel

 @{
     ViewData["Title"] = "Index";
 }

<h2>Index</h2>
<p>
    <a asp-page="Create">Create New</a>
</p>

<table class="table">
    <thead>
        <tr>
            <th>
                <a asp-page="./Index" asp-route-sortOrder="@Model.NameSort">
                    @Html.DisplayNameFor(model => model.Student[0].LastName)
                </a>
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Student[0].FirstMidName)
            </th>
            <th>
                <a asp-page="./Index" asp-route-sortOrder="@Model.DateSort">
                    @Html.DisplayNameFor(model => model.Student[0].EnrollmentDate)
                </a>
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model.Student)
        {
            <tr>
                <td>
                    @Html.DisplayFor(modelItem => item.LastName)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.FirstMidName)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.EnrollmentDate)
                </td>
                <td>
                    <a asp-page="./Edit" asp-route-id="@item.ID">Edit</a> |
                    <a asp-page="./Details" asp-route-id="@item.ID">Details</a> |
                    <a asp-page=".Delete" asp-route-id="@item.ID">Delete</a>
                </td>
            </tr>
        }
    </tbody>
</table>

```

The preceding code:

- Adds hyperlinks to the `LastName` and `EnrollmentDate` column headings.
- Uses the information in `NameSort` and `DateSort` to set up hyperlinks with the current sort order values.

To verify that sorting works:

- Run the app and select the **Students** tab.
- Click **Last Name**.
- Click **Enrollment Date**.

To get a better understanding of the code:

- In *Student/Index.cshtml.cs*, set a breakpoint on `switch (sortOrder)`.
- Add a watch for `NameSort` and `DateSort`.
- In *Student/Index.cshtml*, set a breakpoint on `@Html.DisplayNameFor(model => model.Student[0].LastName)`.

Step through the debugger.

## Add a Search Box to the Students Index page

To add filtering to the Students Index page:

- A text box and a submit button is added to the Razor Page. The text box supplies a search string on the first or last name.
- The page model is updated to use the text box value.

### Add filtering functionality to the Index method

Update the *Students/Index.cshtml.cs* `OnGetAsync` with the following code:

```
public async Task OnGetAsync(string sortOrder, string searchString)
{
    NameSort = String.IsNullOrEmpty(sortOrder) ? "name_desc" : "";
    DateSort = sortOrder == "Date" ? "date_desc" : "Date";
    CurrentFilter = searchString;

    IQueryable<Student> studentIQ = from s in _context.Student
                                         select s;
    if (!String.IsNullOrEmpty(searchString))
    {
        studentIQ = studentIQ.Where(s => s.LastName.Contains(searchString)
                               || s.FirstMidName.Contains(searchString));
    }

    switch (sortOrder)
    {
        case "name_desc":
            studentIQ = studentIQ.OrderByDescending(s => s.LastName);
            break;
        case "Date":
            studentIQ = studentIQ.OrderBy(s => s.EnrollmentDate);
            break;
        case "date_desc":
            studentIQ = studentIQ.OrderByDescending(s => s.EnrollmentDate);
            break;
        default:
            studentIQ = studentIQ.OrderBy(s => s.LastName);
            break;
    }

    Student = await studentIQ.AsNoTracking().ToListAsync();
}
```

The preceding code:

- Adds the `searchString` parameter to the `OnGetAsync` method. The search string value is received from a text box that's added in the next section.
- Added to the LINQ statement a `Where` clause. The `Where` clause selects only students whose first name or last name contains the search string. The LINQ statement is executed only if there's a value to search for.

Note: The preceding code calls the `Where` method on an `IQueryable` object, and the filter is processed on the server. In some scenarios, the app might be calling the `Where` method as an extension method on an in-memory

collection. For example, suppose `_context.Students` changes from EF Core `dbSet` to a repository method that returns an `IEnumerable` collection. The result would normally be the same but in some cases may be different.

For example, the .NET Framework implementation of `Contains` performs a case-sensitive comparison by default. In SQL Server, `Contains` case-sensitivity is determined by the collation setting of the SQL Server instance. SQL Server defaults to case-insensitive. `ToUpper` could be called to make the test explicitly case-insensitive:

```
Where(s => s.LastName.ToUpper().Contains(searchString.ToUpper()))
```

The preceding code would ensure that results are case-insensitive if the code changes to use `IEnumerable`. When `Contains` is called on an `IEnumerable` collection, the .NET Core implementation is used. When `contains` is called on an `IQueryable` object, the database implementation is used. Returning an `IEnumerable` from a repository can have a significant performance penalty:

1. All the rows are returned from the DB server.
2. The filter is applied to all the returned rows in the application.

There's a performance penalty for calling `ToUpper`. The `ToUpper` code adds a function in the WHERE clause of the TSQL SELECT statement. The added function prevents the optimizer from using an index. Given that SQL is installed as case-insensitive, it's best to avoid the `ToUpper` call when it's not needed.

## Add a Search Box to the Student Index page

In `Pages/Students/Index.cshtml`, add the following highlighted code to create a **Search** button and assorted chrome.

```
@page
@model ContosoUniversity.Pages.Students.IndexModel

 @{
    ViewData["Title"] = "Index";
}

<h2>Index</h2>

<p>
    <a asp-page="Create">Create New</a>
</p>

<form asp-page=".Index" method="get">
    <div class="form-actions no-color">
        <p>
            Find by name:
            <input type="text" name="SearchString" value="@Model.CurrentFilter" />
            <input type="submit" value="Search" class="btn btn-default" /> |
            <a asp-page=".Index">Back to full List</a>
        </p>
    </div>
</form>

<table class="table">
```

The preceding code uses the `<form>` tag helper to add the search text box and button. By default, the `<form>` tag helper submits form data with a POST. With POST, the parameters are passed in the HTTP message body and not in the URL. When HTTP GET is used, the form data is passed in the URL as query strings. Passing the data with query strings enables users to bookmark the URL. The [W3C guidelines](#) recommend that GET should be used when the action doesn't result in an update.

Test the app:

- Select the **Students** tab and enter a search string.

- Select **Search**.

Notice that the URL contains the search string.

```
http://localhost:5000/Students?SearchString=an
```

If the page is bookmarked, the bookmark contains the URL to the page and the `SearchString` query string. The `method="get"` in the `form` tag is what caused the query string to be generated.

Currently, when a column heading sort link is selected, the filter value from the **Search** box is lost. The lost filter value is fixed in the next section.

## Add paging functionality to the Students Index page

In this section, a `PaginatedList` class is created to support paging. The `PaginatedList` class uses `Skip` and `Take` statements to filter data on the server instead of retrieving all rows of the table. The following illustration shows the paging buttons.

The screenshot shows a web browser window titled "Index - Contoso University". The address bar displays "localhost:5813/Student". The main content area is titled "Index" and contains a table of student data. At the top of the table, there are three columns: "Last Name", "First Name", and "Enrollment Date". Below the table, there are three student records:

Last Name	First Name	Enrollment Date	Action
Alexander	Carson	9/1/2005 12:00:00 AM	Edit   Details   Delete
Alonso	Meredith	9/1/2002 12:00:00 AM	Edit   Details   Delete
Anand	Arturo	9/1/2003 12:00:00 AM	Edit   Details   Delete

At the bottom of the table, there are two buttons: "Previous" and "Next".

In the project folder, create `PaginatedList.cs` with the following code:

```

using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.EntityFrameworkCore;

namespace ContosoUniversity
{
    public class PaginatedList<T> : List<T>
    {
        public int PageIndex { get; private set; }
        public int TotalPages { get; private set; }

        public PaginatedList(List<T> items, int count, int pageIndex, int pageSize)
        {
            PageIndex = pageIndex;
            TotalPages = (int)Math.Ceiling(count / (double)pageSize);

            this.AddRange(items);
        }

        public bool HasPreviousPage
        {
            get
            {
                return (PageIndex > 1);
            }
        }

        public bool HasNextPage
        {
            get
            {
                return (PageIndex < TotalPages);
            }
        }

        public static async Task<PaginatedList<T>> CreateAsync(
            IQueryable<T> source, int pageIndex, int pageSize)
        {
            var count = await source.CountAsync();
            var items = await source.Skip(
                (pageIndex - 1) * pageSize)
                .Take(pageSize).ToListAsync();
            return new PaginatedList<T>(items, count, pageIndex, pageSize);
        }
    }
}

```

The `CreateAsync` method in the preceding code takes page size and page number and applies the appropriate `Skip` and `Take` statements to the `IQueryable`. When `ToListAsync` is called on the `IQueryable`, it returns a List containing only the requested page. The properties `HasPreviousPage` and `HasNextPage` are used to enable or disable **Previous** and **Next** paging buttons.

The `CreateAsync` method is used to create the `PaginatedList<T>`. A constructor can't create the `PaginatedList<T>` object, constructors can't run asynchronous code.

## Add paging functionality to the Index method

In `Students/Index.cshtml.cs`, update the type of `Student` from `IList<Student>` to `PaginatedList<Student>`:

```
public PaginatedList<Student> Student { get; set; }
```

Update the `Students/Index.cshtml.cs` `OnGetAsync` with the following code:

```
public async Task OnGetAsync(string sortOrder,
    string currentFilter, string searchString, int? pageIndex)
{
    CurrentSort = sortOrder;
    NameSort = String.IsNullOrEmpty(sortOrder) ? "name_desc" : "";
    DateSort = sortOrder == "Date" ? "date_desc" : "Date";
    if (searchString != null)
    {
        pageIndex = 1;
    }
    else
    {
        searchString = currentFilter;
    }

    CurrentFilter = searchString;

    IQueryable<Student> studentIQ = from s in _context.Student
                                         select s;
    if (!String.IsNullOrEmpty(searchString))
    {
        studentIQ = studentIQ.Where(s => s.LastName.Contains(searchString)
                               || s.FirstMidName.Contains(searchString));
    }
    switch (sortOrder)
    {
        case "name_desc":
            studentIQ = studentIQ.OrderByDescending(s => s.LastName);
            break;
        case "Date":
            studentIQ = studentIQ.OrderBy(s => s.EnrollmentDate);
            break;
        case "date_desc":
            studentIQ = studentIQ.OrderByDescending(s => s.EnrollmentDate);
            break;
        default:
            studentIQ = studentIQ.OrderBy(s => s.LastName);
            break;
    }

    int pageSize = 3;
    Student = await PaginatedList<Student>.CreateAsync(
        studentIQ.AsNoTracking(), pageIndex ?? 1, pageSize);
}
```

The preceding code adds the page index, the current `sortOrder`, and the `currentFilter` to the method signature.

```
public async Task OnGetAsync(string sortOrder,
    string currentFilter, string searchString, int? pageIndex)
```

All the parameters are null when:

- The page is called from the **Students** link.
- The user hasn't clicked a paging or sorting link.

When a paging link is clicked, the page index variable contains the page number to display.

`CurrentSort` provides the Razor Page with the current sort order. The current sort order must be included in the paging links to keep the sort order while paging.

`CurrentFilter` provides the Razor Page with the current filter string. The `CurrentFilter` value:

- Must be included in the paging links in order to maintain the filter settings during paging.
- Must be restored to the text box when the page is redisplayed.

If the search string is changed while paging, the page is reset to 1. The page has to be reset to 1 because the new filter can result in different data to display. When a search value is entered and **Submit** is selected:

- The search string is changed.
- The `searchString` parameter isn't null.

```
if (searchString != null)
{
    pageIndex = 1;
}
else
{
    searchString = currentFilter;
}
```

The `PaginatedList.CreateAsync` method converts the student query to a single page of students in a collection type that supports paging. That single page of students is passed to the Razor Page.

```
Student = await PaginatedList<Student>.CreateAsync(
    studentIQ.AsNoTracking(), pageIndex ?? 1, pageSize);
```

The two question marks in `PaginatedList.CreateAsync` represent the [null-coalescing operator] (<https://docs.microsoft.com/dotnet/csharp/language-reference/operators/null-conditional-operator>). The null-coalescing operator defines a default value for a nullable type. The expression `(pageIndex ?? 1)` means return the value of `pageIndex` if it has a value. If `pageIndex` doesn't have a value, return 1.

## Add paging links to the student Razor Page

Update the markup in `Students/Index.cshtml`. The changes are highlighted:

```
@page
@model ContosoUniversity.Pages.Students.IndexModel

 @{
     ViewData["Title"] = "Index";
 }

<h2>Index</h2>

<p>
    <a asp-page="Create">Create New</a>
</p>

<form asp-page=".Index" method="get">
    <div class="form-actions no-color">
        <p>
            Find by name: <input type="text" name="SearchString" value="@Model.CurrentFilter" />
            <input type="submit" value="Search" class="btn btn-default" /> |
            <a asp-page=".Index">Back to full List</a>
        </p>
    </div>
</form>

<table class="table">
    <thead>
        <tr>
            <th>
```

```

        <a asp-page=".Index" asp-route-sortOrder="@Model.NameSort"
           asp-route-currentFilter="@Model.CurrentFilter">
            @Html.DisplayNameFor(model => model.Student[0].LastName)
        </a>
    </th>
    <th>
        @Html.DisplayNameFor(model => model.Student[0].FirstMidName)
    </th>
    <th>
        <a asp-page=".Index" asp-route-sortOrder="@Model.DateSort"
           asp-route-currentFilter="@Model.CurrentFilter">
            @Html.DisplayNameFor(model => model.Student[0].EnrollmentDate)
        </a>
    </th>
    <th></th>
</tr>
</thead>
<tbody>
    @foreach (var item in Model.Student)
    {
        <tr>
            <td>
                @Html.DisplayFor(modelItem => item.LastName)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.FirstMidName)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.EnrollmentDate)
            </td>
            <td>
                <a asp-page=".Edit" asp-route-id="@item.ID">Edit</a> |
                <a asp-page=".Details" asp-route-id="@item.ID">Details</a> |
                <a asp-page=".Delete" asp-route-id="@item.ID">Delete</a>
            </td>
        </tr>
    }
</tbody>
</table>

@{
    var prevDisabled = !Model.Student.HasPreviousPage ? "disabled" : "";
    var nextDisabled = !Model.Student.HasNextPage ? "disabled" : "";
}

<a asp-page=".Index"
   asp-route-sortOrder="@Model.CurrentSort"
   asp-route-pageIndex="@((Model.StudentPageIndex - 1))"
   asp-route-currentFilter="@Model.CurrentFilter"
   class="btn btn-default @prevDisabled">
    Previous
</a>
<a asp-page=".Index"
   asp-route-sortOrder="@Model.CurrentSort"
   asp-route-pageIndex="@((Model.StudentPageIndex + 1))"
   asp-route-currentFilter="@Model.CurrentFilter"
   class="btn btn-default @nextDisabled">
    Next
</a>

```

The column header links use the query string to pass the current search string to the `OnGetAsync` method so that the user can sort within filter results:

```

<a asp-page=".~/Index" asp-route-sortOrder="@Model.NameSort"
    asp-route-currentFilter="@Model.CurrentFilter">
    @Html.DisplayNameFor(model => model.Student[0].LastName)
</a>

```

The paging buttons are displayed by tag helpers:

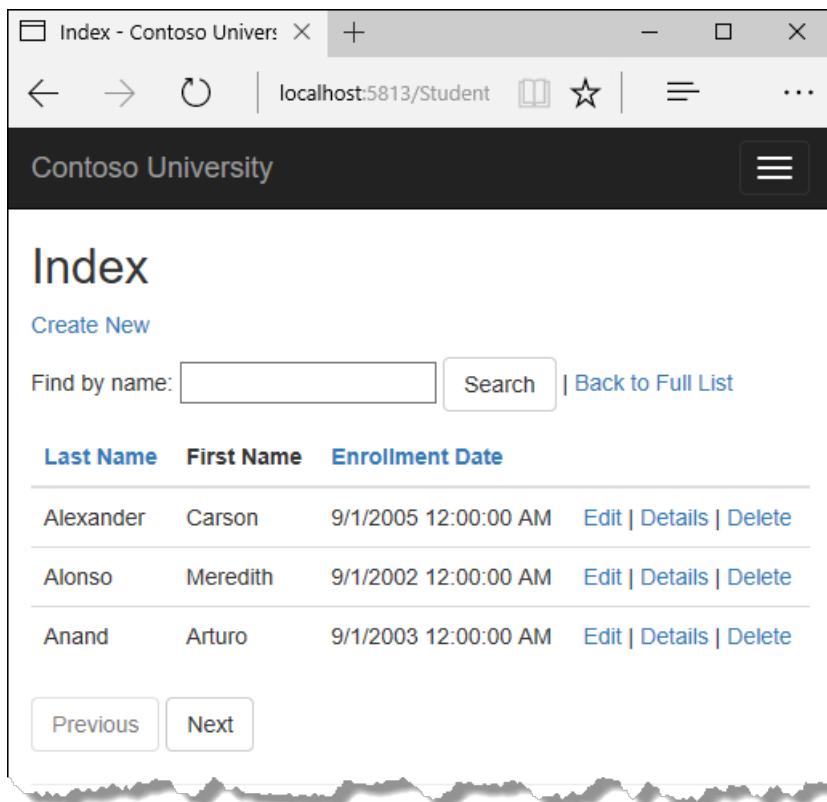
```

<a asp-page=".~/Index"
    asp-route-sortOrder="@Model.CurrentSort"
    asp-route-pageIndex="@Model.Student.PageIndex - 1"
    asp-route-currentFilter="@Model.CurrentFilter"
    class="btn btn-default @prevDisabled">
    Previous
</a>
<a asp-page=".~/Index"
    asp-route-sortOrder="@Model.CurrentSort"
    asp-route-pageIndex="@Model.Student.PageIndex + 1"
    asp-route-currentFilter="@Model.CurrentFilter"
    class="btn btn-default @nextDisabled">
    Next
</a>

```

Run the app and navigate to the students page.

- To make sure paging works, click the paging links in different sort orders.
- To verify that paging works correctly with sorting and filtering, enter a search string and try paging.



To get a better understanding of the code:

- In *Student/Index.cshtml.cs*, set a breakpoint on `switch (sortOrder)`.
- Add a watch for `NameSort`, `DateSort`, `CurrentSort`, and `Model.StudentPageIndex`.
- In *Student/Index.cshtml*, set a breakpoint on `@Html.DisplayNameFor(model => model.Student[0].LastName)`.

Step through the debugger.

## Update the About page to show student statistics

In this step, *Pages/About.cshtml* is updated to display how many students have enrolled for each enrollment date.

The update uses grouping and includes the following steps:

- Create a view model for the data used by the **About** Page.
- Update the About page to use the view model.

### Create the view model

Create a *SchoolViewModels* folder in the *Models* folder.

In the *SchoolViewModels* folder, add a *EnrollmentDateGroup.cs* with the following code:

```
using System;
using System.ComponentModel.DataAnnotations;

namespace ContosoUniversity.Models.SchoolViewModels
{
    public class EnrollmentDateGroup
    {
        [DataType(DataType.Date)]
        public DateTime? EnrollmentDate { get; set; }

        public int StudentCount { get; set; }
    }
}
```

### Update the About page model

Update the *Pages/About.cshtml.cs* file with the following code:

```

using ContosoUniversity.Models.SchoolViewModels;
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using ContosoUniversity.Models;
using ContosoUniversity.Data;

namespace ContosoUniversity.Pages
{
    public class AboutModel : PageModel
    {
        private readonly SchoolContext _context;

        public AboutModel(SchoolContext context)
        {
            _context = context;
        }

        public IList<EnrollmentDateGroup> Student { get; set; }

        public async Task OnGetAsync()
        {
            IQueryable<EnrollmentDateGroup> data =
                from student in _context.Student
                group student by student.EnrollmentDate into dateGroup
                select new EnrollmentDateGroup()
                {
                    EnrollmentDate = dateGroup.Key,
                    StudentCount = dateGroup.Count()
                };
            Student = await data.AsNoTracking().ToListAsync();
        }
    }
}

```

The LINQ statement groups the student entities by enrollment date, calculates the number of entities in each group, and stores the results in a collection of `EnrollmentDateGroup` view model objects.

Note: The LINQ `group` command isn't currently supported by EF Core. In the preceding code, all the student records are returned from SQL Server. The `group` command is applied in the Razor Pages app, not on the SQL Server. EF Core 2.1 will support this LINQ `group` operator, and the grouping occurs on the SQL Server. See [Relational: Support translating GroupBy\(\) to SQL](#). EF Core 2.1 will be released with .NET Core 2.1. For more information, see the [.NET Core Roadmap](#).

## Modify the About Razor Page

Replace the code in the `Pages/Aabout.cshtml` file with the following code:

```

@page
@model ContosoUniversity.Pages.AboutModel

 @{
     ViewData["Title"] = "Student Body Statistics";
 }

<h2>Student Body Statistics</h2>

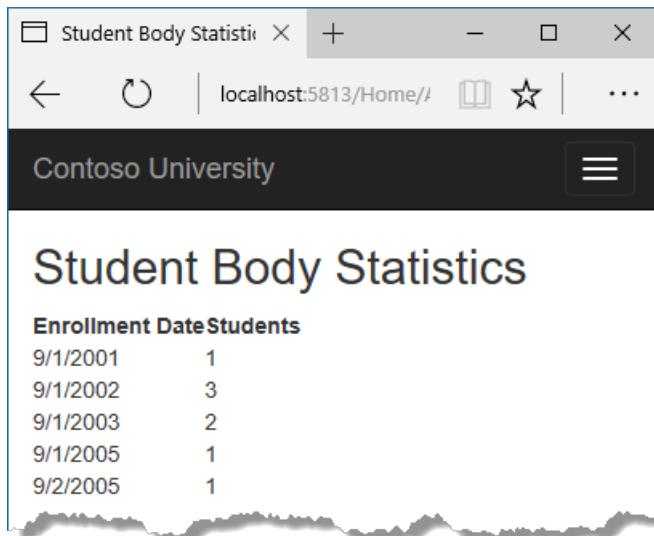





```

Run the app and navigate to the About page. The count of students for each enrollment date is displayed in a table.

If you run into problems you can't solve, download the [completed app for this stage](#).



## Additional resources

- [Debugging ASP.NET Core 2.x source](#)

In the next tutorial, the app uses migrations to update the data model.



# Razor Pages with EF Core in ASP.NET Core - Migrations - 4 of 8

7/10/2018 • 5 minutes to read • [Edit Online](#)

The ASP.NET Core 2.0 version of this tutorial can be found in [this PDF file](#).

The ASP.NET Core 2.1 version of this tutorial has many improvements over the 2.0 version.

By [Tom Dykstra](#), [Jon P Smith](#), and [Rick Anderson](#)

The Contoso University web app demonstrates how to create Razor Pages web apps using EF Core and Visual Studio. For information about the tutorial series, see [the first tutorial](#).

In this tutorial, the EF Core migrations feature for managing data model changes is used.

If you run into problems you can't solve, download the [completed app](#).

When a new app is developed, the data model changes frequently. Each time the model changes, the model gets out of sync with the database. This tutorial started by configuring the Entity Framework to create the database if it doesn't exist. Each time the data model changes:

- The DB is dropped.
- EF creates a new one that matches the model.
- The app seeds the DB with test data.

This approach to keeping the DB in sync with the data model works well until you deploy the app to production. When the app is running in production, it's usually storing data that needs to be maintained. The app can't start with a test DB each time a change is made (such as adding a new column). The EF Core Migrations feature solves this problem by enabling EF Core to update the DB schema instead of creating a new DB.

Rather than dropping and recreating the DB when the data model changes, migrations updates the schema and retains existing data.

## Drop the database

Use **SQL Server Object Explorer** (SSOX) or the `database drop` command:

- [Visual Studio](#)
- [.NET Core CLI](#)

In the **Package Manager Console** (PMC), run the following command:

```
Drop-Database
```

Run `Get-Help about_EntityFrameworkCore` from the PMC to get help information.

## Create an initial migration and update the DB

Build the project and create the first migration.

- [Visual Studio](#)
- [.NET Core CLI](#)

```
Add-Migration InitialCreate  
Update-Database
```

## Examine the Up and Down methods

The EF Core `migrations add` command generated code to create the DB. This migrations code is in the `Migrations<timestamp>_InitialCreate.cs` file. The `Up` method of the `InitialCreate` class creates the DB tables that correspond to the data model entity sets. The `Down` method deletes them, as shown in the following example:

```
public partial class InitialCreate : Migration
{
    protected override void Up(MigrationBuilder migrationBuilder)
    {
        migrationBuilder.CreateTable(
            name: "Course",
            columns: table => new
            {
                CourseID = table.Column<int>(nullable: false),
                Title = table.Column<string>(nullable: true),
                Credits = table.Column<int>(nullable: false)
            },
            constraints: table =>
            {
                table.PrimaryKey("PK_Course", x => x.CourseID);
            });
    }

    protected override void Down(MigrationBuilder migrationBuilder)
    {
        migrationBuilder.DropTable(
            name: "Enrollment");

        migrationBuilder.DropTable(
            name: "Course");

        migrationBuilder.DropTable(
            name: "Student");
    }
}
```

Migrations calls the `Up` method to implement the data model changes for a migration. When you enter a command to roll back the update, migrations calls the `Down` method.

The preceding code is for the initial migration. That code was created when the `migrations add InitialCreate` command was run. The migration name parameter ("InitialCreate" in the example) is used for the file name. The migration name can be any valid file name. It's best to choose a word or phrase that summarizes what is being done in the migration. For example, a migration that added a department table might be called "AddDepartmentTable."

If the initial migration is created and the DB exists:

- The DB creation code is generated.
- The DB creation code doesn't need to run because the DB already matches the data model. If the DB creation code is run, it doesn't make any changes because the DB already matches the data model.

When the app is deployed to a new environment, the DB creation code must be run to create the DB.

Previously the DB was dropped and doesn't exist, so migrations creates the new DB.

## The data model snapshot

Migrations create a *snapshot* of the current database schema in `Migrations/SchoolContextModelSnapshot.cs`.

When you add a migration, EF determines what changed by comparing the data model to the snapshot file.

To delete a migration, use the following command:

- [Visual Studio](#)
- [.NET Core CLI](#)

`Remove-Migration`

The remove migrations command deletes the migration and ensures the snapshot is correctly reset.

### Remove EnsureCreated and test the app

For early development, `EnsureCreated` was used. In this tutorial, migrations are used. `EnsureCreated` has the following limitations:

- Bypasses migrations and creates the DB and schema.
- Doesn't create a migrations table.
- Can *not* be used with migrations.
- Is designed for testing or rapid prototyping where the DB is dropped and re-created frequently.

Remove the following line from `DbInitializer`:

```
context.Database.EnsureCreated();
```

Run the app and verify the DB is seeded.

### Inspect the database

Use **SQL Server Object Explorer** to inspect the DB. Notice the addition of an `__EFMigrationsHistory` table. The `__EFMigrationsHistory` table keeps track of which migrations have been applied to the DB. View the data in the `__EFMigrationsHistory` table, it shows one row for the first migration. The last log in the preceding CLI output example shows the INSERT statement that creates this row.

Run the app and verify that everything works.

## Applying migrations in production

We recommend production apps should **not** call `Database.Migrate` at application startup. `Migrate` shouldn't be called from an app in server farm. For example, if the app has been cloud deployed with scale-out (multiple instances of the app are running).

Database migration should be done as part of deployment, and in a controlled way. Production database migration approaches include:

- Using migrations to create SQL scripts and using the SQL scripts in deployment.
- Running `dotnet ef database update` from a controlled environment.

EF Core uses the `__MigrationsHistory` table to see if any migrations need to run. If the DB is up-to-date, no migration is run.

## Troubleshooting

Download the [completed app](#).

The app generates the following exception:

```
SqlException: Cannot open database "ContosoUniversity" requested by the login.  
The login failed.  
Login failed for user 'user name'.
```

Solution: Run `dotnet ef database update`

## Additional resources

- [.NET Core CLI](#).
- [Package Manager Console \(Visual Studio\)](#)

[PREVIOUS](#)

[NEXT](#)

# Razor Pages with EF Core in ASP.NET Core - Data Model - 5 of 8

6/28/2018 • 28 minutes to read • [Edit Online](#)

The ASP.NET Core 2.0 version of this tutorial can be found in [this PDF file](#).

The ASP.NET Core 2.1 version of this tutorial has many improvements over the 2.0 version.

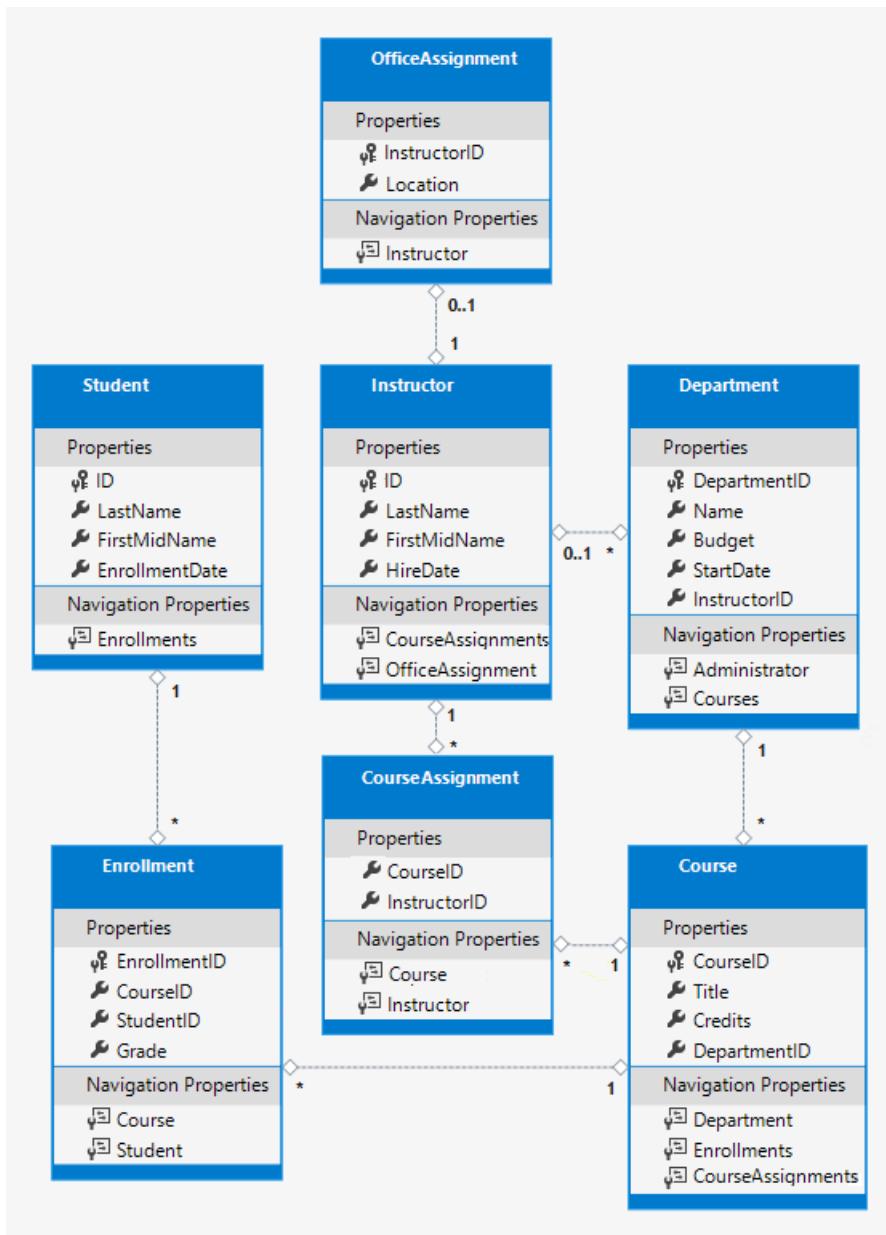
By [Tom Dykstra](#) and [Rick Anderson](#)

The Contoso University web app demonstrates how to create Razor Pages web apps using EF Core and Visual Studio. For information about the tutorial series, see [the first tutorial](#).

The previous tutorials worked with a basic data model that was composed of three entities. In this tutorial:

- More entities and relationships are added.
- The data model is customized by specifying formatting, validation, and database mapping rules.

The entity classes for the completed data model is shown in the following illustration:



If you run into problems you can't solve, download the [completed app](#).

## Customize the data model with attributes

In this section, the data model is customized using attributes.

### The `DataType` attribute

The student pages currently displays the time of the enrollment date. Typically, date fields show only the date and not the time.

Update `Models/Student.cs` with the following highlighted code:

```

using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;

namespace ContosoUniversity.Models
{
    public class Student
    {
        public int ID { get; set; }
        public string LastName { get; set; }
        public string FirstMidName { get; set; }
        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        public DateTime EnrollmentDate { get; set; }

        public ICollection<Enrollment> Enrollments { get; set; }
    }
}

```

The `DataType` attribute specifies a data type that's more specific than the database intrinsic type. In this case only the date should be displayed, not the date and time. The [DataType Enumeration](#) provides for many data types, such as Date, Time, PhoneNumber, Currency, EmailAddress, etc. The `DataType` attribute can also enable the app to automatically provide type-specific features. For example:

- The `mailto:` link is automatically created for `DataType.EmailAddress`.
- The date selector is provided for `DataType.Date` in most browsers.

The `DataType` attribute emits HTML 5 `data-` (pronounced data dash) attributes that HTML 5 browsers consume. The `DataType` attributes don't provide validation.

`DataType.Date` doesn't specify the format of the date that's displayed. By default, the date field is displayed according to the default formats based on the server's [CultureInfo](#).

The `DisplayFormat` attribute is used to explicitly specify the date format:

```
[DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
```

The `ApplyFormatInEditMode` setting specifies that the formatting should also be applied to the edit UI. Some fields shouldn't use `ApplyFormatInEditMode`. For example, the currency symbol should generally not be displayed in an edit text box.

The `DisplayFormat` attribute can be used by itself. It's generally a good idea to use the `DataType` attribute with the `DisplayFormat` attribute. The `DataType` attribute conveys the semantics of the data as opposed to how to render it on a screen. The `DataType` attribute provides the following benefits that are not available in `DisplayFormat`:

- The browser can enable HTML5 features. For example, show a calendar control, the locale-appropriate currency symbol, email links, client-side input validation, etc.
- By default, the browser renders data using the correct format based on the locale.

For more information, see the [<input> Tag Helper documentation](#).

Run the app. Navigate to the Students Index page. Times are no longer displayed. Every view that uses the `Student` model displays the date without time.

Last Name	First Name	Enrollment Date	
Alexander	Carson	2005-09-01	Edit   Details   Delete
Alonso	Meredith	2002-09-01	Edit   Details   Delete
Anand	Arturo	2003-09-01	Edit   Details   Delete

## The StringLength attribute

Data validation rules and validation error messages can be specified with attributes. The `StringLength` attribute specifies the minimum and maximum length of characters that are allowed in a data field. The `StringLength` attribute also provides client-side and server-side validation. The minimum value has no impact on the database schema.

Update the `Student` model with the following code:

```
using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;

namespace ContosoUniversity.Models
{
    public class Student
    {
        public int ID { get; set; }
        [StringLength(50)]
        public string LastName { get; set; }
        [StringLength(50, ErrorMessage = "First name cannot be longer than 50 characters.")]  
        public string FirstMidName { get; set; }
        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        public DateTime EnrollmentDate { get; set; }

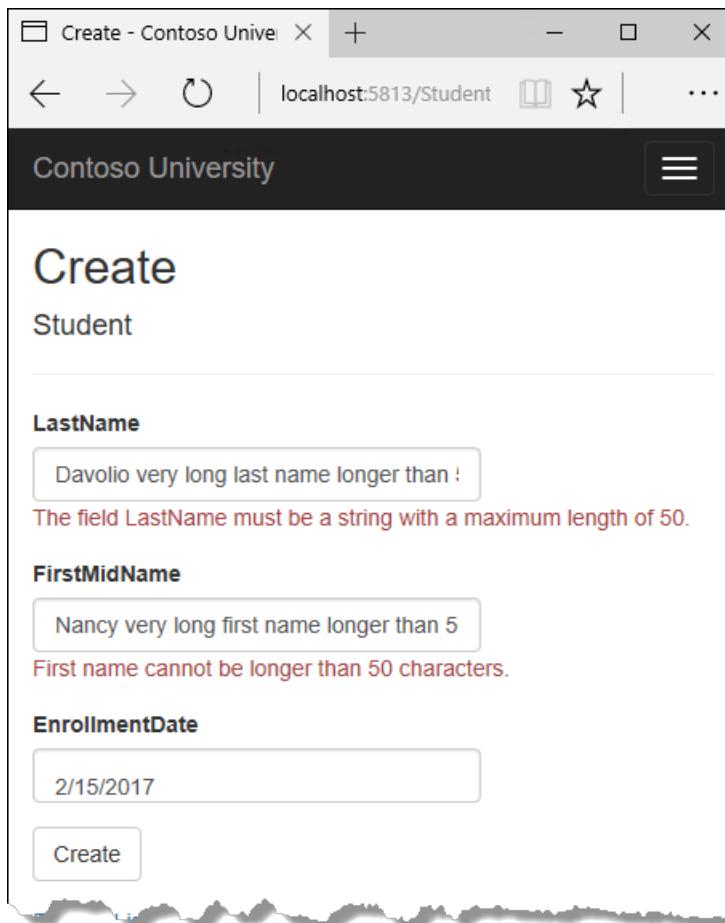
        public ICollection<Enrollment> Enrollments { get; set; }
    }
}
```

The preceding code limits names to no more than 50 characters. The `StringLength` attribute doesn't prevent a user from entering white space for a name. The `RegularExpression` attribute is used to apply restrictions to the input. For example, the following code requires the first character to be upper case and the remaining characters to be alphabetical:

```
[RegularExpression(@"^([A-Z][a-zA-Z\s-]*$)")]
```

Run the app:

- Navigate to the Students page.
- Select **Create New**, and enter a name longer than 50 characters.
- Select **Create**, client-side validation shows an error message.



In **SQL Server Object Explorer** (SSOX), open the Student table designer by double-clicking the **Student** table.

The screenshot shows the "dbo.Student [Design]" table in SQL Server Object Explorer. The table has four columns: "ID" (int, primary key, clustered), "EnrollmentDate" (datetime2(7)), "FirstMidName" (nvarchar(MAX), nullable), and "LastName" (nvarchar(MAX), nullable). The "T-SQL" tab displays the following CREATE TABLE script:

```
CREATE TABLE [dbo].[Student] (
    [ID] INT IDENTITY (1, 1) NOT NULL,
    [EnrollmentDate] DATETIME2 (7) NOT NULL,
    [FirstMidName] NVARCHAR (MAX) NULL,
    [LastName] NVARCHAR (MAX) NULL,
    CONSTRAINT [PK_Student] PRIMARY KEY CLUSTERED ([ID] ASC)
);
```

The preceding image shows the schema for the `Student` table. The name fields have type `nvarchar(MAX)` because migrations has not been run on the DB. When migrations are run later in this tutorial, the name fields become

```
nvarchar(50) .
```

## The Column attribute

Attributes can control how classes and properties are mapped to the database. In this section, the `Column` attribute is used to map the name of the `FirstMidName` property to "FirstName" in the DB.

When the DB is created, property names on the model are used for column names (except when the `Column` attribute is used).

The `student` model uses `FirstMidName` for the first-name field because the field might also contain a middle name.

Update the `Student.cs` file with the following highlighted code:

```
using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Student
    {
        public int ID { get; set; }
        [StringLength(50)]
        public string LastName { get; set; }
        [StringLength(50, ErrorMessage = "First name cannot be longer than 50 characters.")]  
[Column("FirstName")]
        public string FirstMidName { get; set; }
        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        public DateTime EnrollmentDate { get; set; }

        public ICollection<Enrollment> Enrollments { get; set; }
    }
}
```

With the preceding change, `Student.FirstMidName` in the app maps to the `FirstName` column of the `Student` table.

The addition of the `Column` attribute changes the model backing the `SchoolContext`. The model backing the `SchoolContext` no longer matches the database. If the app is run before applying migrations, the following exception is generated:

```
SqlException: Invalid column name 'FirstName'.
```

To update the DB:

- Build the project.
- Open a command window in the project folder. Enter the following commands to create a new migration and update the DB:
  - [Visual Studio](#)
  - [.NET Core CLI](#)

```
Add-Migration ColumnFirstName  
Update-Database
```

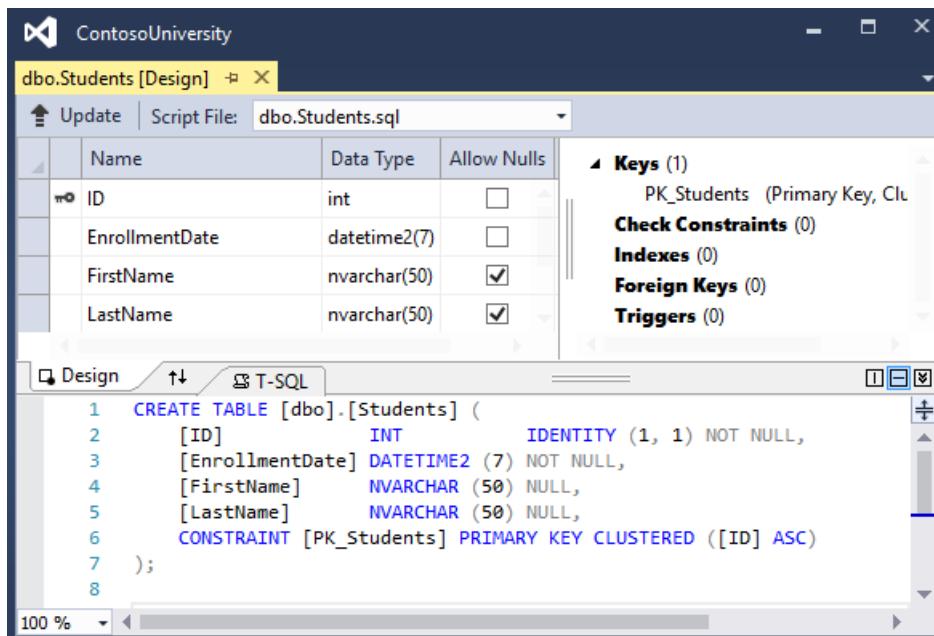
The `migrations add ColumnFirstName` command generates the following warning message:

An operation was scaffolded that may result in the loss of data.  
Please review the migration for accuracy.

The warning is generated because the name fields are now limited to 50 characters. If a name in the DB had more than 50 characters, the 51 to last character would be lost.

- Test the app.

Open the Student table in SSOX:

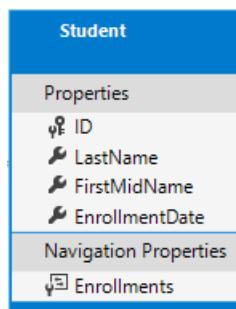


Before migration was applied, the name columns were of type `nvarchar(MAX)`. The name columns are now `nvarchar(50)`. The column name has changed from `FirstMidName` to `FirstName`.

#### NOTE

In the following section, building the app at some stages generates compiler errors. The instructions specify when to build the app.

## Student entity update



Update `Models/Student.cs` with the following code:

```

using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Student
    {
        public int ID { get; set; }
        [Required]
        [StringLength(50)]
        [Display(Name = "Last Name")]
        public string LastName { get; set; }
        [Required]
        [StringLength(50, ErrorMessage = "First name cannot be longer than 50 characters.")]
        [Column("FirstName")]
        [Display(Name = "First Name")]
        public string FirstMidName { get; set; }
        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        [Display(Name = "Enrollment Date")]
        public DateTime EnrollmentDate { get; set; }
        [Display(Name = "Full Name")]
        public string FullName
        {
            get
            {
                return LastName + ", " + FirstMidName;
            }
        }

        public ICollection<Enrollment> Enrollments { get; set; }
    }
}

```

## The Required attribute

The `Required` attribute makes the name properties required fields. The `Required` attribute isn't needed for non-nullable types such as value types (`DateTime`, `int`, `double`, etc.). Types that can't be null are automatically treated as required fields.

The `Required` attribute could be replaced with a minimum length parameter in the `StringLength` attribute:

```

[Display(Name = "Last Name")]
[StringLength(50, MinimumLength=1)]
public string LastName { get; set; }

```

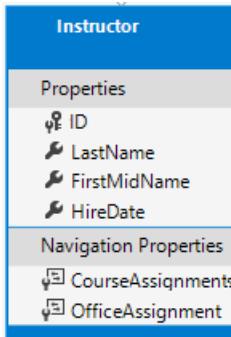
## The Display attribute

The `Display` attribute specifies that the caption for the text boxes should be "First Name", "Last Name", "Full Name", and "Enrollment Date." The default captions had no space dividing the words, for example "Lastname."

## The FullName calculated property

`FullName` is a calculated property that returns a value that's created by concatenating two other properties. `FullName` cannot be set, it has only a get accessor. No `FullName` column is created in the database.

# Create the Instructor Entity



Create `Models/Instructor.cs` with the following code:

```
using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Instructor
    {
        public int ID { get; set; }

        [Required]
        [Display(Name = "Last Name")]
        [StringLength(50)]
        public string LastName { get; set; }

        [Required]
        [Column("FirstName")]
        [Display(Name = "First Name")]
        [StringLength(50)]
        public string FirstMidName { get; set; }

        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        [Display(Name = "Hire Date")]
        public DateTime HireDate { get; set; }

        [Display(Name = "Full Name")]
        public string FullName
        {
            get { return LastName + ", " + FirstMidName; }
        }

        public ICollection<CourseAssignment> CourseAssignments { get; set; }
        public OfficeAssignment OfficeAssignment { get; set; }
    }
}
```

Multiple attributes can be on one line. The `HireDate` attributes could be written as follows:

```
[DataType(DataType.Date), Display(Name = "Hire Date"), DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
```

## The `CourseAssignments` and `OfficeAssignment` navigation properties

The `CourseAssignments` and `OfficeAssignment` properties are navigation properties.

An instructor can teach any number of courses, so `CourseAssignments` is defined as a collection.

```
public ICollection<CourseAssignment> CourseAssignments { get; set; }
```

If a navigation property holds multiple entities:

- It must be a list type where the entries can be added, deleted, and updated.

Navigation property types include:

- `ICollection<T>`
- `List<T>`
- `HashSet<T>`

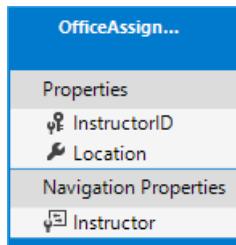
If `ICollection<T>` is specified, EF Core creates a `HashSet<T>` collection by default.

The `CourseAssignment` entity is explained in the section on many-to-many relationships.

Contoso University business rules state that an instructor can have at most one office. The `OfficeAssignment` property holds a single `OfficeAssignment` entity. `OfficeAssignment` is null if no office is assigned.

```
public OfficeAssignment OfficeAssignment { get; set; }
```

## Create the OfficeAssignment entity



Create `Models/OfficeAssignment.cs` with the following code:

```
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class OfficeAssignment
    {
        [Key]
        public int InstructorID { get; set; }
        [StringLength(50)]
        [Display(Name = "Office Location")]
        public string Location { get; set; }

        public Instructor Instructor { get; set; }
    }
}
```

### The Key attribute

The `[Key]` attribute is used to identify a property as the primary key (PK) when the property name is something other than `classnameID` or `ID`.

There's a one-to-zero-or-one relationship between the `Instructor` and `OfficeAssignment` entities. An office assignment only exists in relation to the instructor it's assigned to. The `OfficeAssignment` PK is also its foreign key

(FK) to the `Instructor` entity. EF Core can't automatically recognize `InstructorID` as the PK of `OfficeAssignment` because:

- `InstructorID` doesn't follow the ID or `classnameID` naming convention.

Therefore, the `key` attribute is used to identify `InstructorID` as the PK:

```
[Key]  
public int InstructorID { get; set; }
```

By default, EF Core treats the key as non-database-generated because the column is for an identifying relationship.

### The Instructor navigation property

The `OfficeAssignment` navigation property for the `Instructor` entity is nullable because:

- Reference types (such as classes) are nullable.
- An instructor might not have an office assignment.

The `OfficeAssignment` entity has a non-nullable `Instructor` navigation property because:

- `InstructorID` is non-nullable.
- An office assignment can't exist without an instructor.

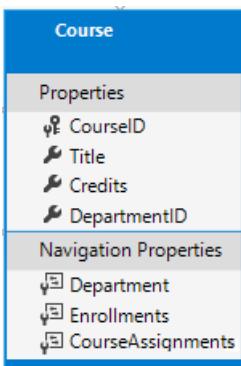
When an `Instructor` entity has a related `OfficeAssignment` entity, each entity has a reference to the other one in its navigation property.

The `[Required]` attribute could be applied to the `Instructor` navigation property:

```
[Required]  
public Instructor Instructor { get; set; }
```

The preceding code specifies that there must be a related instructor. The preceding code is unnecessary because the `InstructorID` foreign key (which is also the PK) is non-nullable.

## Modify the Course Entity



Update `Models/Course.cs` with the following code:

```

using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Course
    {
        [DatabaseGenerated(DatabaseGeneratedOption.None)]
        [Display(Name = "Number")]
        public int CourseID { get; set; }

        [StringLength(50, MinimumLength = 3)]
        public string Title { get; set; }

        [Range(0, 5)]
        public int Credits { get; set; }

        public int DepartmentID { get; set; }

        public Department Department { get; set; }
        public ICollection<Enrollment> Enrollments { get; set; }
        public ICollection<CourseAssignment> CourseAssignments { get; set; }
    }
}

```

The `Course` entity has a foreign key (FK) property `DepartmentID`. `DepartmentID` points to the related `Department` entity. The `Course` entity has a `Department` navigation property.

EF Core doesn't require a FK property for a data model when the model has a navigation property for a related entity.

EF Core automatically creates FKs in the database wherever they're needed. EF Core creates [shadow properties](#) for automatically created FKs. Having the FK in the data model can make updates simpler and more efficient. For example, consider a model where the FK property `DepartmentID` is *not* included. When a course entity is fetched to edit:

- The `Department` entity is null if it's not explicitly loaded.
- To update the course entity, the `Department` entity must first be fetched.

When the FK property `DepartmentID` is included in the data model, there's no need to fetch the `Department` entity before an update.

### The `DatabaseGenerated` attribute

The `[DatabaseGenerated(DatabaseGeneratedOption.None)]` attribute specifies that the PK is provided by the application rather than generated by the database.

```

[DatabaseGenerated(DatabaseGeneratedOption.None)]
[Display(Name = "Number")]
public int CourseID { get; set; }

```

By default, EF Core assumes that PK values are generated by the DB. DB generated PK values is generally the best approach. For `course` entities, the user specifies the PK. For example, a course number such as a 1000 series for the math department, a 2000 series for the English department.

The `DatabaseGenerated` attribute can also be used to generate default values. For example, the DB can automatically generate a date field to record the date a row was created or updated. For more information, see [Generated Properties](#).

## Foreign key and navigation properties

The foreign key (FK) properties and navigation properties in the `course` entity reflect the following relationships:

A course is assigned to one department, so there's a `DepartmentID` FK and a `Department` navigation property.

```
public int DepartmentID { get; set; }
public Department Department { get; set; }
```

A course can have any number of students enrolled in it, so the `Enrollments` navigation property is a collection:

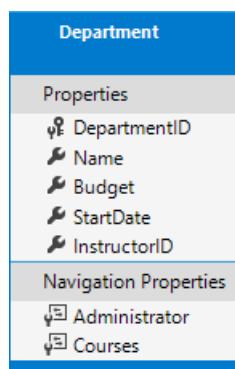
```
public ICollection<Enrollment> Enrollments { get; set; }
```

A course may be taught by multiple instructors, so the `CourseAssignments` navigation property is a collection:

```
public ICollection<CourseAssignment> CourseAssignments { get; set; }
```

`CourseAssignment` is explained [later](#).

## Create the Department entity



Create `Models/Department.cs` with the following code:

```

using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Department
    {
        public int DepartmentID { get; set; }

        [StringLength(50, MinimumLength = 3)]
        public string Name { get; set; }

        [DataType(DataType.Currency)]
        [Column(TypeName = "money")]
        public decimal Budget { get; set; }

        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        [Display(Name = "Start Date")]
        public DateTime StartDate { get; set; }

        public int? InstructorID { get; set; }

        public Instructor Administrator { get; set; }
        public ICollection<Course> Courses { get; set; }
    }
}

```

## The Column attribute

Previously the `Column` attribute was used to change column name mapping. In the code for the `Department` entity, the `Column` attribute is used to change SQL data type mapping. The `Budget` column is defined using the SQL Server money type in the DB:

```

[Column(TypeName="money")]
public decimal Budget { get; set; }

```

Column mapping is generally not required. EF Core generally chooses the appropriate SQL Server data type based on the CLR type for the property. The CLR `decimal` type maps to a SQL Server `decimal` type. `Budget` is for currency, and the money data type is more appropriate for currency.

## Foreign key and navigation properties

The FK and navigation properties reflect the following relationships:

- A department may or may not have an administrator.
- An administrator is always an instructor. Therefore the `InstructorID` property is included as the FK to the `Instructor` entity.

The navigation property is named `Administrator` but holds an `Instructor` entity:

```

public int? InstructorID { get; set; }
public Instructor Administrator { get; set; }

```

The question mark (?) in the preceding code specifies the property is nullable.

A department may have many courses, so there's a `Courses` navigation property:

```
public ICollection<Course> Courses { get; set; }
```

Note: By convention, EF Core enables cascade delete for non-nullable FKs and for many-to-many relationships. Cascading delete can result in circular cascade delete rules. Circular cascade delete rules causes an exception when a migration is added.

For example, if the `Department.InstructorID` property wasn't defined as nullable:

- EF Core configures a cascade delete rule to delete the instructor when the department is deleted.
- Deleting the instructor when the department is deleted isn't the intended behavior.

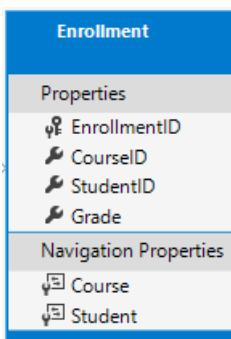
If business rules required the `InstructorID` property be non-nullable, use the following fluent API statement:

```
modelBuilder.Entity<Department>()
    .HasOne(d => d.Administrator)
    .WithMany()
    .OnDelete(DeleteBehavior.Restrict)
```

The preceding code disables cascade delete on the department-instructor relationship.

## Update the Enrollment entity

An enrollment record is for a one course taken by one student.



Update `Models/Enrollment.cs` with the following code:

```
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public enum Grade
    {
        A, B, C, D, F
    }

    public class Enrollment
    {
        public int EnrollmentID { get; set; }
        public int CourseID { get; set; }
        public int StudentID { get; set; }
        [DisplayFormat(NullDisplayText = "No grade")]
        public Grade? Grade { get; set; }

        public Course Course { get; set; }
        public Student Student { get; set; }
    }
}
```

## Foreign key and navigation properties

The FK properties and navigation properties reflect the following relationships:

An enrollment record is for one course, so there's a `CourseID` FK property and a `Course` navigation property:

```
public int CourseID { get; set; }
public Course Course { get; set; }
```

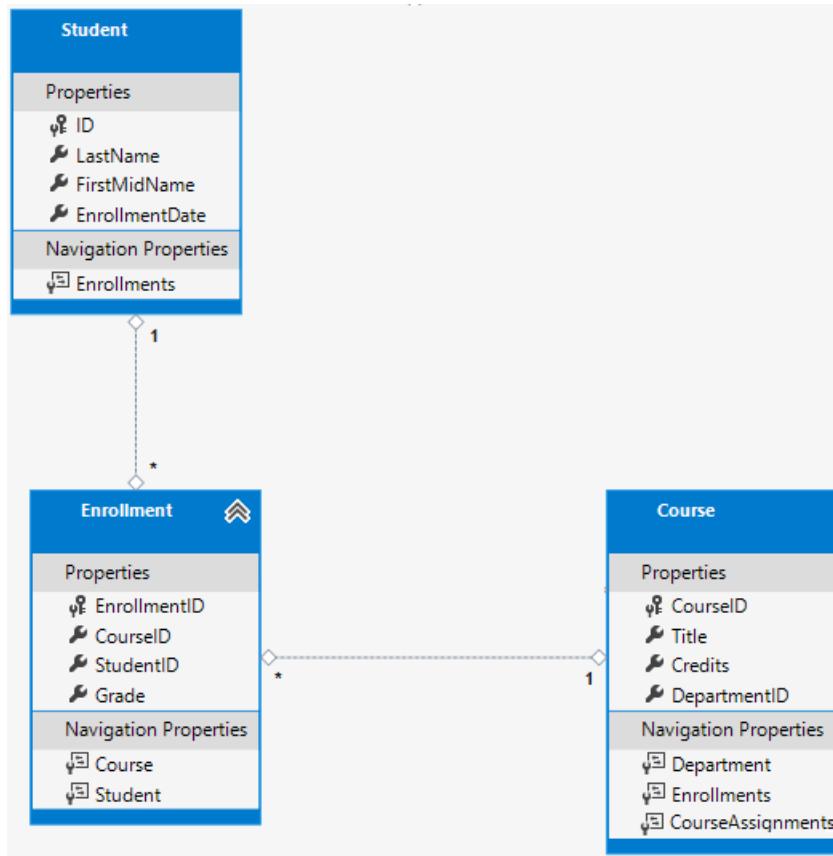
An enrollment record is for one student, so there's a `StudentID` FK property and a `Student` navigation property:

```
public int StudentID { get; set; }
public Student Student { get; set; }
```

## Many-to-Many Relationships

There's a many-to-many relationship between the `Student` and `Course` entities. The `Enrollment` entity functions as a many-to-many join table *with payload* in the database. "With payload" means that the `Enrollment` table contains additional data besides FKS for the joined tables (in this case, the PK and `Grade`).

The following illustration shows what these relationships look like in an entity diagram. (This diagram was generated using EF Power Tools for EF 6.x. Creating the diagram isn't part of the tutorial.)



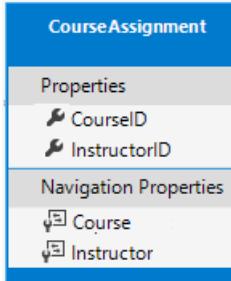
Each relationship line has a 1 at one end and an asterisk (\*) at the other, indicating a one-to-many relationship.

If the `Enrollment` table didn't include grade information, it would only need to contain the two FKS (`CourseID` and `StudentID`). A many-to-many join table without payload is sometimes called a pure join table (PJT).

The `Instructor` and `Course` entities have a many-to-many relationship using a pure join table.

Note: EF 6.x supports implicit join tables for many-to-many relationships, but EF Core doesn't. For more information, see [Many-to-many relationships in EF Core 2.0](#).

# The CourseAssignment entity

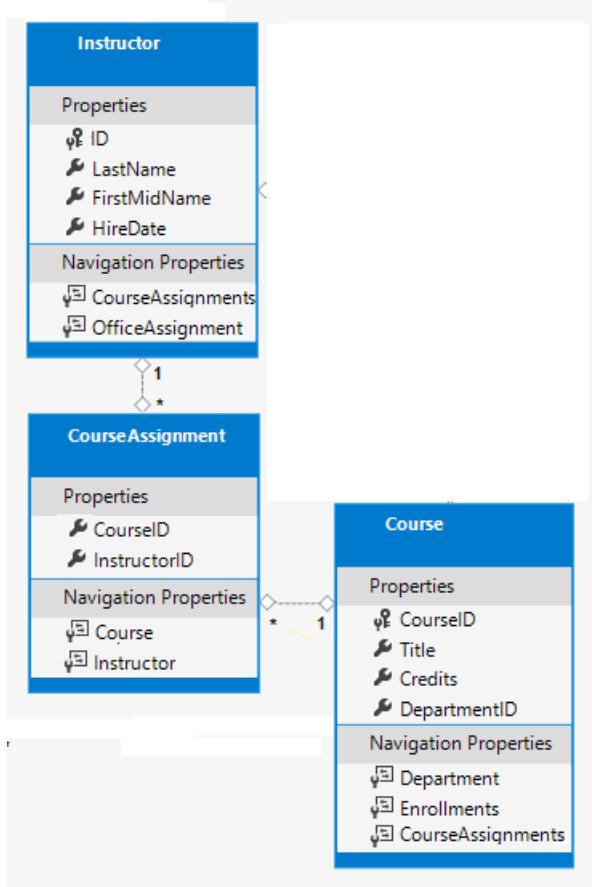


Create `Models/CourseAssignment.cs` with the following code:

```
using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class CourseAssignment
    {
        public int InstructorID { get; set; }
        public int CourseID { get; set; }
        public Instructor Instructor { get; set; }
        public Course Course { get; set; }
    }
}
```

## Instructor-to-Courses



The Instructor-to-Courses many-to-many relationship:

- Requires a join table that must be represented by an entity set.

- Is a pure join table (table without payload).

It's common to name a join entity `EntityName1EntityName2`. For example, the Instructor-to-Courses join table using this pattern is `CourseInstructor`. However, we recommend using a name that describes the relationship.

Data models start out simple and grow. No-payload joins (PJs) frequently evolve to include payload. By starting with a descriptive entity name, the name doesn't need to change when the join table changes. Ideally, the join entity would have its own natural (possibly single word) name in the business domain. For example, Books and Customers could be linked with a join entity called Ratings. For the Instructor-to-Courses many-to-many relationship, `CourseAssignment` is preferred over `CourseInstructor`.

### Composite key

FKs are not nullable. The two FKs in `CourseAssignment` (`InstructorID` and `CourseID`) together uniquely identify each row of the `CourseAssignment` table. `CourseAssignment` doesn't require a dedicated PK. The `InstructorID` and `CourseID` properties function as a composite PK. The only way to specify composite PKs to EF Core is with the *fluent API*. The next section shows how to configure the composite PK.

The composite key ensures:

- Multiple rows are allowed for one course.
- Multiple rows are allowed for one instructor.
- Multiple rows for the same instructor and course isn't allowed.

The `Enrollment` join entity defines its own PK, so duplicates of this sort are possible. To prevent such duplicates:

- Add a unique index on the FK fields, or
- Configure `Enrollment` with a primary composite key similar to `CourseAssignment`. For more information, see [Indexes](#).

## Update the DB context

Add the following highlighted code to `Data/SchoolContext.cs`:

```

using ContosoUniversity.Models;
using Microsoft.EntityFrameworkCore;

namespace ContosoUniversity.Models
{
    public class SchoolContext : DbContext
    {
        public SchoolContext(DbContextOptions<SchoolContext> options) : base(options)
        {

        }

        public DbSet<Course> Courses { get; set; }
        public DbSet<Enrollment> Enrollment { get; set; }
        public DbSet<Student> Student { get; set; }
        public DbSet<Department> Departments { get; set; }
        public DbSet<Instructor> Instructors { get; set; }
        public DbSet<OfficeAssignment> OfficeAssignments { get; set; }
        public DbSet<CourseAssignment> CourseAssignments { get; set; }

        protected override void OnModelCreating(ModelBuilder modelBuilder)
        {
            modelBuilder.Entity<Course>().ToTable("Course");
            modelBuilder.Entity<Enrollment>().ToTable("Enrollment");
            modelBuilder.Entity<Student>().ToTable("Student");
            modelBuilder.Entity<Department>().ToTable("Department");
            modelBuilder.Entity<Instructor>().ToTable("Instructor");
            modelBuilder.Entity<OfficeAssignment>().ToTable("OfficeAssignment");
            modelBuilder.Entity<CourseAssignment>().ToTable("CourseAssignment");

            modelBuilder.Entity<CourseAssignment>()
                .HasKey(c => new { c.CourseID, c.InstructorID });
        }
    }
}

```

The preceding code adds the new entities and configures the `CourseAssignment` entity's composite PK.

## Fluent API alternative to attributes

The `OnModelCreating` method in the preceding code uses the *fluent API* to configure EF Core behavior. The API is called "fluent" because it's often used by stringing a series of method calls together into a single statement. The [following code](#) is an example of the fluent API:

```

protected override void OnModelCreating(ModelBuilder modelBuilder)
{
    modelBuilder.Entity<Blog>()
        .Property(b => b.Url)
        .IsRequired();
}

```

In this tutorial, the fluent API is used only for DB mapping that can't be done with attributes. However, the fluent API can specify most of the formatting, validation, and mapping rules that can be done with attributes.

Some attributes such as `MinimumLength` can't be applied with the fluent API. `MinimumLength` doesn't change the schema, it only applies a minimum length validation rule.

Some developers prefer to use the fluent API exclusively so that they can keep their entity classes "clean." Attributes and the fluent API can be mixed. There are some configurations that can only be done with the fluent API (specifying a composite PK). There are some configurations that can only be done with attributes (`MinimumLength`). The recommended practice for using fluent API or attributes:

- Choose one of these two approaches.
- Use the chosen approach consistently as much as possible.

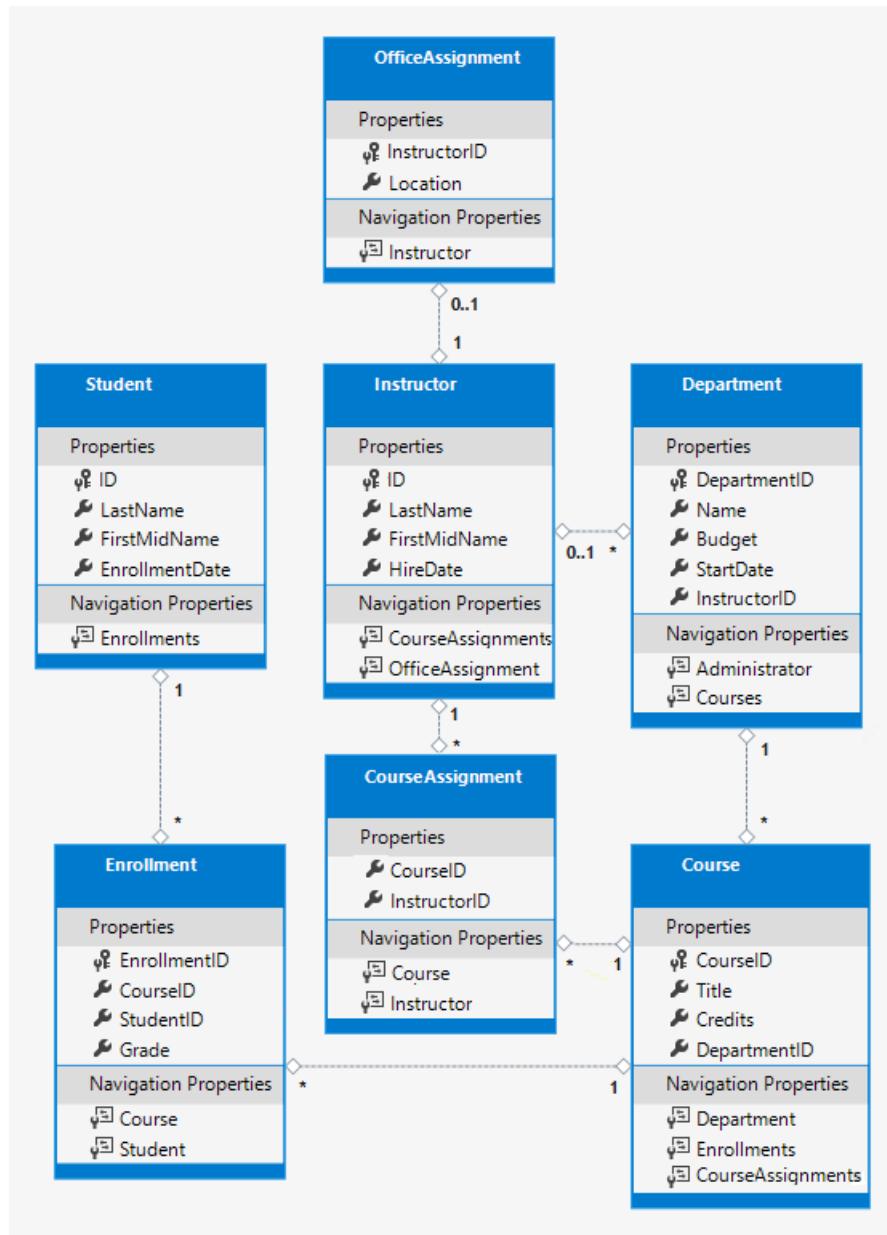
Some of the attributes used in the this tutorial are used for:

- Validation only (for example, `MinimumLength` ).
- EF Core configuration only (for example, `HasKey` ).
- Validation and EF Core configuration (for example, `[StringLength(50)]` ).

For more information about attributes vs. fluent API, see [Methods of configuration](#).

## Entity Diagram Showing Relationships

The following illustration shows the diagram that EF Power Tools create for the completed School model.



The preceding diagram shows:

- Several one-to-many relationship lines (1 to \*).
- The one-to-zero-or-one relationship line (1 to 0..1) between the `Instructor` and `OfficeAssignment` entities.
- The zero-or-one-to-many relationship line (0..1 to \*) between the `Instructor` and `Department` entities.

## Seed the DB with Test Data

Update the code in *Data/DbInitializer.cs*:

```
using System;
using System.Linq;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using ContosoUniversity.Models;

namespace ContosoUniversity.Data
{
    public static class DbInitializer
    {
        public static void Initialize(SchoolContext context)
        {
            //context.Database.EnsureCreated();

            // Look for any students.
            if (context.Student.Any())
            {
                return; // DB has been seeded
            }

            var students = new Student[]
            {
                new Student { FirstMidName = "Carson", LastName = "Alexander",
                    EnrollmentDate = DateTime.Parse("2010-09-01") },
                new Student { FirstMidName = "Meredith", LastName = "Alonso",
                    EnrollmentDate = DateTime.Parse("2012-09-01") },
                new Student { FirstMidName = "Arturo", LastName = "Anand",
                    EnrollmentDate = DateTime.Parse("2013-09-01") },
                new Student { FirstMidName = "Gytis", LastName = "Barzdukas",
                    EnrollmentDate = DateTime.Parse("2012-09-01") },
                new Student { FirstMidName = "Yan", LastName = "Li",
                    EnrollmentDate = DateTime.Parse("2012-09-01") },
                new Student { FirstMidName = "Peggy", LastName = "Justice",
                    EnrollmentDate = DateTime.Parse("2011-09-01") },
                new Student { FirstMidName = "Laura", LastName = "Norman",
                    EnrollmentDate = DateTime.Parse("2013-09-01") },
                new Student { FirstMidName = "Nino", LastName = "Olivetto",
                    EnrollmentDate = DateTime.Parse("2005-09-01") }
            };

            foreach (Student s in students)
            {
                context.Student.Add(s);
            }
            context.SaveChanges();

            var instructors = new Instructor[]
            {
                new Instructor { FirstMidName = "Kim", LastName = "Abercrombie",
                    HireDate = DateTime.Parse("1995-03-11") },
                new Instructor { FirstMidName = "Fadi", LastName = "Fakhouri",
                    HireDate = DateTime.Parse("2002-07-06") },
                new Instructor { FirstMidName = "Roger", LastName = "Harui",
                    HireDate = DateTime.Parse("1998-07-01") },
                new Instructor { FirstMidName = "Candace", LastName = "Kapoor",
                    HireDate = DateTime.Parse("2001-01-15") },
                new Instructor { FirstMidName = "Roger", LastName = "Zheng",
                    HireDate = DateTime.Parse("2004-02-12") }
            };

            foreach (Instructor i in instructors)
            {
                context.Instructors.Add(i);
            }
        }
    }
}
```

```

        }

        context.SaveChanges();

        var departments = new Department[]
        {
            new Department { Name = "English",      Budget = 350000,
                StartDate = DateTime.Parse("2007-09-01"),
                InstructorID = instructors.Single( i => i.LastName == "Abercrombie").ID },
            new Department { Name = "Mathematics",   Budget = 100000,
                StartDate = DateTime.Parse("2007-09-01"),
                InstructorID = instructors.Single( i => i.LastName == "Fakhouri").ID },
            new Department { Name = "Engineering",   Budget = 350000,
                StartDate = DateTime.Parse("2007-09-01"),
                InstructorID = instructors.Single( i => i.LastName == "Harui").ID },
            new Department { Name = "Economics",     Budget = 100000,
                StartDate = DateTime.Parse("2007-09-01"),
                InstructorID = instructors.Single( i => i.LastName == "Kapoor").ID }
        };

        foreach (Department d in departments)
        {
            context.Departments.Add(d);
        }
        context.SaveChanges();

        var courses = new Course[]
        {
            new Course {CourseID = 1050, Title = "Chemistry",      Credits = 3,
                DepartmentID = departments.Single( s => s.Name == "Engineering").DepartmentID
            },
            new Course {CourseID = 4022, Title = "Microeconomics", Credits = 3,
                DepartmentID = departments.Single( s => s.Name == "Economics").DepartmentID
            },
            new Course {CourseID = 4041, Title = "Macroeconomics", Credits = 3,
                DepartmentID = departments.Single( s => s.Name == "Economics").DepartmentID
            },
            new Course {CourseID = 1045, Title = "Calculus",       Credits = 4,
                DepartmentID = departments.Single( s => s.Name == "Mathematics").DepartmentID
            },
            new Course {CourseID = 3141, Title = "Trigonometry",   Credits = 4,
                DepartmentID = departments.Single( s => s.Name == "Mathematics").DepartmentID
            },
            new Course {CourseID = 2021, Title = "Composition",    Credits = 3,
                DepartmentID = departments.Single( s => s.Name == "English").DepartmentID
            },
            new Course {CourseID = 2042, Title = "Literature",     Credits = 4,
                DepartmentID = departments.Single( s => s.Name == "English").DepartmentID
            },
        };

        foreach (Course c in courses)
        {
            context.Courses.Add(c);
        }
        context.SaveChanges();

        var officeAssignments = new OfficeAssignment[]
        {
            new OfficeAssignment {
                InstructorID = instructors.Single( i => i.LastName == "Fakhouri").ID,
                Location = "Smith 17" },
            new OfficeAssignment {
                InstructorID = instructors.Single( i => i.LastName == "Harui").ID,
                Location = "Gowan 27" },
            new OfficeAssignment {
                InstructorID = instructors.Single( i => i.LastName == "Kapoor").ID,
                Location = "Thompson 304" },
        };
    }
}

```

```

foreach (OfficeAssignment o in officeAssignments)
{
    context.OfficeAssignments.Add(o);
}
context.SaveChanges();

var courseInstructors = new CourseAssignment[]
{
    new CourseAssignment {
        CourseID = courses.Single(c => c.Title == "Chemistry" ).CourseID,
        InstructorID = instructors.Single(i => i.LastName == "Kapoor").ID
    },
    new CourseAssignment {
        CourseID = courses.Single(c => c.Title == "Chemistry" ).CourseID,
        InstructorID = instructors.Single(i => i.LastName == "Harui").ID
    },
    new CourseAssignment {
        CourseID = courses.Single(c => c.Title == "Microeconomics" ).CourseID,
        InstructorID = instructors.Single(i => i.LastName == "Zheng").ID
    },
    new CourseAssignment {
        CourseID = courses.Single(c => c.Title == "Macroeconomics" ).CourseID,
        InstructorID = instructors.Single(i => i.LastName == "Zheng").ID
    },
    new CourseAssignment {
        CourseID = courses.Single(c => c.Title == "Calculus" ).CourseID,
        InstructorID = instructors.Single(i => i.LastName == "Fakhouri").ID
    },
    new CourseAssignment {
        CourseID = courses.Single(c => c.Title == "Trigonometry" ).CourseID,
        InstructorID = instructors.Single(i => i.LastName == "Harui").ID
    },
    new CourseAssignment {
        CourseID = courses.Single(c => c.Title == "Composition" ).CourseID,
        InstructorID = instructors.Single(i => i.LastName == "Abercrombie").ID
    },
    new CourseAssignment {
        CourseID = courses.Single(c => c.Title == "Literature" ).CourseID,
        InstructorID = instructors.Single(i => i.LastName == "Abercrombie").ID
    },
},
};

foreach (CourseAssignment ci in courseInstructors)
{
    context.CourseAssignments.Add(ci);
}
context.SaveChanges();

var enrollments = new Enrollment[]
{
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Alexander").ID,
        CourseID = courses.Single(c => c.Title == "Chemistry" ).CourseID,
        Grade = Grade.A
    },
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Alexander").ID,
        CourseID = courses.Single(c => c.Title == "Microeconomics" ).CourseID,
        Grade = Grade.C
    },
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Alexander").ID,
        CourseID = courses.Single(c => c.Title == "Macroeconomics" ).CourseID,
        Grade = Grade.B
    },
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Alonso").ID,
        CourseID = courses.Single(c => c.Title == "Calculus" ).CourseID,
        Grade = Grade.B
    }
};

```

The preceding code provides seed data for the new entities. Most of this code creates new entity objects and loads sample data. The sample data is used for testing. The preceding code creates the following many-to-many relationships:

- Enrollments
  - CourseAssignment

Note: EF Core 2.1 will support data seeding.

## Add a migration

Build the project.

- [Visual Studio](#)
- [.NET Core CLI](#)

```
Add-Migration ComplexDataModel
```

The preceding command displays a warning about possible data loss.

```
An operation was scaffolded that may result in the loss of data.  
Please review the migration for accuracy.  
Done. To undo this action, use 'ef migrations remove'
```

If the `database update` command is run, the following error is produced:

```
The ALTER TABLE statement conflicted with the FOREIGN KEY constraint  
"FK_dbo.Course_dbo.Department_DepartmentID". The conflict occurred in  
database "ContosoUniversity", table "dbo.Department", column 'DepartmentID'.
```

When migrations are run with existing data, there may be FK constraints that are not satisfied with the exiting data. For this tutorial, a new DB is created, so there are no FK constraint violations. See [Fixing foreign key constraints with legacy data](#) for instructions on how to fix the FK violations on the current DB.

### Drop and update the database

The code in the updated `DbInitializer` adds seed data for the new entities. To force EF Core to create a new DB, drop and update the DB:

- [Visual Studio](#)
- [.NET Core CLI](#)

In the **Package Manager Console** (PMC), run the following command:

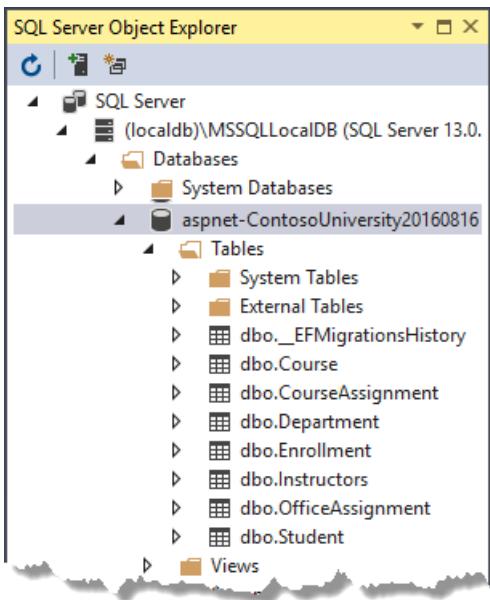
```
Drop-Database  
Update-Database
```

Run `Get-Help about_EntityFrameworkCore` from the PMC to get help information.

Run the app. Running the app runs the `DbInitializer.Initialize` method. The `DbInitializer.Initialize` populates the new DB.

Open the DB in SSOX:

- If SSOX was opened previously, click the **Refresh** button.
- Expand the **Tables** node. The created tables are displayed.



Examine the **CourseAssignment** table:

- Right-click the **CourseAssignment** table and select **View Data**.
- Verify the **CourseAssignment** table contains data.

	CourseID	InstructorID
▶	2021	1
	2042	1
	1045	2
	1050	3
	3141	3
	1050	4
	4022	5
	4041	5
★	NULL	NULL

## Fixing foreign key constraints with legacy data

This section is optional.

When migrations are run with existing data, there may be FK constraints that are not satisfied with the exiting data. With production data, steps must be taken to migrate the existing data. This section provides an example of fixing FK constraint violations. Don't make these code changes without a backup. Don't make these code changes if you completed the previous section and updated the database.

The `{timestamp}_ComplexDataModel.cs` file contains the following code:

```
migrationBuilder.AddColumn<int>(
    name: "DepartmentID",
    table: "Course",
    type: "int",
    nullable: false,
    defaultValue: 0);
```

The preceding code adds a non-nullable `DepartmentID` FK to the `course` table. The DB from the previous tutorial contains rows in `Course`, so that table cannot be updated by migrations.

To make the `ComplexDataModel` migration work with existing data:

- Change the code to give the new column (`DepartmentID`) a default value.
- Create a fake department named "Temp" to act as the default department.

### Fix the foreign key constraints

Update the `ComplexDataModel` classes `Up` method:

- Open the `{timestamp}_ComplexDataModel.cs` file.
- Comment out the line of code that adds the `DepartmentID` column to the `Course` table.

```
migrationBuilder.AlterColumn<string>(
    name: "Title",
    table: "Course",
    maxLength: 50,
    nullable: true,
    oldClrType: typeof(string),
    oldNullable: true);

//migrationBuilder.AddColumn<int>(
//    name: "DepartmentID",
//    table: "Course",
//    nullable: false,
//    defaultValue: 0);
```

Add the following highlighted code. The new code goes after the `.CreateTable( name: "Department" )` block:

```
migrationBuilder.CreateTable(
    name: "Department",
    columns: table => new
    {
        DepartmentID = table.Column<int>(type: "int", nullable: false)
            .Annotation("SqlServer:ValueGenerationStrategy", SqlServerValueGenerationStrategy.IdentityColumn),
        Budget = table.Column<decimal>(type: "money", nullable: false),
        InstructorID = table.Column<int>(type: "int", nullable: true),
        Name = table.Column<string>(type: "nvarchar(50)", maxLength: 50, nullable: true),
        StartDate = table.Column<DateTime>(type: "datetime2", nullable: false)
    },
    constraints: table =>
    {
        table.PrimaryKey("PK_Department", x => x.DepartmentID);
        table.ForeignKey(
            name: "FK_Department_Instructor_InstructorID",
            column: x => x.InstructorID,
            principalTable: "Instructor",
            principalColumn: "ID",
            onDelete: ReferentialAction.Restrict);
    });
}

migrationBuilder.Sql("INSERT INTO dbo.Department (Name, Budget, StartDate) VALUES ('Temp', 0.00,
GETDATE())");
// Default value for FK points to department created above, with
// defaultValue changed to 1 in following AddColumn statement.

migrationBuilder.AddColumn<int>(
    name: "DepartmentID",
    table: "Course",
    nullable: false,
    defaultValue: 1);
```

With the preceding changes, existing `Course` rows will be related to the "Temp" department after the `ComplexDataModel` `Up` method runs.

A production app would:

- Include code or scripts to add `Department` rows and related `Course` rows to the new `Department` rows.
- Not use the "Temp" department or the default value for `Course.DepartmentID`.

The next tutorial covers related data.

[PREVIOUS](#)

[NEXT](#)

# Razor Pages with EF Core in ASP.NET Core - Read Related Data - 6 of 8

7/14/2018 • 14 minutes to read • [Edit Online](#)

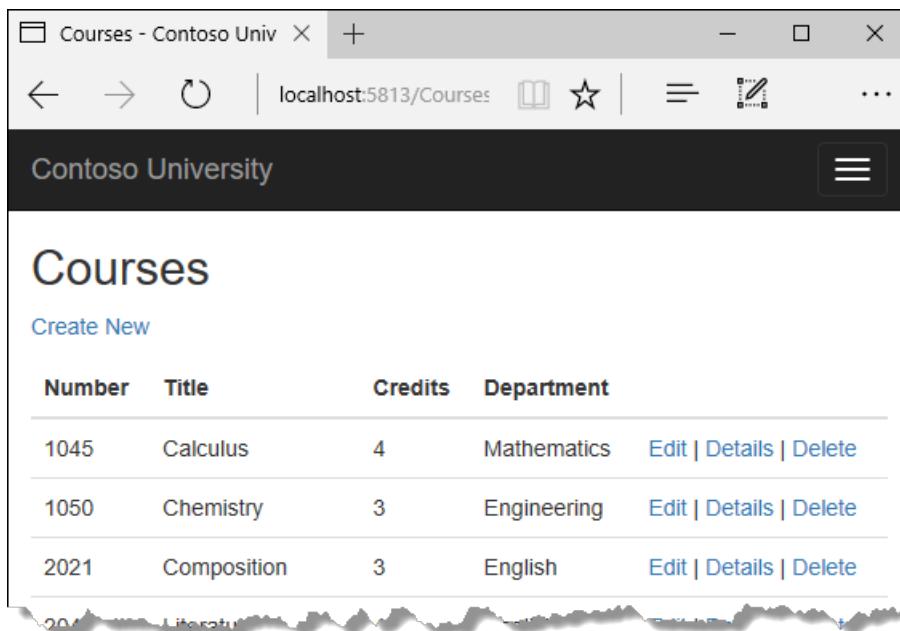
By [Tom Dykstra](#), [Jon P Smith](#), and [Rick Anderson](#)

The Contoso University web app demonstrates how to create Razor Pages web apps using EF Core and Visual Studio. For information about the tutorial series, see [the first tutorial](#).

In this tutorial, related data is read and displayed. Related data is data that EF Core loads into navigation properties.

If you run into problems you can't solve, download the [completed app for this stage](#).

The following illustrations show the completed pages for this tutorial:



A screenshot of a web browser window titled "Courses - Contoso Univ". The address bar shows "localhost:5813/Courses". The page header reads "Contoso University". The main content area is titled "Courses" and contains a table with three rows of course data. The table has columns for "Number", "Title", "Credits", and "Department". Each row includes "Edit | Details | Delete" links. The browser interface includes standard controls like back, forward, and search.

Number	Title	Credits	Department	
1045	Calculus	4	Mathematics	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
1050	Chemistry	3	Engineering	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
2021	Composition	3	English	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

Instructors - Contoso Un X

localhost:1234/Instructors/3?courseID=1050&action=OnGetAsync

Contoso University

## Instructors

Create New

Last Name	First Name	Hire Date	Office	Courses	
Abercrombie	Kim	1995-03-11		2021 Composition 2042 Literature	Select   Edit   Details   Delete
Fakhouri	Fadi	2002-07-06	Smith 17	1045 Calculus	Select   Edit   Details   Delete
Harui	Roger	1998-07-01	Gowan 27	1050 Chemistry 3141 Trigonometry	Select   Edit   Details   Delete
Kapoor	Candace	2001-01-15	Thompson 304	1050 Chemistry	Select   Edit   Details   Delete
Zheng	Roger	2004-02-12		4022 Microeconomics 4041 Macroeconomics	Select   Edit   Details   Delete

### Courses Taught by Selected Instructor

	Number	Title	Department
Select	1050	Chemistry	Engineering
Select	3141	Trigonometry	Mathematics

### Students Enrolled in Selected Course

Name	Grade
Alexander, Carson	A
Anand, Arturo	No grade
Barzdukas, Gytis	B

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## Eager, explicit, and lazy Loading of related data

There are several ways that EF Core can load related data into the navigation properties of an entity:

- **Eager loading.** Eager loading is when a query for one type of entity also loads related entities. When the entity is read, its related data is retrieved. This typically results in a single join query that retrieves all of the data that's needed. EF Core will issue multiple queries for some types of eager loading. Issuing multiple queries can be more efficient than was the case for some queries in EF6 where there was a single query.

Eager loading is specified with the `Include` and `ThenInclude` methods.

```
var departments = _context.Departments.Include(d => d.Courses);
foreach (Department d in departments)
{
    foreach(Course c in d.Courses)
    {
        courseList.Add(d.Name + c.Title);
    }
}
```

Query: all Department entities and related Course entities

Eager loading sends multiple queries when a collection navigation is included:

- One query for the main query
- One query for each collection "edge" in the load tree.
- Separate queries with `Load`: The data can be retrieved in separate queries, and EF Core "fixes up" the navigation properties. "fixes up" means that EF Core automatically populates the navigation properties. Separate queries with `Load` is more like explicit loading than eager loading.

```
var departments = _context.Departments;
foreach (Department d in departments)
{
    _context.Courses.Where(c => c.DepartmentID == d.DepartmentID).Load();
    foreach (Course c in d.Courses)
    {
        courseList.Add(d.Name + c.Title);
    }
}
```

Query: all Department rows

Query: Course rows related to Department d

Note: EF Core automatically fixes up navigation properties to any other entities that were previously loaded into the context instance. Even if the data for a navigation property is *not* explicitly included, the property may still be populated if some or all of the related entities were previously loaded.

- **Explicit loading**. When the entity is first read, related data isn't retrieved. Code must be written to retrieve the related data when it's needed. Explicit loading with separate queries results in multiple queries sent to the DB. With explicit loading, the code specifies the navigation properties to be loaded. Use the `Load` method to do explicit loading. For example:

```
var departments = _context.Departments;
foreach (Department d in departments)
{
    _context.Entry(d).Collection(p => p.Courses).Load();
    foreach (Course c in d.Courses)
    {
        courseList.Add(d.Name + c.Title);
    }
}
```

Query: all Department rows

Query: Course rows related to Department d

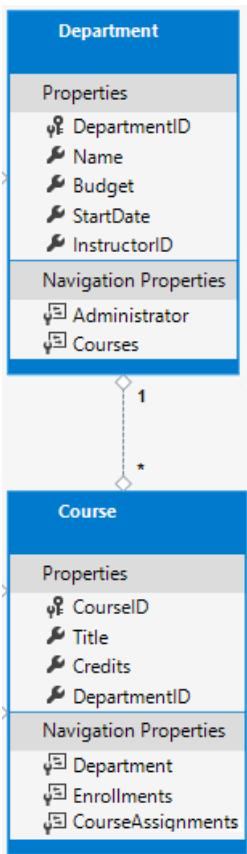
- **Lazy loading**. EF Core doesn't currently support lazy loading. When the entity is first read, related data isn't retrieved. The first time a navigation property is accessed, the data required for that navigation property is automatically retrieved. A query is sent to the DB each time a navigation property is accessed for the first time.
- The `Select` operator loads only the related data needed.

## Create a Courses page that displays department name

The Course entity includes a navigation property that contains the `Department` entity. The `Department` entity contains the department that the course is assigned to.

To display the name of the assigned department in a list of courses:

- Get the `Name` property from the `Department` entity.
- The `Department` entity comes from the `Course.Department` navigation property.



## Scaffold the Course model

- Exit Visual Studio.
- Open a command window in the project directory (The directory that contains the *Program.cs*, *Startup.cs*, and *.csproj* files).
- Run the following command:

```

dotnet add package Microsoft.VisualStudio.Web.CodeGeneration.Design --version 2.1.0
dotnet aspnet-codegenerator razorpage -m Course -dc SchoolContext -udl -outDir Pages\Courses --
referenceScriptLibraries

```

The preceding command scaffolds the **Course** model. Open the project in Visual Studio.

Open *Pages/Courses/Index.cshtml.cs* and examine the `OnGetAsync` method. The scaffolding engine specified eager loading for the `Department` navigation property. The `Include` method specifies eager loading.

Run the app and select the **Courses** link. The department column displays the `DepartmentID`, which isn't useful.

Update the `OnGetAsync` method with the following code:

```

public async Task OnGetAsync()
{
    Course = await _context.Courses
        .Include(c => c.Department)
        .AsNoTracking()
        .ToListAsync();
}

```

The preceding code adds `AsNoTracking`. `AsNoTracking` improves performance because the entities returned are not tracked. The entities are not tracked because they're not updated in the current context.

Update *Pages/Courses/Index.cshtml* with the following highlighted markup:

```

@page
@model ContosoUniversity.Pages.Courses.IndexModel
 @{
     ViewData["Title"] = "Courses";
 }

<h2>Courses</h2>

<p>
    <a asp-page="TestCreate">Create New</a>
</p>
<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.Course[0].CourseID)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Course[0].Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Course[0].Credits)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Course[0].Department)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model.Course)
        {
            <tr>
                <td>
                    @Html.DisplayFor(modelItem => item.CourseID)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Title)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Credits)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Department.Name)
                </td>
                <td>
                    <a asp-page=".Edit" asp-route-id="@item.CourseID">Edit</a> |
                    <a asp-page=".Details" asp-route-id="@item.CourseID">Details</a> |
                    <a asp-page=".Delete" asp-route-id="@item.CourseID">Delete</a>
                </td>
            </tr>
        }
    </tbody>
</table>

```

The following changes have been made to the scaffolded code:

- Changed the heading from Index to Courses.
- Added a **Number** column that shows the `courseID` property value. By default, primary keys aren't scaffolded because normally they're meaningless to end users. However, in this case the primary key is meaningful.
- Changed the **Department** column to display the department name. The code displays the `Name` property of the `Department` entity that's loaded into the `Department` navigation property:

```
@Html.DisplayFor(modelItem => item.Department.Name)
```

Run the app and select the **Courses** tab to see the list with department names.

Number	Title	Credits	Department	
1045	Calculus	4	Mathematics	Edit   Details   Delete
1050	Chemistry	3	Engineering	Edit   Details   Delete
2021	Composition	3	English	Edit   Details   Delete

### Loading related data with Select

The `OnGetAsync` method loads related data with the `Include` method:

```
public async Task OnGetAsync()
{
    Course = await _context.Courses
        .Include(c => c.Department)
        .AsNoTracking()
        .ToListAsync();
}
```

The `select` operator loads only the related data needed. For single items, like the `Department.Name` it uses a SQL INNER JOIN. For collections, it uses another database access, but so does the `Include` operator on collections.

The following code loads related data with the `Select` method:

```
public IList<CourseViewModel> CourseVM { get; set; }

public async Task OnGetAsync()
{
    CourseVM = await _context.Courses
        .Select(p => new CourseViewModel
        {
            CourseID = p.CourseID,
            Title = p.Title,
            Credits = p.Credits,
            DepartmentName = p.Department.Name
        }).ToListAsync();
}
```

The `CourseViewModel`:

```
public class CourseViewModel
{
    public int CourseID { get; set; }
    public string Title { get; set; }
    public int Credits { get; set; }
    public string DepartmentName { get; set; }
}
```

See [IndexSelect.cshtml](#) and [IndexSelect.cshtml.cs](#) for a complete example.

## Create an Instructors page that shows Courses and Enrollments

In this section, the Instructors page is created.

Instructors - Contoso University

localhost:1234/Instructors/3?courseID=1050&action=OnGetAsync

## Instructors

Create New

Last Name	First Name	Hire Date	Office	Courses	
Abercrombie	Kim	1995-03-11		2021 Composition 2042 Literature	Select   Edit   Details   Delete
Fakhouri	Fadi	2002-07-06	Smith 17	1045 Calculus	Select   Edit   Details   Delete
Harui	Roger	1998-07-01	Gowan 27	1050 Chemistry 3141 Trigonometry	Select   Edit   Details   Delete
Kapoor	Candace	2001-01-15	Thompson 304	1050 Chemistry	Select   Edit   Details   Delete
Zheng	Roger	2004-02-12		4022 Microeconomics 4041 Macroeconomics	Select   Edit   Details   Delete

### Courses Taught by Selected Instructor

	Number	Title	Department
Select	1050	Chemistry	Engineering
Select	3141	Trigonometry	Mathematics

### Students Enrolled in Selected Course

Name	Grade
Alexander, Carson	A
Anand, Arturo	No grade
Barzdukas, Gytis	B

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This page reads and displays related data in the following ways:

- The list of instructors displays related data from the `OfficeAssignment` entity (Office in the preceding image). The `Instructor` and `OfficeAssignment` entities are in a one-to-zero-or-one relationship. Eager loading is used for the `OfficeAssignment` entities. Eager loading is typically more efficient when the related data needs to be displayed. In this case, office assignments for the instructors are displayed.
- When the user selects an instructor (Harui in the preceding image), related `Course` entities are displayed. The

`Instructor` and `Course` entities are in a many-to-many relationship. Eager loading is used for the `Course` entities and their related `Department` entities. In this case, separate queries might be more efficient because only courses for the selected instructor are needed. This example shows how to use eager loading for navigation properties in entities that are in navigation properties.

- When the user selects a course (Chemistry in the preceding image), related data from the `Enrollments` entity is displayed. In the preceding image, student name and grade are displayed. The `Course` and `Enrollment` entities are in a one-to-many relationship.

### Create a view model for the Instructor Index view

The instructors page shows data from three different tables. A view model is created that includes the three entities representing the three tables.

In the `SchoolViewModels` folder, create `InstructorIndexData.cs` with the following code:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;

namespace ContosoUniversity.Models.SchoolViewModels
{
    public class InstructorIndexData
    {
        public IEnumerable<Instructor> Instructors { get; set; }
        public IEnumerable<Course> Courses { get; set; }
        public IEnumerable<Enrollment> Enrollments { get; set; }
    }
}
```

### Scaffold the Instructor model

- Exit Visual Studio.
- Open a command window in the project directory (The directory that contains the `Program.cs`, `Startup.cs`, and `.csproj` files).
- Run the following command:

```
dotnet aspnet-codegenerator razorpage -m Instructor -dc SchoolContext -udl -outDir Pages\Instructors --referenceScriptLibraries
```

The preceding command scaffolds the `Instructor` model. Open the project in Visual Studio.

Build the project. The build generates errors.

Globally change `_context.Instructor` to `_context.Instructors` (that is, add an "s" to `Instructor`). 7 occurrences are found and updated.

Run the app and navigate to the instructors page.

Replace `Pages\Instructors\Index.cshtml.cs` with the following code:

```

using ContosoUniversity.Models;
using ContosoUniversity.Models.SchoolViewModels; // Add VM
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using System.Linq;
using System.Threading.Tasks;

namespace ContosoUniversity.Pages.Instructors
{
    public class IndexModel : PageModel
    {
        private readonly ContosoUniversity.Data.SchoolContext _context;

        public IndexModel(ContosoUniversity.Data.SchoolContext context)
        {
            _context = context;
        }

        public InstructorIndexData Instructor { get; set; }
        public int InstructorID { get; set; }

        public async Task OnGetAsync(int? id)
        {
            Instructor = new InstructorIndexData();
            Instructor.Instructors = await _context.Instructors
                .Include(i => i.OfficeAssignment)
                .Include(i => i.CourseAssignments)
                .ThenInclude(i => i.Course)
                .AsNoTracking()
                .OrderBy(i => i.LastName)
                .ToListAsync();

            if (id != null)
            {
                InstructorID = id.Value;
            }
        }
    }
}

```

The `OnGetAsync` method accepts optional route data for the ID of the selected instructor.

Examine the query in the `Pages/Instructors/Index.cshtml.cs` file:

```

Instructor.Instructors = await _context.Instructors
    .Include(i => i.OfficeAssignment)
    .Include(i => i.CourseAssignments)
    .ThenInclude(i => i.Course)
    .AsNoTracking()
    .OrderBy(i => i.LastName)
    .ToListAsync();

```

The query has two includes:

- `OfficeAssignment` : Displayed in the [instructors view](#).
- `CourseAssignments` : Which brings in the courses taught.

## Update the instructors Index page

Update `Pages/Instructors/Index.cshtml` with the following markup:

```

@page "{id:int?}"
@model ContosoUniversity.Pages.Instructors.IndexModel

 @{
     ViewData["Title"] = "Instructors";
 }

<h2>Instructors</h2>

<p>
    <a asp-page="Create">Create New</a>
</p>
<table class="table">
    <thead>
        <tr>
            <th>Last Name</th>
            <th>First Name</th>
            <th>Hire Date</th>
            <th>Office</th>
            <th>Courses</th>
            <th></th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model.Instructor.Instructors)
        {
            string selectedRow = "";
            if (item.ID == Model.InstructorID)
            {
                selectedRow = "success";
            }
            <tr class="@selectedRow">
                <td>
                    @Html.DisplayFor(modelItem => item.LastName)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.FirstMidName)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.HireDate)
                </td>
                <td>
                    @if (item.OfficeAssignment != null)
                    {
                        @item.OfficeAssignment.Location
                    }
                </td>
                <td>
                    @{
                        foreach (var course in item.CourseAssignments)
                        {
                            @course.Course.CourseID @: @course.Course.Title <br />
                        }
                    }
                </td>
                <td>
                    <a asp-page=".~/Index" asp-route-id="@item.ID">Select</a> |
                    <a asp-page=".~/Edit" asp-route-id="@item.ID">Edit</a> |
                    <a asp-page=".~/Details" asp-route-id="@item.ID">Details</a> |
                    <a asp-page=".~/Delete" asp-route-id="@item.ID">Delete</a>
                </td>
            </tr>
        }
    </tbody>
</table>

```

The preceding markup makes the following changes:

- Updates the `page` directive from `@page` to `@page "{id:int?}"`. `{id:int?}"` is a route template. The route template changes integer query strings in the URL to route data. For example, clicking on the **Select** link for an instructor with only the `page` directive produces a URL like the following:

```
http://localhost:1234/Instructors?id=2
```

When the page directive is `@page "{id:int?}"`, the previous URL is:

```
http://localhost:1234/Instructors/2
```

- Page title is **Instructors**.
- Added an **Office** column that displays `item.OfficeAssignment.Location` only if `item.OfficeAssignment` isn't null. Because this is a one-to-zero-or-one relationship, there might not be a related `OfficeAssignment` entity.

```
@if (item.OfficeAssignment != null)
{
    @item.OfficeAssignment.Location
}
```

- Added a **Courses** column that displays courses taught by each instructor. See [Explicit Line Transition with @:](#) for more about this razor syntax.
- Added code that dynamically adds `class="success"` to the `tr` element of the selected instructor. This sets a background color for the selected row using a Bootstrap class.

```
string selectedRow = "";
if (item.CourseID == Model.CourseID)
{
    selectedRow = "success";
}
<tr class="@selectedRow">
```

- Added a new hyperlink labeled **Select**. This link sends the selected instructor's ID to the `Index` method and sets a background color.

```
<a asp-action="Index" asp-route-id="@item.ID">Select</a> |
```

Run the app and select the **Instructors** tab. The page displays the `Location` (office) from the related `OfficeAssignment` entity. If `OfficeAssignment`` is null, an empty table cell is displayed.

Last Name	First Name	Hire Date	Office	Courses
Abercrombie	Kim	1995-03-11		2021 Composition 2042 Literature
Fakhouri	Fadi	2002-07-06	Smith 17	1045 Calculus

Click on the **Select** link. The row style changes.

### Add courses taught by selected instructor

Update the `OnGetAsync` method in `Pages/Instructors/Index.cshtml.cs` with the following code:

```
public async Task OnGetAsync(int? id, int? courseID)
{
    Instructor = new InstructorIndexData();
    Instructor.Instructors = await _context.Instructors
        .Include(i => i.OfficeAssignment)
        .Include(i => i.CourseAssignments)
        .ThenInclude(i => i.Course)
        .ThenInclude(i => i.Department)
        .AsNoTracking()
        .OrderBy(i => i.LastName)
        .ToListAsync();

    if (id != null)
    {
        InstructorID = id.Value;
        Instructor instructor = Instructor.Instructors.Where(
            i => i.ID == id.Value).Single();
        Instructor.Courses = instructor.CourseAssignments.Select(s => s.Course);
    }

    if (courseID != null)
    {
        CourseID = courseID.Value;
        Instructor.Enrollments = Instructor.Courses.Where(
            x => x.CourseID == courseID).Single().Enrollments;
    }
}
```

Add `public int CourseID { get; set; }`

```

public class IndexModel : PageModel
{
    private readonly ContosoUniversity.Data.SchoolContext _context;

    public IndexModel(ContosoUniversity.Data.SchoolContext context)
    {
        _context = context;
    }

    public InstructorIndexData Instructor { get; set; }
    public int InstructorID { get; set; }
    public int CourseID { get; set; }

    public async Task OnGetAsync(int? id, int? courseID)
    {
        Instructor = new InstructorIndexData();
        Instructor.Instructors = await _context.Instructors
            .Include(i => i.OfficeAssignment)
            .Include(i => i.CourseAssignments)
            .ThenInclude(i => i.Course)
            .ThenInclude(i => i.Department)
            .AsNoTracking()
            .OrderBy(i => i.LastName)
            .ToListAsync();

        if (id != null)
        {
            InstructorID = id.Value;
            Instructor.instructor = Instructor.Instructors.Where(
                i => i.ID == id.Value).Single();
            Instructor.Courses = instructor.CourseAssignments.Select(s => s.Course);
        }

        if (courseID != null)
        {
            CourseID = courseID.Value;
            Instructor.Enrollments = Instructor.Courses.Where(
                x => x.CourseID == courseID).Single().Enrollments;
        }
    }
}

```

Examine the updated query:

```

Instructor.Instructors = await _context.Instructors
    .Include(i => i.OfficeAssignment)
    .Include(i => i.CourseAssignments)
    .ThenInclude(i => i.Course)
    .ThenInclude(i => i.Department)
    .AsNoTracking()
    .OrderBy(i => i.LastName)
    .ToListAsync();

```

The preceding query adds the `Department` entities.

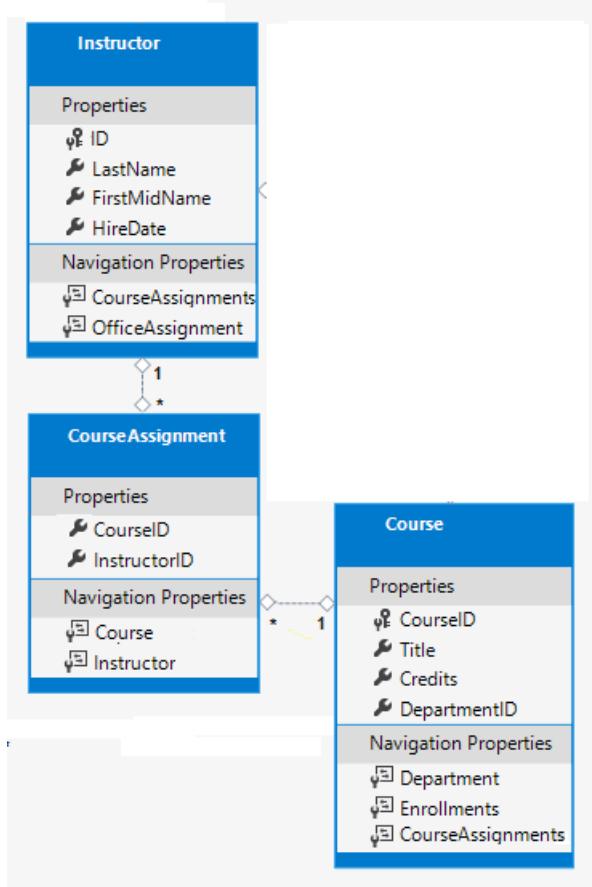
The following code executes when an instructor is selected (`id != null`). The selected instructor is retrieved from the list of instructors in the view model. The view model's `Courses` property is loaded with the `course` entities from that instructor's `CourseAssignments` navigation property.

```

if (id != null)
{
    InstructorID = id.Value;
    Instructor instructor = Instructor.Instructors.Where(
        i => i.ID == id.Value).Single();
    Instructor.Courses = instructor.CourseAssignments.Select(s => s.Course);
}

```

The `Where` method returns a collection. In the preceding `Where` method, only a single `Instructor` entity is returned. The `Single` method converts the collection into a single `Instructor` entity. The `Instructor` entity provides access to the `CourseAssignments` property. `CourseAssignments` provides access to the related `Course` entities.



The `Single` method is used on a collection when the collection has only one item. The `Single` method throws an exception if the collection is empty or if there's more than one item. An alternative is `SingleOrDefault`, which returns a default value (null in this case) if the collection is empty. Using `SingleOrDefault` on an empty collection:

- Results in an exception (from trying to find a `Courses` property on a null reference).
- The exception message would less clearly indicate the cause of the problem.

The following code populates the view model's `Enrollments` property when a course is selected:

```

if (courseID != null)
{
    CourseID = courseID.Value;
    Instructor.Enrollments = Instructor.Courses.Where(
        x => x.CourseID == courseID).Single().Enrollments;
}

```

Add the following markup to the end of the `Pages/Instructors/Index.cshtml` Razor Page:

```

        <a href="#" asp-page="./Delete" asp-route-id="@item.ID">Delete</a>
    </td>
</tr>
}
</tbody>
</table>

@if (Model.Instructor.Courses != null)
{
    <h3>Courses Taught by Selected Instructor</h3>
    <table class="table">
        <tr>
            <th></th>
            <th>Number</th>
            <th>Title</th>
            <th>Department</th>
        </tr>

        @foreach (var item in Model.Instructor.Courses)
        {
            string selectedRow = "";
            if (item.CourseID == Model.CourseID)
            {
                selectedRow = "success";
            }
            <tr class="@selectedRow">
                <td>
                    @Html.ActionLink("Select", "OnGetAsync",
                        new { courseID = item.CourseID })
                </td>
                <td>
                    @item.CourseID
                </td>
                <td>
                    @item.Title
                </td> <td>
                    @item.Department.Name
                </td>
            </tr>
        }
    </table>
}

```

The preceding markup displays a list of courses related to an instructor when an instructor is selected.

Test the app. Click on a **Select** link on the instructors page.

Last Name	First Name	Hire Date	Office	Courses
Abercrombie	Kim	1995-03-11		2021 Composition 2042 Literature
Fakhouri	Fadi	2002-07-06	Smith 17	1045 Calculus

## Courses Taught by Selected Instructor

	Number	Title	Department
Select	2021	Composition	English
Select	2042	Literature	English

## Show student data

In this section, the app is updated to show the student data for a selected course.

Update the query in the `onGetAsync` method in *Pages/Instructors/Index.cshtml.cs* with the following code:

```
Instructor.Instructors = await _context.Instructors
    .Include(i => i.OfficeAssignment)
    .Include(i => i.CourseAssignments)
    .ThenInclude(i => i.Course)
    .ThenInclude(i => i.Department)
    .Include(i => i.CourseAssignments)
    .ThenInclude(i => i.Course)
    .ThenInclude(i => i.Enrollments)
    .ThenInclude(i => i.Student)
    .AsNoTracking()
    .OrderBy(i => i.LastName)
    .ToListAsync();
```

Update *Pages/Instructors/Index.cshtml*. Add the following markup to the end of the file:

```
@if (Model.Instructor.Enrollments != null)
{
    <h3>
        Students Enrolled in Selected Course
    </h3>
    <table class="table">
        <tr>
            <th>Name</th>
            <th>Grade</th>
        </tr>
        @foreach (var item in Model.Instructor.Enrollments)
        {
            <tr>
                <td>
                    @item.Student.FullName
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Grade)
                </td>
            </tr>
        }
    </table>
}
```

The preceding markup displays a list of the students who are enrolled in the selected course.

Refresh the page and select an instructor. Select a course to see the list of enrolled students and their grades.

Instructors - Contoso Un X

localhost:1234/Instructors/3?courseID=1050&action=OnGetAsync

Contoso University

## Instructors

Create New

Last Name	First Name	Hire Date	Office	Courses	
Abercrombie	Kim	1995-03-11		2021 Composition 2042 Literature	Select   Edit   Details   Delete
Fakhouri	Fadi	2002-07-06	Smith 17	1045 Calculus	Select   Edit   Details   Delete
Harui	Roger	1998-07-01	Gowan 27	1050 Chemistry 3141 Trigonometry	Select   Edit   Details   Delete
Kapoor	Candace	2001-01-15	Thompson 304	1050 Chemistry	Select   Edit   Details   Delete
Zheng	Roger	2004-02-12		4022 Microeconomics 4041 Macroeconomics	Select   Edit   Details   Delete

### Courses Taught by Selected Instructor

	Number	Title	Department
Select	1050	Chemistry	Engineering
Select	3141	Trigonometry	Mathematics

### Students Enrolled in Selected Course

Name	Grade
Alexander, Carson	A
Anand, Arturo	No grade
Barzdukas, Gytis	B

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## Using Single

The `Single` method can pass in the `Where` condition instead of calling the `Where` method separately:

```

public async Task OnGetAsync(int? id, int? courseID)
{
    Instructor = new InstructorIndexData();

    Instructor.Instructors = await _context.Instructors
        .Include(i => i.OfficeAssignment)
        .Include(i => i.CourseAssignments)
        .ThenInclude(i => i.Course)
            .ThenInclude(i => i.Department)
        .Include(i => i.CourseAssignments)
            .ThenInclude(i => i.Course)
                .ThenInclude(i => i.Enrollments)
                    .ThenInclude(i => i.Student)
        .AsNoTracking()
        .OrderBy(i => i.LastName)
        .ToListAsync();

    if (id != null)
    {
        InstructorID = id.Value;
        Instructor instructor = Instructor.Instructors.Single(
            i => i.ID == id.Value);
        Instructor.Courses = instructor.CourseAssignments.Select(
            s => s.Course);
    }

    if (courseID != null)
    {
        CourseID = courseID.Value;
        Instructor.Enrollments = Instructor.Courses.Single(
            x => x.CourseID == courseID).Enrollments;
    }
}

```

The preceding `single` approach provides no benefits over using `where`. Some developers prefer the `single` approach style.

## Explicit loading

The current code specifies eager loading for `Enrollments` and `Students`:

```

Instructor.Instructors = await _context.Instructors
    .Include(i => i.OfficeAssignment)
    .Include(i => i.CourseAssignments)
    .ThenInclude(i => i.Course)
        .ThenInclude(i => i.Department)
    .Include(i => i.CourseAssignments)
        .ThenInclude(i => i.Course)
            .ThenInclude(i => i.Enrollments)
                .ThenInclude(i => i.Student)
    .AsNoTracking()
    .OrderBy(i => i.LastName)
    .ToListAsync();

```

Suppose users rarely want to see enrollments in a course. In that case, an optimization would be to only load the enrollment data if it's requested. In this section, the `OnGetAsync` is updated to use explicit loading of `Enrollments` and `Students`.

Update the `OnGetAsync` with the following code:

```

public async Task OnGetAsync(int? id, int? courseID)
{
    Instructor = new InstructorIndexData();
    Instructor.Instructors = await _context.Instructors
        .Include(i => i.OfficeAssignment)
        .Include(i => i.CourseAssignments)
        .ThenInclude(i => i.Course)
        .ThenInclude(i => i.Department)
        // .Include(i => i.CourseAssignments)
        //     .ThenInclude(i => i.Course)
        //         .ThenInclude(i => i.Enrollments)
        //             .ThenInclude(i => i.Student)
        // .AsNoTracking()
        .OrderBy(i => i.LastName)
        .ToListAsync();

    if (id != null)
    {
        InstructorID = id.Value;
        Instructor instructor = Instructor.Instructors.Where(
            i => i.ID == id.Value).Single();
        Instructor.Courses = instructor.CourseAssignments.Select(s => s.Course);
    }

    if (courseID != null)
    {
        CourseID = courseID.Value;
        var selectedCourse = Instructor.Courses.Where(x => x.CourseID == courseID).Single();
        await _context.Entry(selectedCourse).Collection(x => x.Enrollments).LoadAsync();
        foreach (Enrollment enrollment in selectedCourse.Enrollments)
        {
            await _context.Entry(enrollment).Reference(x => x.Student).LoadAsync();
        }
        Instructor.Enrollments = selectedCourse.Enrollments;
    }
}

```

The preceding code drops the `ThenInclude` method calls for enrollment and student data. If a course is selected, the highlighted code retrieves:

- The `Enrollment` entities for the selected course.
- The `Student` entities for each `Enrollment`.

Notice the preceding code comments out `.AsNoTracking()`. Navigation properties can only be explicitly loaded for tracked entities.

Test the app. From a users perspective, the app behaves identically to the previous version.

The next tutorial shows how to update related data.

# Razor Pages with EF Core in ASP.NET Core - Update Related Data - 7 of 8

6/21/2018 • 16 minutes to read • [Edit Online](#)

By [Tom Dykstra](#), and [Rick Anderson](#)

The Contoso University web app demonstrates how to create Razor Pages web apps using EF Core and Visual Studio. For information about the tutorial series, see [the first tutorial](#).

This tutorial demonstrates updating related data. If you run into problems you can't solve, download the [completed app for this stage](#).

The following illustrations shows some of the completed pages.

A screenshot of a web browser window displaying an 'Edit' page for a course. The browser's address bar shows 'localhost:58'. The page title is 'Contoso University'. The main content area has a heading 'Edit' and a sub-heading 'Course'. There are four form fields: 'Number' (value: 1000), 'Title' (value: Algebra 2), 'Credits' (value: 5), and 'Department' (dropdown menu showing 'Mathematics'). A 'Save' button is at the bottom left. The browser interface includes standard controls like back, forward, and search.

The screenshot shows a web browser window titled "Edit - Contoso University". The address bar displays "localhost:5813/Instruct". The main content area is titled "Edit" and has a sub-section "Instructor". It contains the following form fields:

- Last Name:** Abercrombie
- First Name:** Kim
- Hire Date:** 3/11/1995
- Office Location:** 44/3P

Below these fields is a list of course checkboxes:

<input type="checkbox"/> 1000 Algebra 2	<input type="checkbox"/> 1045 Calculus	<input type="checkbox"/> 1050 Chemistry
<input checked="" type="checkbox"/> 2021 Composition	<input checked="" type="checkbox"/> 2042 Literature	<input type="checkbox"/> 3141 Trigonometry
<input type="checkbox"/> 4022 Microeconomics	<input type="checkbox"/> 4041 Macroeconomics	

A "Save" button is located at the bottom left of the form.

Examine and test the Create and Edit course pages. Create a new course. The department is selected by its primary key (an integer), not its name. Edit the new course. When you have finished testing, delete the new course.

## Create a base class to share common code

The Courses/Create and Courses/Edit pages each need a list of department names. Create the *Pages/Courses/DepartmentNamePageModel.cshtml.cs* base class for the Create and Edit pages:

```

using ContosoUniversity.Data;
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.AspNetCore.Mvc.Rendering;
using Microsoft.EntityFrameworkCore;
using System.Linq;

namespace ContosoUniversity.Pages.Courses
{
    public class DepartmentNamePageModel : PageModel
    {
        public SelectList DepartmentNameSL { get; set; }

        public void PopulateDepartmentsDropDownList(SchoolContext _context,
            object selectedDepartment = null)
        {
            var departmentsQuery = from d in _context.Departments
                orderby d.Name // Sort by name.
                select d;

            DepartmentNameSL = new SelectList(departmentsQuery.AsNoTracking(),
                "DepartmentID", "Name", selectedDepartment);
        }
    }
}

```

The preceding code creates a `SelectList` to contain the list of department names. If `selectedDepartment` is specified, that department is selected in the `SelectList`.

The Create and Edit page model classes will derive from `DepartmentNamePageModel`.

## Customize the Courses Pages

When a new course entity is created, it must have a relationship to an existing department. To add a department while creating a course, the base class for Create and Edit contains a drop-down list for selecting the department. The drop-down list sets the `Course.DepartmentID` foreign key (FK) property. EF Core uses the `Course.DepartmentID` FK to load the `Department` navigation property.

Screenshot of a web browser showing the 'Create' page for a 'Course'. The URL is 'localhost:1234/Courses/Create'. The page title is 'Create DepartmentName'. The page header says 'Contoso University'. The main content area has a heading 'Create' and a sub-heading 'Course'. There are four input fields: 'Number' (value: 1003), 'Title' (value: Algebra 2), 'Credits' (value: 3), and a 'Department' dropdown menu. The 'Department' dropdown is highlighted with a red border. It contains the following options: '-- Select Department --', 'Economics', 'Engineering', 'English', and 'Mathematics'. The option '-- Select Department --' is currently selected.

Number  
1003

Title  
Algebra 2

Credits  
3

Department

-- Select Department --

-- Select Department --

Economics

Engineering

English

Mathematics

Update the Create page model with the following code:

```

using ContosoUniversity.Models;
using Microsoft.AspNetCore.Mvc;
using System.Threading.Tasks;

namespace ContosoUniversity.Pages.Courses
{
    public class CreateModel : DepartmentNamePageModel
    {
        private readonly ContosoUniversity.Data.SchoolContext _context;

        public CreateModel(ContosoUniversity.Data.SchoolContext context)
        {
            _context = context;
        }

        public IActionResult OnGet()
        {
            PopulateDepartmentsDropDownList(_context);
            return Page();
        }

        [BindProperty]
        public Course Course { get; set; }

        public async Task<IActionResult> OnPostAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            var emptyCourse = new Course();

            if (await TryUpdateModelAsync<Course>(
                emptyCourse,
                "course", // Prefix for form value.
                s => s.CourseID, s => s.DepartmentID, s => s.Title, s => s.Credits))
            {
                _context.Courses.Add(emptyCourse);
                await _context.SaveChangesAsync();
                return RedirectToPage("./Index");
            }

            // Select DepartmentID if TryUpdateModelAsync fails.
            PopulateDepartmentsDropDownList(_context, emptyCourse.DepartmentID);
            return Page();
        }
    }
}

```

The preceding code:

- Derives from `DepartmentNamePageModel`.
- Uses `TryUpdateModelAsync` to prevent [overposting](#).
- Replaces `ViewData["DepartmentID"]` with `DepartmentNameSL` (from the base class).

`ViewData["DepartmentID"]` is replaced with the strongly typed `DepartmentNameSL`. Strongly typed models are preferred over weakly typed. For more information, see [Weakly typed data \(ViewData and ViewBag\)](#).

## Update the Courses Create page

Update `Pages/Courses/Create.cshtml` with the following markup:

```

@page
@model ContosoUniversity.Pages.Courses.CreateModel
 @{
     ViewData["Title"] = "Create Course";
 }
<h2>Create</h2>
<h4>Course</h4>
<hr />
<div class="row">
    <div class="col-md-4">
        <form method="post">
            <div asp-validation-summary="ModelOnly" class="text-danger"></div>
            <div class="form-group">
                <label asp-for="Course.CourseID" class="control-label"></label>
                <input asp-for="Course.CourseID" class="form-control" />
                <span asp-validation-for="Course.CourseID" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Course.Title" class="control-label"></label>
                <input asp-for="Course.Title" class="form-control" />
                <span asp-validation-for="Course.Title" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Course.Credits" class="control-label"></label>
                <input asp-for="Course.Credits" class="form-control" />
                <span asp-validation-for="Course.Credits" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Course.Department" class="control-label"></label>
                <select asp-for="Course.DepartmentID" class="form-control" asp-items="@Model.DepartmentNameSL">
                    <option value="">-- Select Department --</option>
                </select>
                <span asp-validation-for="Course.DepartmentID" class="text-danger" />
            </div>
            <div class="form-group">
                <input type="submit" value="Create" class="btn btn-default" />
            </div>
        </form>
    </div>
</div>
<a asp-page="Index">Back to List</a>
</div>
@section Scripts {
    @{await Html.RenderPartialAsync("_ValidationScriptsPartial");}
}

```

The preceding markup makes the following changes:

- Changes the caption from **DepartmentID** to **Department**.
- Replaces `"ViewBag.DepartmentID"` with `DepartmentNamesL` (from the base class).
- Adds the "Select Department" option. This change renders "Select Department" rather than the first department.
- Adds a validation message when the department isn't selected.

The Razor Page uses the [Select Tag Helper](#):

```
<div class="form-group">
    <label asp-for="Course.Department" class="control-label"></label>
    <select asp-for="Course.DepartmentID" class="form-control"
        asp-items="@Model.DepartmentNameSL">
        <option value="">-- Select Department --</option>
    </select>
    <span asp-validation-for="Course.DepartmentID" class="text-danger" />
</div>
```

Test the Create page. The Create page displays the department name rather than the department ID.

### **Update the Courses Edit page.**

Update the edit page model with the following code:

```

using ContosoUniversity.Models;
using Microsoft.AspNetCore.Mvc;
using Microsoft.EntityFrameworkCore;
using System.Threading.Tasks;

namespace ContosoUniversity.Pages.Courses
{
    public class EditModel : DepartmentNamePageModel
    {
        private readonly ContosoUniversity.Data.SchoolContext _context;

        public EditModel(ContosoUniversity.Data.SchoolContext context)
        {
            _context = context;
        }

        [BindProperty]
        public Course Course { get; set; }

        public async Task<IActionResult> OnGetAsync(int? id)
        {
            if (id == null)
            {
                return NotFound();
            }

            Course = await _context.Courses
                .Include(c => c.Department).FirstOrDefaultAsync(m => m.CourseID == id);

            if (Course == null)
            {
                return NotFound();
            }

            // Select current DepartmentID.
            PopulateDepartmentsDropDownList(_context, Course.DepartmentID);
            return Page();
        }

        public async Task<IActionResult> OnPostAsync(int? id)
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            var courseToUpdate = await _context.Courses.FindAsync(id);

            if (await TryUpdateModelAsync<Course>(
                courseToUpdate,
                "course", // Prefix for form value.
                c => c.Credits, c => c.DepartmentID, c => c.Title))
            {
                await _context.SaveChangesAsync();
                return RedirectToPage("./Index");
            }

            // Select DepartmentID if TryUpdateModelAsync fails.
            PopulateDepartmentsDropDownList(_context, courseToUpdate.DepartmentID);
            return Page();
        }
    }
}

```

The changes are similar to those made in the Create page model. In the preceding code,

`PopulateDepartmentsDropDownList` passes in the department ID, which select the department specified in the drop-

down list.

Update *Pages/Courses/Edit.cshtml* with the following markup:

```
@page
@model ContosoUniversity.Pages.Courses.EditModel

@{
    ViewData["Title"] = "Edit";
}

<h2>Edit</h2>

<h4>Course</h4>
<hr />


<div class="col-md-4">
        <form method="post">
            <div asp-validation-summary="ModelOnly" class="text-danger"></div>
            <input type="hidden" asp-for="Course.CourseID" />
            <div class="form-group">
                <label asp-for="Course.CourseID" class="control-label"></label>
                <div>@Html.DisplayFor(model => model.Course.CourseID)</div>
            </div>
            <div class="form-group">
                <label asp-for="Course.Title" class="control-label"></label>
                <input asp-for="Course.Title" class="form-control" />
                <span asp-validation-for="Course.Title" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Course.Credits" class="control-label"></label>
                <input asp-for="Course.Credits" class="form-control" />
                <span asp-validation-for="Course.Credits" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Course.Department" class="control-label"></label>
                <select asp-for="Course.DepartmentID" class="form-control" asp-items="@Model.DepartmentNameSL"></select>
                <span asp-validation-for="Course.DepartmentID" class="text-danger"></span>
            </div>
            <div class="form-group">
                <input type="submit" value="Save" class="btn btn-default" />
            </div>
        </form>
    </div>



The preceding markup makes the following changes:



- Displays the course ID. Generally the Primary Key (PK) of an entity isn't displayed. PKs are usually meaningless to users. In this case, the PK is the course number.
- Changes the caption from DepartmentID to Department.
- Replaces "ViewBag.DepartmentID" with DepartmentNameSL (from the base class).



The page contains a hidden field (<input type="hidden">) for the course number. Adding a <label> tag helper with asp-for="Course.CourseID" doesn't eliminate the need for the hidden field. <input type="hidden"> is required


```

for the course number to be included in the posted data when the user clicks **Save**.

Test the updated code. Create, edit, and delete a course.

## Add `AsNoTracking` to the Details and Delete page models

`AsNoTracking` can improve performance when tracking isn't required. Add `AsNoTracking` to the Delete and Details page model. The following code shows the updated Delete page model:

```
public class DeleteModel : PageModel
{
    private readonly ContosoUniversity.Data.SchoolContext _context;

    public DeleteModel(ContosoUniversity.Data.SchoolContext context)
    {
        _context = context;
    }

    [BindProperty]
    public Course Course { get; set; }

    public async Task<IActionResult> OnGetAsync(int? id)
    {
        if (id == null)
        {
            return NotFound();
        }

        Course = await _context.Courses
            .AsNoTracking()
            .Include(c => c.Department)
            .FirstOrDefaultAsync(m => m.CourseID == id);

        if (Course == null)
        {
            return NotFound();
        }
        return Page();
    }

    public async Task<IActionResult> OnPostAsync(int? id)
    {
        if (id == null)
        {
            return NotFound();
        }

        Course = await _context.Courses
            .AsNoTracking()
            .FirstOrDefaultAsync(m => m.CourseID == id);

        if (Course != null)
        {
            _context.Courses.Remove(Course);
            await _context.SaveChangesAsync();
        }

        return RedirectToPage("./Index");
    }
}
```

Update the `OnGetAsync` method in the *Pages/Courses/Details.cshtml.cs* file:

```
public async Task<IActionResult> OnGetAsync(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    Course = await _context.Courses
        .AsNoTracking()
        .Include(c => c.Department)
        .FirstOrDefaultAsync(m => m.CourseID == id);

    if (Course == null)
    {
        return NotFound();
    }
    return Page();
}
```

## Modify the Delete and Details pages

Update the Delete Razor page with the following markup:

```

@page
@model ContosoUniversity.Pages.Courses.DeleteModel

 @{
     ViewData["Title"] = "Delete";
 }

<h2>Delete</h2>

<h3>Are you sure you want to delete this?</h3>
<div>
    <h4>Course</h4>
    <hr />
    <dl class="dl-horizontal">
        <dt>
            @Html.DisplayNameFor(model => model.Course.CourseID)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Course.CourseID)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Course.Title)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Course.Title)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Course.Credits)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Course.Credits)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Course.Department)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Course.Department.DepartmentID)
        </dd>
    </dl>

    <form method="post">
        <input type="hidden" asp-for="Course.CourseID" />
        <input type="submit" value="Delete" class="btn btn-default" /> |
        <a asp-page="./Index">Back to List</a>
    </form>
</div>

```

Make the same changes to the Details page.

## Test the Course pages

Test create, edit, details, and delete.

## Update the instructor pages

The following sections update the instructor pages.

### Add office location

When editing an instructor record, you may want to update the instructor's office assignment. The `Instructor` entity has a one-to-zero-or-one relationship with the `OfficeAssignment` entity. The instructor code must handle:

- If the user clears the office assignment, delete the `OfficeAssignment` entity.
- If the user enters an office assignment and it was empty, create a new `OfficeAssignment` entity.

- If the user changes the office assignment, update the `OfficeAssignment` entity.

Update the instructors Edit page model with the following code:

```
public class EditModel : PageModel
{
    private readonly ContosoUniversity.Data.SchoolContext _context;

    public EditModel(ContosoUniversity.Data.SchoolContext context)
    {
        _context = context;
    }

    [BindProperty]
    public Instructor Instructor { get; set; }

    public async Task<IActionResult> OnGetAsync(int? id)
    {
        if (id == null)
        {
            return NotFound();
        }

        Instructor = await _context.Instructors
            .Include(i => i.OfficeAssignment)
            .AsNoTracking()
            .FirstOrDefaultAsync(m => m.ID == id);

        if (Instructor == null)
        {
            return NotFound();
        }
        return Page();
    }

    public async Task<IActionResult> OnPostAsync(int? id)
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        var instructorToUpdate = await _context.Instructors
            .Include(i => i.OfficeAssignment)
            .FirstOrDefaultAsync(s => s.ID == id);

        if (await TryUpdateModelAsync<Instructor>(
            instructorToUpdate,
            "Instructor",
            i => i.FirstMidName, i => i.LastName,
            i => i.HireDate, i => i.OfficeAssignment))
        {
            if (String.IsNullOrWhiteSpace(
                instructorToUpdate.OfficeAssignment?.Location))
            {
                instructorToUpdate.OfficeAssignment = null;
            }
            await _context.SaveChangesAsync();
        }
        return RedirectToPage("./Index");
    }
}
```

The preceding code:

- Gets the current `Instructor` entity from the database using eager loading for the `OfficeAssignment` navigation property.
- Updates the retrieved `Instructor` entity with values from the model binder. `TryUpdateModel` prevents **overposting**.
- If the office location is blank, sets `Instructor.OfficeAssignment` to null. When `Instructor.OfficeAssignment` is null, the related row in the `OfficeAssignment` table is deleted.

## Update the instructor Edit page

Update `Pages/Instructors/Edit.cshtml` with the office location:

```

@page
@model ContosoUniversity.Pages.Instructors.EditModel
 @{
    ViewData["Title"] = "Edit";
}
<h2>Edit</h2>
<h4>Instructor</h4>
<hr />
<div class="row">
    <div class="col-md-4">
        <form method="post">
            <div asp-validation-summary="ModelOnly" class="text-danger"></div>
            <input type="hidden" asp-for="Instructor.ID" />
            <div class="form-group">
                <label asp-for="Instructor.LastName" class="control-label"></label>
                <input asp-for="Instructor.LastName" class="form-control" />
                <span asp-validation-for="Instructor.LastName" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Instructor.FirstMidName" class="control-label"></label>
                <input asp-for="Instructor.FirstMidName" class="form-control" />
                <span asp-validation-for="Instructor.FirstMidName" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Instructor.HireDate" class="control-label"></label>
                <input asp-for="Instructor.HireDate" class="form-control" />
                <span asp-validation-for="Instructor.HireDate" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Instructor.OfficeAssignment.Location" class="control-label"></label>
                <input asp-for="Instructor.OfficeAssignment.Location" class="form-control" />
                <span asp-validation-for="Instructor.OfficeAssignment.Location" class="text-danger" />
            </div>
            <div class="form-group">
                <input type="submit" value="Save" class="btn btn-default" />
            </div>
        </form>
    </div>
</div>
<div>
    <a asp-page=".~/Index">Back to List</a>
</div>

@section Scripts {
    @{await Html.RenderPartialAsync("_ValidationScriptsPartial");}
}

```

Verify you can change an instructors office location.

## Add Course assignments to the instructor Edit page

Instructors may teach any number of courses. In this section, you add the ability to change course assignments.

The following image shows the updated instructor Edit page:

Last Name  
Abercrombie

First Name  
Kim

Hire Date  
3/11/1995

Office Location  
44/3P

1000 Algebra 2    1045 Calculus    1050 Chemistry  
 2021 Composition    2042 Literature    3141 Trigonometry  
 4022 Microeconomics    4041 Macroeconomics

Save

`Course` and `Instructor` has a many-to-many relationship. To add and remove relationships, you add and remove entities from the `CourseAssignments` join entity set.

Check boxes enable changes to courses an instructor is assigned to. A check box is displayed for every course in the database. Courses that the instructor is assigned to are checked. The user can select or clear check boxes to change course assignments. If the number of courses were much greater:

- You'd probably use a different user interface to display the courses.
- The method of manipulating a join entity to create or delete relationships wouldn't change.

#### Add classes to support Create and Edit instructor pages

Create `SchoolViewModels/AssignedCourseData.cs` with the following code:

```
namespace ContosoUniversity.Models.SchoolViewModels
{
    public class AssignedCourseData
    {
        public int CourseID { get; set; }
        public string Title { get; set; }
        public bool Assigned { get; set; }
    }
}
```

The `AssignedCourseData` class contains data to create the check boxes for assigned courses by an instructor.

Create the *Pages/Instructors/InstructorCoursesPageModel.cshtml.cs* base class:

```
using ContosoUniversity.Data;
using ContosoUniversity.Models;
using ContosoUniversity.Models.SchoolViewModels;
using Microsoft.AspNetCore.Mvc.RazorPages;
using System.Collections.Generic;
using System.Linq;

namespace ContosoUniversity.Pages.Instructors
{
    public class InstructorCoursesPageModel : PageModel
    {

        public List<AssignedCourseData> AssignedCourseDataList;

        public void PopulateAssignedCourseData(SchoolContext context,
                                              Instructor instructor)
        {
            var allCourses = context.Courses;
            var instructorCourses = new HashSet<int>(
                instructor.CourseAssignments.Select(c => c.CourseID));
            AssignedCourseDataList = new List<AssignedCourseData>();
            foreach (var course in allCourses)
            {
                AssignedCourseDataList.Add(new AssignedCourseData
                {
                    CourseID = course.CourseID,
                    Title = course.Title,
                    Assigned = instructorCourses.Contains(course.CourseID)
                });
            }
        }

        public void UpdateInstructorCourses(SchoolContext context,
                                            string[] selectedCourses, Instructor instructorToUpdate)
        {
            if (selectedCourses == null)
            {
                instructorToUpdate.CourseAssignments = new List<CourseAssignment>();
                return;
            }

            var selectedCoursesHS = new HashSet<string>(selectedCourses);
            var instructorCourses = new HashSet<int>(
                (instructorToUpdate.CourseAssignments.Select(c => c.Course.CourseID)));
            foreach (var course in context.Courses)
            {
                if (selectedCoursesHS.Contains(course.CourseID.ToString()))
                {
                    if (!instructorCourses.Contains(course.CourseID))
                    {
                        instructorToUpdate.CourseAssignments.Add(
                            new CourseAssignment
                            {
                                InstructorID = instructorToUpdate.ID,
                                CourseID = course.CourseID
                            });
                    }
                }
                else
                {
                    if (instructorCourses.Contains(course.CourseID))
                    {
                        CourseAssignment courseToRemove
                            = instructorToUpdate
                                .CourseAssignments
                                .SingleOrDefault(i => i.CourseID == course.CourseID);
                    }
                }
            }
        }
    }
}
```

```
        context.Remove(courseToRemove);
    }
}
}
}
}
```

The `InstructorCoursesPageModel` is the base class you will use for the Edit and Create page models.

`PopulateAssignedCourseData` reads all `Course` entities to populate `AssignedCourseDataList`. For each course, the code sets the `CourseID`, title, and whether or not the instructor is assigned to the course. A `HashSet` is used to create efficient lookups.

### Instructors Edit page model

Update the instructor Edit page model with the following code:

```

public class EditModel : InstructorCoursesPageModel
{
    private readonly ContosoUniversity.Data.SchoolContext _context;

    public EditModel(ContosoUniversity.Data.SchoolContext context)
    {
        _context = context;
    }

    [BindProperty]
    public Instructor Instructor { get; set; }

    public async Task<IActionResult> OnGetAsync(int? id)
    {
        if (id == null)
        {
            return NotFound();
        }

        Instructor = await _context.Instructors
            .Include(i => i.OfficeAssignment)
            .Include(i => i.CourseAssignments).ThenInclude(i => i.Course)
            .AsNoTracking()
            .FirstOrDefaultAsync(m => m.ID == id);

        if (Instructor == null)
        {
            return NotFound();
        }
        PopulateAssignedCourseData(_context, Instructor);
        return Page();
    }

    public async Task<IActionResult> OnPostAsync(int? id, string[] selectedCourses)
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        var instructorToUpdate = await _context.Instructors
            .Include(i => i.OfficeAssignment)
            .Include(i => i.CourseAssignments)
            .ThenInclude(i => i.Course)
            .FirstOrDefaultAsync(s => s.ID == id);

        if (await TryUpdateModelAsync<Instructor>(
            instructorToUpdate,
            "Instructor",
            i => i.FirstMidName, i => i.LastName,
            i => i.HireDate, i => i.OfficeAssignment))
        {
            if (String.IsNullOrWhiteSpace(
                instructorToUpdate.OfficeAssignment?.Location))
            {
                instructorToUpdate.OfficeAssignment = null;
            }
            UpdateInstructorCourses(_context, selectedCourses, instructorToUpdate);
            await _context.SaveChangesAsync();
            return RedirectToPage("./Index");
        }
        UpdateInstructorCourses(_context, selectedCourses, instructorToUpdate);
        PopulateAssignedCourseData(_context, instructorToUpdate);
        return Page();
    }
}

```

The preceding code handles office assignment changes.

Update the instructor Razor View:

```
@page
@model ContosoUniversity.Pages.Instructors.EditModel
 @{
    ViewData["Title"] = "Edit";
}
<h2>Edit</h2>
<h4>Instructor</h4>
<hr />


<div class="col-md-4">
        <form method="post">
            <div asp-validation-summary="ModelOnly" class="text-danger"></div>
            <input type="hidden" asp-for="Instructor.ID" />
            <div class="form-group">
                <label asp-for="Instructor.LastName" class="control-label"></label>
                <input asp-for="Instructor.LastName" class="form-control" />
                <span asp-validation-for="Instructor.LastName" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Instructor.FirstMidName" class="control-label"></label>
                <input asp-for="Instructor.FirstMidName" class="form-control" />
                <span asp-validation-for="Instructor.FirstMidName" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Instructor.HireDate" class="control-label"></label>
                <input asp-for="Instructor.HireDate" class="form-control" />
                <span asp-validation-for="Instructor.HireDate" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Instructor.OfficeAssignment.Location" class="control-label"></label>
                <input asp-for="Instructor.OfficeAssignment.Location" class="form-control" />
                <span asp-validation-for="Instructor.OfficeAssignment.Location" class="text-danger" />
            </div>
            <div class="form-group">
                <div class="col-md-offset-2 col-md-10">
                    <table>
                        <tr>
                            @{
                                int cnt = 0;

                                foreach (var course in Model.AssignedCourseDataList)
                                {
                                    if (cnt++ % 3 == 0)
                                    {
                                        @:</tr><tr>
                                    }
                                    @:<td>
                                        <input type="checkbox"
                                                name="selectedCourses"
                                                value="@course.CourseID"
                                                @(Html.Raw(course.Assigned ? "checked=\"checked\"" : ""))
                                                @course.CourseID @: @course.Title
                                    @:</td>
                                }
                                @:</tr>
                            }
                        </table>
                </div>
            <div class="form-group">
                <input type="submit" value="Save" class="btn btn-default" />
            </div>
        </form>
    </div>


```

```

</div>

<div>
    <a asp-page=".~/Index">Back to List</a>
</div>

@section Scripts {
    @{await Html.RenderPartialAsync("_ValidationScriptsPartial");}
}

```

#### **NOTE**

When you paste the code in Visual Studio, line breaks are changed in a way that breaks the code. Press Ctrl+Z one time to undo the automatic formatting. Ctrl+Z fixes the line breaks so that they look like what you see here. The indentation doesn't have to be perfect, but the `@</tr><tr>`, `@:<td>`, `@:</td>`, and `@:</tr>` lines must each be on a single line as shown. With the block of new code selected, press Tab three times to line up the new code with the existing code. Vote on or review the status of this bug [with this link](#).

The preceding code creates an HTML table that has three columns. Each column has a check box and a caption containing the course number and title. The check boxes all have the same name ("selectedCourses"). Using the same name informs the model binder to treat them as a group. The value attribute of each check box is set to `CourseID`. When the page is posted, the model binder passes an array that consists of the `CourseID` values for only the check boxes that are selected.

When the check boxes are initially rendered, courses assigned to the instructor have checked attributes.

Run the app and test the updated instructors Edit page. Change some course assignments. The changes are reflected on the Index page.

Note: The approach taken here to edit instructor course data works well when there's a limited number of courses. For collections that are much larger, a different UI and a different updating method would be more useable and efficient.

#### **Update the instructors Create page**

Update the instructor Create page model with the following code:

```

using ContosoUniversity.Models;
using Microsoft.AspNetCore.Mvc;
using System.Collections.Generic;
using System.Threading.Tasks;

namespace ContosoUniversity.Pages.Instructors
{
    public class CreateModel : InstructorCoursesPageModel
    {
        private readonly ContosoUniversity.Data.SchoolContext _context;

        public CreateModel(ContosoUniversity.Data.SchoolContext context)
        {
            _context = context;
        }

        public IActionResult OnGet()
        {
            var instructor = new Instructor();
            instructor.CourseAssignments = new List<CourseAssignment>();

            // Provides an empty collection for the foreach loop
            // foreach (var course in Model.AssignedCourseDataList)
            // in the Create Razor page.
            PopulateAssignedCourseData( context, instructor);
        }
    }
}

```

```

        return Page();
    }

    [BindProperty]
    public Instructor Instructor { get; set; }

    public async Task<IActionResult> OnPostAsync(string[] selectedCourses)
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        var newInstructor = new Instructor();
        if (selectedCourses != null)
        {
            newInstructor.CourseAssignments = new List<CourseAssignment>();
            foreach (var course in selectedCourses)
            {
                var courseToAdd = new CourseAssignment
                {
                    CourseID = int.Parse(course)
                };
                newInstructor.CourseAssignments.Add(courseToAdd);
            }
        }

        if (await TryUpdateModelAsync<Instructor>(
            newInstructor,
            "Instructor",
            i => i.FirstMidName, i => i.LastName,
            i => i.HireDate, i => i.OfficeAssignment))
        {
            _context.Instructors.Add(newInstructor);
            await _context.SaveChangesAsync();
            return RedirectToPage("./Index");
        }
        PopulateAssignedCourseData(_context, newInstructor);
        return Page();
    }
}
}
}

```

The preceding code is similar to the *Pages/Instructors/Edit.cshtml.cs* code.

Update the instructor Create Razor page with the following markup:

```

@page
@model ContosoUniversity.Pages.Instructors.CreateModel

 @{
     ViewData["Title"] = "Create";
 }

<h2>Create</h2>

<h4>Instructor</h4>
<hr />
<div class="row">
    <div class="col-md-4">
        <form method="post">
            <div asp-validation-summary="ModelOnly" class="text-danger"></div>
            <div class="form-group">
                <label asp-for="Instructor.LastName" class="control-label"></label>
                <input asp-for="Instructor.LastName" class="form-control" />
                <span asp-validation-for="Instructor.LastName" class="text-danger"></span>
            </div>
    </div>

```

```

<div class="form-group">
    <label asp-for="Instructor.FirstMidName" class="control-label"></label>
    <input asp-for="Instructor.FirstMidName" class="form-control" />
    <span asp-validation-for="Instructor.FirstMidName" class="text-danger"></span>
</div>
<div class="form-group">
    <label asp-for="Instructor.HireDate" class="control-label"></label>
    <input asp-for="Instructor.HireDate" class="form-control" />
    <span asp-validation-for="Instructor.HireDate" class="text-danger"></span>
</div>

<div class="form-group">
    <label asp-for="Instructor.OfficeAssignment.Location" class="control-label"></label>
    <input asp-for="Instructor.OfficeAssignment.Location" class="form-control" />
    <span asp-validation-for="Instructor.OfficeAssignment.Location" class="text-danger" />
</div>
<div class="form-group">
    <div class="col-md-offset-2 col-md-10">
        <table>
            <tr>
                @{
                    int cnt = 0;

                    foreach (var course in Model.AssignedCourseDataList)
                    {
                        if (cnt++ % 3 == 0)
                        {
                            @:</tr><tr>
                        }
                        @:<td>
                            <input type="checkbox"
                                name="selectedCourses"
                                value="@course.CourseID"
                                @(Html.Raw(course.Assigned ? "checked=\"checked\"" : ""))
                                @course.CourseID @: @course.Title
                            @:</td>
                        }
                        @:</tr>
                    }
                </table>
            </div>
        <div class="form-group">
            <input type="submit" value="Create" class="btn btn-default" />
        </div>
    </form>
</div>
</div>

<div>
    <a asp-page="Index">Back to List</a>
</div>

@section Scripts {
    @{await Html.RenderPartialAsync("_ValidationScriptsPartial");}
}

```

Test the instructor Create page.

## Update the Delete page

Update the Delete page model with the following code:

```

using ContosoUniversity.Models;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using System.Linq;
using System.Threading.Tasks;

namespace ContosoUniversity.Pages.Instructors
{
    public class DeleteModel : PageModel
    {
        private readonly ContosoUniversity.Data.SchoolContext _context;

        public DeleteModel(ContosoUniversity.Data.SchoolContext context)
        {
            _context = context;
        }

        [BindProperty]
        public Instructor Instructor { get; set; }

        public async Task<IActionResult> OnGetAsync(int? id)
        {
            if (id == null)
            {
                return NotFound();
            }

            Instructor = await _context.Instructors.SingleAsync(m => m.ID == id);

            if (Instructor == null)
            {
                return NotFound();
            }
            return Page();
        }

        public async Task<IActionResult> OnPostAsync(int id)
        {
            Instructor instructor = await _context.Instructors
                .Include(i => i.CourseAssignments)
                .SingleAsync(i => i.ID == id);

            var departments = await _context.Departments
                .Where(d => d.InstructorID == id)
                .ToListAsync();
            departments.ForEach(d => d.InstructorID = null);

            _context.Instructors.Remove(instructor);

            await _context.SaveChangesAsync();
            return RedirectToPage("./Index");
        }
    }
}

```

The preceding code makes the following changes:

- Uses eager loading for the `CourseAssignments` navigation property. `CourseAssignments` must be included or they aren't deleted when the instructor is deleted. To avoid needing to read them, configure cascade delete in the database.
- If the instructor to be deleted is assigned as administrator of any departments, removes the instructor assignment from those departments.

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en-us/

# Razor Pages with EF Core in ASP.NET Core - Concurrency - 8 of 8

By [Rick Anderson](#), [Tom Dykstra](#), and [Jon P Smith](#)

The Contoso University web app demonstrates how to create Razor Pages web apps using EF Core and Visual Studio. For information about the tutorial series, see [the first tutorial](#).

This tutorial shows how to handle conflicts when multiple users update an entity concurrently (at the same time). If you run into problems you can't solve, download the [completed app for this stage](#).

## Concurrency conflicts

A concurrency conflict occurs when:

- A user navigates to the edit page for an entity.
- Another user updates the same entity before the first user's change is written to the DB.

If concurrency detection isn't enabled, when concurrent updates occur:

- The last update wins. That is, the last update values are saved to the DB.
- The first of the current updates are lost.

### Optimistic concurrency

Optimistic concurrency allows concurrency conflicts to happen, and then reacts appropriately when they do. For example, Jane visits the Department edit page and changes the budget for the English department from \$350,000.00 to \$0.00.

Edit

Department

Budget

Administrator

Name

Start Date

Save

Before Jane clicks **Save**, John visits the same page and changes the Start Date field from 9/1/2007 to 9/1/2013.

Edit

Department

Budget

Administrator

Name

Start Date

Save

Jane clicks **Save** first and sees her change when the browser displays the Index page.

Name	Budget	Administrator	Start Date	
English	\$0.00	Abercrombie, Kim	2007-09-01	Edit   Details   Delete
Mather	\$350,000.00	Eakhouri, Fadi	2007-09-01	Edit   Details   Delete

John clicks **Save** on an Edit page that still shows a budget of \$350,000.00. What happens next is determined by how you handle concurrency conflicts.

Optimistic concurrency includes the following options:

- You can keep track of which property a user has modified and update only the corresponding columns in the DB.

In the scenario, no data would be lost. Different properties were updated by the two users. The next time someone browses the English department, they will see both Jane's and John's changes. This method of updating can reduce the number of conflicts that could result in data loss. This approach:  
\* Can't avoid data loss if competing changes are made to the same property.  
\* Is generally not practical in a web app. It requires maintaining significant state in order to keep track of all fetched values and new values.  
Maintaining large amounts of state can affect app performance.  
\* Can increase app complexity compared to concurrency detection on an entity.

- You can let John's change overwrite Jane's change.

The next time someone browses the English department, they will see 9/1/2013 and the fetched \$350,000.00 value. This approach is called a *Client Wins* or *Last in Wins* scenario. (All values from the client take precedence over what's in the data store.) If you don't do any coding for concurrency handling, Client Wins happens automatically.

- You can prevent John's change from being updated in the DB. Typically, the app would:  
\* Display an error message.  
\* Show the current state of the data.  
\* Allow the user to reapply the changes.

This is called a *Store Wins* scenario. (The data-store values take precedence over the values submitted by the client.) You implement the Store Wins scenario in this tutorial. This method ensures that no changes are overwritten without a user being alerted.

## Handling concurrency

When a property is configured as a [concurrency token](#):

- EF Core verifies that property has not been modified after it was fetched. The check occurs when `SaveChanges` or `SaveChangesAsync` is called.
- If the property has been changed after it was fetched, a `DbUpdateConcurrencyException` is thrown.

The DB and data model must be configured to support throwing `DbUpdateConcurrencyException`.

### Detecting concurrency conflicts on a property

Concurrency conflicts can be detected at the property level with the `ConcurrencyCheck` attribute. The attribute can be applied to multiple properties on the model. For more information, see [Data Annotations-ConcurrencyCheck](#).

The `[ConcurrencyCheck]` attribute isn't used in this tutorial.

### Detecting concurrency conflicts on a row

To detect concurrency conflicts, a `rowversion` tracking column is added to the model. `rowversion` :

- Is SQL Server specific. Other databases may not provide a similar feature.
- Is used to determine that an entity has not been changed since it was fetched from the DB.

The DB generates a sequential `rowversion` number that's incremented each time the row is updated. In an `Update` or `Delete` command, the `Where` clause includes the fetched value of `rowversion`. If the row being updated has changed:

- `rowversion` doesn't match the fetched value.
- The `Update` or `Delete` commands don't find a row because the `Where` clause includes the fetched `rowversion`.
- A `DbUpdateConcurrencyException` is thrown.

In EF Core, when no rows have been updated by an `Update` or `Delete` command, a concurrency exception is thrown.

### Add a tracking property to the Department entity

In `Models/Department.cs`, add a tracking property named RowVersion:

```
using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Department
    {
        public int DepartmentID { get; set; }

        [StringLength(50, MinimumLength = 3)]
        public string Name { get; set; }

        [DataType(DataType.Currency)]
        [Column(TypeName = "money")]
        public decimal Budget { get; set; }

        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        [Display(Name = "Start Date")]
        public DateTime StartDate { get; set; }

        public int? InstructorID { get; set; }

        [Timestamp]
        public byte[] RowVersion { get; set; }

        public Instructor Administrator { get; set; }
        public ICollection<Course> Courses { get; set; }
    }
}
```

The `Timestamp` attribute specifies that this column is included in the `Where` clause of `Update` and `Delete`

commands. The attribute is called `Timestamp` because previous versions of SQL Server used a SQL `timestamp` data type before the SQL `rowversion` type replaced it.

The fluent API can also specify the tracking property:

```
modelBuilder.Entity<Department>()
    .Property<byte[]>("RowVersion")
    .IsRowVersion();
```

The following code shows a portion of the T-SQL generated by EF Core when the Department name is updated:

```
SET NOCOUNT ON;
UPDATE [Department] SET [Name] = @p0
WHERE [DepartmentID] = @p1 AND [RowVersion] = @p2;
SELECT [RowVersion]
FROM [Department]
WHERE @@ROWCOUNT = 1 AND [DepartmentID] = @p1;
```

The preceding highlighted code shows the `WHERE` clause containing `RowVersion`. If the DB `RowVersion` doesn't equal the `RowVersion` parameter (`@p2`), no rows are updated.

The following highlighted code shows the T-SQL that verifies exactly one row was updated:

```
SET NOCOUNT ON;
UPDATE [Department] SET [Name] = @p0
WHERE [DepartmentID] = @p1 AND [RowVersion] = @p2;
SELECT [RowVersion]
FROM [Department]
WHERE @@ROWCOUNT = 1 AND [DepartmentID] = @p1;
```

`@@ROWCOUNT` returns the number of rows affected by the last statement. In no rows are updated, EF Core throws a `DbUpdateConcurrencyException`.

You can see the T-SQL EF Core generates in the output window of Visual Studio.

## Update the DB

Adding the `RowVersion` property changes the DB model, which requires a migration.

Build the project. Enter the following in a command window:

```
dotnet ef migrations add RowVersion
dotnet ef database update
```

The preceding commands:

- Adds the `Migrations/{time stamp}_RowVersion.cs` migration file.
- Updates the `Migrations/SchoolContextModelSnapshot.cs` file. The update adds the following highlighted code to the `BuildModel` method:

```

modelBuilder.Entity("ContosoUniversity.Models.Department", b =>
{
    b.Property<int>("DepartmentID")
        .ValueGeneratedOnAdd();

    b.Property<decimal>("Budget")
        .HasColumnType("money");

    b.Property<int?>("InstructorID");

    b.Property<string>("Name")
        .HasMaxLength(50);

    b.Property<byte[]>("RowVersion")
        .IsConcurrencyToken()
        .ValueGeneratedOnAddOrUpdate();

    b.Property<DateTime>("StartDate");

    b.HasKey("DepartmentID");

    b.HasIndex("InstructorID");

    b.ToTable("Department");
});

```

- Runs migrations to update the DB.

## Scaffold the Departments model

- Exit Visual Studio.
- Open a command window in the project directory (The directory that contains the *Program.cs*, *Startup.cs*, and *.csproj* files).
- Run the following command:

```
dotnet aspnet-codegenerator razorpage -m Department -dc SchoolContext -udl -outDir Pages\Departments --referenceScriptLibraries
```

The preceding command scaffolds the `Department` model. Open the project in Visual Studio.

Build the project. The build generates errors like the following:

```
1>Pages/Departments/Index.cshtml.cs(26,37,26,43): error CS1061: 'SchoolContext' does not contain a definition for 'Department' and no extension method 'Department' accepting a first argument of type 'SchoolContext' could be found (are you missing a using directive or an assembly reference?)
```

Globally change `_context.Department` to `_context.Departments` (that is, add an "s" to `Department`). 7 occurrences are found and updated.

### Update the Departments Index page

The scaffolding engine created a `RowVersion` column for the Index page, but that field shouldn't be displayed. In this tutorial, the last byte of the `RowVersion` is displayed to help understand concurrency. The last byte isn't guaranteed to be unique. A real app wouldn't display `RowVersion` or the last byte of `RowVersion`.

Update the Index page:

- Replace `Index` with `Departments`.
- Replace the markup containing `RowVersion` with the last byte of `RowVersion`.

- Replace FirstMidName with FullName.

The following markup shows the updated page:

```

@page
@model ContosoUniversity.Pages.Departments.IndexModel

@{
    ViewData["Title"] = "Departments";
}

<h2>Departments</h2>

<p>
    <a asp-page="Create">Create New</a>
</p>
<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.Department[0].Name)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Department[0].Budget)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Department[0].StartDate)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Department[0].Administrator)
            </th>
            <th>
                RowVersion
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
@foreach (var item in Model.Department) {
        <tr>
            <td>
                @Html.DisplayFor(modelItem => item.Name)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.Budget)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.StartDate)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item Administrator.FullName)
            </td>
            <td>
                @item.RowVersion[7]
            </td>
            <td>
                <a asp-page=".Edit" asp-route-id="@item.DepartmentID">Edit</a> |
                <a asp-page=".Details" asp-route-id="@item.DepartmentID">Details</a> |
                <a asp-page=".Delete" asp-route-id="@item.DepartmentID">Delete</a>
            </td>
        </tr>
}
    </tbody>
</table>

```

## Update the Edit page model

Update `pages\departments\edit.cshtml.cs` with the following code:

```
using ContosoUniversity.Data;
using ContosoUniversity.Models;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.AspNetCore.Mvc.Rendering;
using Microsoft.EntityFrameworkCore;
using System.Linq;
using System.Threading.Tasks;

namespace ContosoUniversity.Pages.Departments
{
    public class EditModel : PageModel
    {
        private readonly ContosoUniversity.Data.SchoolContext _context;

        public EditModel(ContosoUniversity.Data.SchoolContext context)
        {
            _context = context;
        }

        [BindProperty]
        public Department Department { get; set; }
        // Replace ViewData["InstructorID"]
        public SelectList InstructorNameSL { get; set; }

        public async Task<IActionResult> OnGetAsync(int id)
        {
            Department = await _context.Departments
                .Include(d => d.Administrator) // eager loading
                .AsNoTracking() // tracking not required
                .FirstOrDefaultAsync(m => m.DepartmentID == id);

            if (Department == null)
            {
                return NotFound();
            }

            // Use strongly typed data rather than ViewData.
            InstructorNameSL = new SelectList(_context.Instructors,
                "ID", "FirstMidName");

            return Page();
        }

        public async Task<IActionResult> OnPostAsync(int id)
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            var departmentToUpdate = await _context.Departments
                .Include(i => i.Administrator)
                .FirstOrDefaultAsync(m => m.DepartmentID == id);

            // null means Department was deleted by another user.
            if (departmentToUpdate == null)
            {
                return await HandleDeletedDepartment();
            }

            // Update the RowVersion to the value when this entity was
            // fetched. If the entity has been updated after it was
            // fetched, RowVersion won't match the DB RowVersion and
            // a DbUpdateConcurrencyException is thrown.
            // A second postback will make them match, unless a new
```

```

        // concurrency issue happens.
        _context.Entry(departmentToUpdate)
            .Property("RowVersion").OriginalValue = Department.RowVersion;

        if (await TryUpdateModelAsync<Department>(
            departmentToUpdate,
            "Department",
            s => s.Name, s => s.StartDate, s => s.Budget, s => s.InstructorID))
    {
        try
        {
            await _context.SaveChangesAsync();
            return RedirectToPage("./Index");
        }
        catch (DbUpdateConcurrencyException ex)
        {
            var exceptionEntry = ex.Entries.Single();
            var clientValues = (Department)exceptionEntry.Entity;
            var databaseEntry = exceptionEntry.GetDatabaseValues();
            if (databaseEntry == null)
            {
                ModelState.AddModelError(string.Empty, "Unable to save. " +
                    "The department was deleted by another user.");
                return Page();
            }

            var dbValues = (Department)databaseEntry.ToObject();
            await setDbErrorMessage(dbValues, clientValues, _context);

            // Save the current RowVersion so next postback
            // matches unless an new concurrency issue happens.
            Department.RowVersion = (byte[])dbValues.RowVersion;
            // Must clear the model error for the next postback.
            ModelState.Remove("Department.RowVersion");
        }
    }

    InstructorNameSL = new SelectList(_context.Instructors,
        "ID", "FullName", departmentToUpdate.InstructorID);

    return Page();
}

private async Task<IActionResult> HandleDeletedDepartment()
{
    Department deletedDepartment = new Department();
    // ModelState contains the posted data because of the deletion error and will override the
    Department instance values when displaying Page().
    ModelState.AddModelError(string.Empty,
        "Unable to save. The department was deleted by another user.");
    InstructorNameSL = new SelectList(_context.Instructors, "ID", "FullName",
    Department.InstructorID);
    return Page();
}

private async Task setDbErrorMessage(Department dbValues,
    Department clientValues, SchoolContext context)
{

    if (dbValues.Name != clientValues.Name)
    {
        ModelState.AddModelError("Department.Name",
            $"Current value: {dbValues.Name}");
    }
    if (dbValues.Budget != clientValues.Budget)
    {
        ModelState.AddModelError("Department.Budget",
            $"Current value: {dbValues.Budget:c}");
    }
}

```

```

        }

        if (dbValues.StartDate != clientValues.StartDate)
        {
            ModelState.AddModelError("Department.StartDate",
                $"Current value: {dbValues.StartDate:d}");
        }
        if (dbValues.InstructorID != clientValues.InstructorID)
        {
            Instructor dbInstructor = await _context.Instructors
                .FindAsync(dbValues.InstructorID);
            ModelState.AddModelError("Department.InstructorID",
                $"Current value: {dbInstructor?.FullName}");
        }
    }

    ModelState.AddModelError(string.Empty,
        "The record you attempted to edit "
        + "was modified by another user after you. The "
        + "edit operation was canceled and the current values in the database "
        + "have been displayed. If you still want to edit this record, click "
        + "the Save button again.");
}
}
}

```

To detect a concurrency issue, the `OriginalValue` is updated with the `rowVersion` value from the entity it was fetched. EF Core generates a SQL UPDATE command with a WHERE clause containing the original `RowVersion` value. If no rows are affected by the UPDATE command (no rows have the original `RowVersion` value), a `DbUpdateConcurrencyException` exception is thrown.

```

public async Task<IActionResult> OnPostAsync(int id)
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    var departmentToUpdate = await _context.Departments
        .Include(i => i.Administrator)
        .FirstOrDefaultAsync(m => m.DepartmentID == id);

    // null means Department was deleted by another user.
    if (departmentToUpdate == null)
    {
        return await HandleDeletedDepartment();
    }

    // Update the RowVersion to the value when this entity was
    // fetched. If the entity has been updated after it was
    // fetched, RowVersion won't match the DB RowVersion and
    // a DbUpdateConcurrencyException is thrown.
    // A second postback will make them match, unless a new
    // concurrency issue happens.
    _context.Entry(departmentToUpdate)
        .Property("RowVersion").OriginalValue = Department.RowVersion;
}

```

In the preceding code, `Department.RowVersion` is the value when the entity was fetched. `OriginalValue` is the value in the DB when `FirstOrDefaultAsync` was called in this method.

The following code gets the client values (the values posted to this method) and the DB values:

```

try
{
    await _context.SaveChangesAsync();
    return RedirectToPage("./Index");
}
catch (DbUpdateConcurrencyException ex)
{
    var exceptionEntry = ex.Entries.Single();
    var clientValues = (Department)exceptionEntry.Entity;
    var databaseEntry = exceptionEntry.GetDatabaseValues();
    if (databaseEntry == null)
    {
        ModelState.AddModelError(string.Empty, "Unable to save. " +
            "The department was deleted by another user.");
        return Page();
    }

    var dbValues = (Department)databaseEntry.ToObject();
    await setDbErrorMessage(dbValues, clientValues, _context);

    // Save the current RowVersion so next postback
    // matches unless a new concurrency issue happens.
    Department.RowVersion = (byte[])dbValues.RowVersion;
    // Must clear the model error for the next postback.
    ModelState.Remove("Department.RowVersion");
}

```

The following code adds a custom error message for each column that has DB values different from what was posted to `OnPostAsync`:

```

private async Task setDbErrorMessage(Department dbValues,
    Department clientValues, SchoolContext context)
{

    if (dbValues.Name != clientValues.Name)
    {
        ModelState.AddModelError("Department.Name",
            $"Current value: {dbValues.Name}");
    }
    if (dbValues.Budget != clientValues.Budget)
    {
        ModelState.AddModelError("Department.Budget",
            $"Current value: {dbValues.Budget:c}");
    }
    if (dbValues.StartDate != clientValues.StartDate)
    {
        ModelState.AddModelError("Department.StartDate",
            $"Current value: {dbValues.StartDate:d}");
    }
    if (dbValues.InstructorID != clientValues.InstructorID)
    {
        Instructor dbInstructor = await _context.Instructors
            .FindAsync(dbValues.InstructorID);
        ModelState.AddModelError("Department.InstructorID",
            $"Current value: {dbInstructor?.FullName}");
    }

    ModelState.AddModelError(string.Empty,
        "The record you attempted to edit " +
        "was modified by another user after you. The " +
        "edit operation was canceled and the current values in the database " +
        "have been displayed. If you still want to edit this record, click " +
        "the Save button again.");
}

```

The following highlighted code sets the `RowVersion` value to the new value retrieved from the DB. The next time the user clicks **Save**, only concurrency errors that happen since the last display of the Edit page will be caught.

```
try
{
    await _context.SaveChangesAsync();
    return RedirectToPage("./Index");
}
catch (DbUpdateConcurrencyException ex)
{
    var exceptionEntry = ex.Entries.Single();
    var clientValues = (Department)exceptionEntry.Entity;
    var databaseEntry = exceptionEntry.GetDatabaseValues();
    if (databaseEntry == null)
    {
        ModelState.AddModelError(string.Empty, "Unable to save. " +
            "The department was deleted by another user.");
        return Page();
    }

    var dbValues = (Department)databaseEntry.ToObject();
    await setDbErrorMessage(dbValues, clientValues, _context);

    // Save the current RowVersion so next postback
    // matches unless a new concurrency issue happens.
    Department.RowVersion = (byte[])dbValues.RowVersion;
    // Must clear the model error for the next postback.
    ModelState.Remove("Department.RowVersion");
}
```

The `ModelState.Remove` statement is required because `ModelState` has the old `RowVersion` value. In the Razor Page, the `ModelState` value for a field takes precedence over the model property values when both are present.

## Update the Edit page

Update `Pages/Departments/Edit.cshtml` with the following markup:

```

@page "{id:int}"
@model ContosoUniversity.Pages.Departments.EditModel
 @{
     ViewData["Title"] = "Edit";
 }
<h2>Edit</h2>
<h4>Department</h4>
<hr />
<div class="row">
    <div class="col-md-4">
        <form method="post">
            <div asp-validation-summary="ModelOnly" class="text-danger"></div>
            <input type="hidden" asp-for="Department.DepartmentID" />
            <input type="hidden" asp-for="Department.RowVersion" />
            <div class="form-group">
                <label>RowVersion</label>
                @Model.Department.RowVersion[7]
            </div>
            <div class="form-group">
                <label asp-for="Department.Name" class="control-label"></label>
                <input asp-for="Department.Name" class="form-control" />
                <span asp-validation-for="Department.Name" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Department.Budget" class="control-label"></label>
                <input asp-for="Department.Budget" class="form-control" />
                <span asp-validation-for="Department.Budget" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Department.StartDate" class="control-label"></label>
                <input asp-for="Department.StartDate" class="form-control" />
                <span asp-validation-for="Department.StartDate" class="text-danger">
                    </span>
            </div>
            <div class="form-group">
                <label class="control-label">Instructor</label>
                <select asp-for="Department.InstructorID" class="form-control" asp-items="@Model.InstructorNameSL"></select>
                <span asp-validation-for="Department.InstructorID" class="text-danger">
                    </span>
            </div>
            <div class="form-group">
                <input type="submit" value="Save" class="btn btn-default" />
            </div>
        </form>
    </div>
</div>
<a asp-page=".~/Index">Back to List</a>
</div>
@section Scripts {
    @{await Html.RenderPartialAsync("_ValidationScriptsPartial");}
}

```

The preceding markup:

- Updates the `page` directive from `@page` to `@page "{id:int}"`.
- Adds a hidden row version. `RowVersion` must be added so post back binds the value.
- Displays the last byte of `RowVersion` for debugging purposes.
- Replaces `ViewData` with the strongly-typed `InstructorNameSL`.

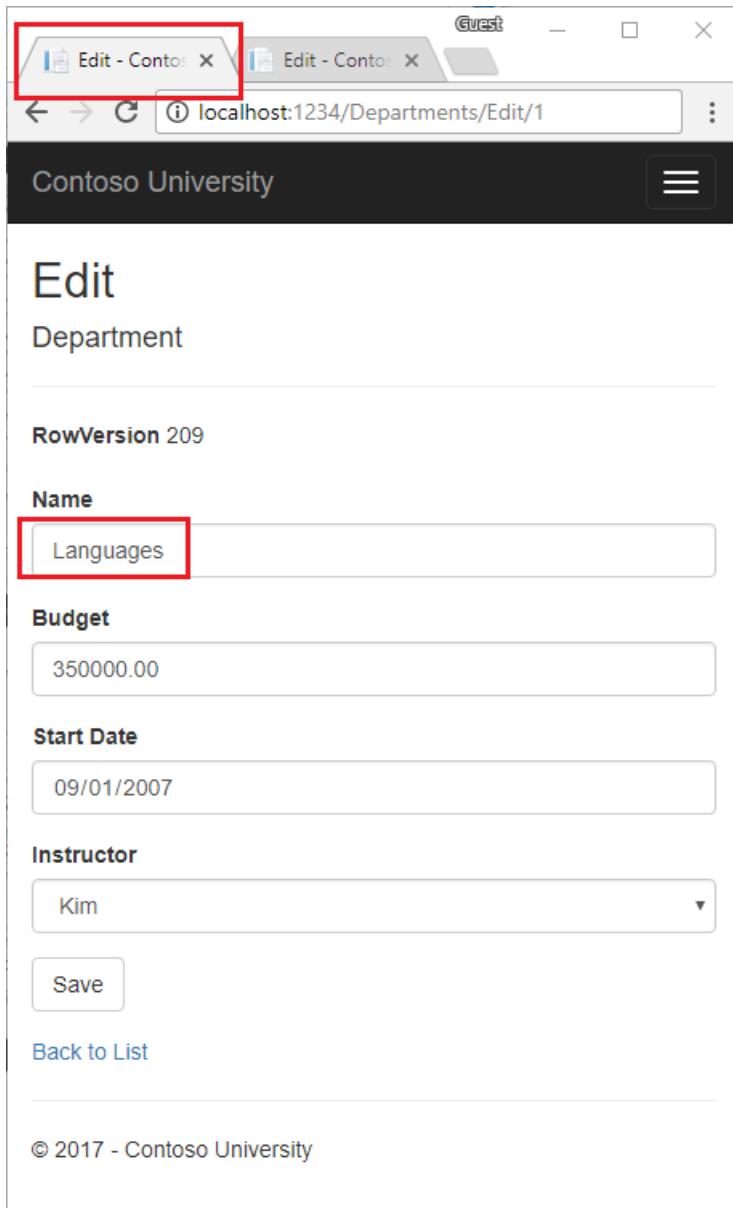
## Test concurrency conflicts with the Edit page

Open two browsers instances of Edit on the English department:

- Run the app and select Departments.
- Right-click the **Edit** hyperlink for the English department and select **Open in new tab**.
- In the first tab, click the **Edit** hyperlink for the English department.

The two browser tabs display the same information.

Change the name in the first browser tab and click **Save**.



The screenshot shows a web browser window with two tabs. The active tab is titled "Edit - Contoso" and displays the "Edit Department" page for the "Languages" department. The "Name" field is highlighted with a red box and contains the value "Languages". The second tab is also titled "Edit - Contoso" and shows the same page, but the "Name" field contains the value "English". The browser address bar shows "localhost:1234/Departments/Edit/1".

**Edit**  
Department

RowVersion 209

**Name**  
Languages

**Budget**  
350000.00

**Start Date**  
09/01/2007

**Instructor**  
Kim

**Save**

[Back to List](#)

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The browser shows the Index page with the changed value and updated rowVersion indicator. Note the updated rowVersion indicator, it's displayed on the second postback in the other tab.

Change a different field in the second browser tab.

Screenshot of a web browser showing the 'Edit - Contoso' page for a department. The browser title bar says 'Edit - Contoso'. The address bar shows 'localhost:1234/Departments/Edit/1'. The page header says 'Contoso University'. The main content area has a heading 'Edit' and 'Department'. It displays a 'RowVersion' of 209. There are four input fields: 'Name' (value: English), 'Budget' (value: 5000000, highlighted with a red box), 'Start Date' (value: 09/01/2007), and 'Instructor' (value: Kim). A 'Save' button is present. Below the form is a link 'Back to List' and a copyright notice '© 2017 - Contoso University'.

Click **Save**. You see error messages for all fields that don't match the DB values:

Guest

Departments Edit - Contoso University

localhost:1234/Departments/Edit/1

## Edit Department

The record you attempted to edit was modified by another user after you. The edit operation was canceled and the current values in the database have been displayed. If you still want to edit this record, click the Save button again.

**RowVersion** 21

**Name**

English

Current value: Languages

**Budget**

5000000

Current value: \$350,000.00

**Start Date**

09/01/2007

**Instructor**

Abercrombie, Kim

**Save**

[Back to List](#)

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This browser window didn't intend to change the Name field. Copy and paste the current value (Languages) into the Name field. Tab out. Client-side validation removes the error message.

The record you attempted to edit was modified by another user after you. The edit operation was canceled and the current values in the database have been displayed. If you still want to edit this record, click the Save button again.

**RowVersion** 21

**Name**

**Budget**

**Start Date**

**Instructor**

**Save**

[Back to List](#)

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Click **Save** again. The value you entered in the second browser tab is saved. You see the saved values in the Index page.

## Update the Delete page

Update the Delete page model with the following code:

```
using ContosoUniversity.Models;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using System.Threading.Tasks;

namespace ContosoUniversity.Pages.Departments
{
    public class DeleteModel : PageModel
    {
        private readonly ContosoUniversity.Data.SchoolContext _context;
```

The Delete page detects concurrency conflicts when the entity has changed after it was fetched.

`Department.RowVersion` is the row version when the entity was fetched. When EF Core creates the SQL DELETE command, it includes a WHERE clause with `RowVersion`. If the SQL DELETE command results in zero rows affected:

- The `RowVersion` in the SQL DELETE command doesn't match `RowVersion` in the DB.
  - A `DbUpdateConcurrencyException` exception is thrown.
  - `OnGetAsync` is called with the `concurrencyError`.

## Update the Delete page

Update *Pages/Departments/Delete.cshtml* with the following code:

```
@page "{id:int}"
@model ContosoUniversity.Pages.Departments.DeleteModel

@{
    ViewData["Title"] = "Delete";
}



## Delete



@Model.ConcurrencyErrorMessage



### Are you sure you want to delete this?



#### Department



---



<dt>
        @Html.DisplayNameFor(model => model.Department.Name)
    </dt>
    <dd>
        @Html.DisplayFor(model => model.Department.Name)
    </dd>
    <dt>
        @Html.DisplayNameFor(model => model.Department.Budget)
    </dt>
    <dd>
        @Html.DisplayFor(model => model.Department.Budget)
    </dd>
    <dt>
        @Html.DisplayNameFor(model => model.Department.StartDate)
    </dt>
    <dd>
        @Html.DisplayFor(model => model.Department.StartDate)
    </dd>
    <dt>
        @Html.DisplayNameFor(model => model.Department.RowVersion)
    </dt>
    <dd>
        @Html.DisplayFor(model => model.Department.RowVersion[7])
    </dd>
    <dt>
        @Html.DisplayNameFor(model => model.DepartmentAdministrator)
    </dt>
    <dd>
        @Html.DisplayFor(model => model.DepartmentAdministrator.FullName)
    </dd>


<form method="post">
    <input type="hidden" asp-for="Department.DepartmentID" />
    <input type="hidden" asp-for="Department.RowVersion" />
    <div class="form-actions no-color">
        <input type="submit" value="Delete" class="btn btn-default" /> |
        <a asp-page=".~/Index">Back to List</a>
    </div>
</form>


```

The preceding markup makes the following changes:

- Updates the `page` directive from `@page` to `@page "{id:int}"`.
- Adds an error message.

- Replaces FirstMidName with FullName in the **Administrator** field.
- Changes `RowVersion` to display the last byte.
- Adds a hidden row version. `RowVersion` must be added so post back binds the value.

## Test concurrency conflicts with the Delete page

Create a test department.

Open two browsers instances of Delete on the test department:

- Run the app and select Departments.
- Right-click the **Delete** hyperlink for the test department and select **Open in new tab**.
- Click the **Edit** hyperlink for the test department.

The two browser tabs display the same information.

Change the budget in the first browser tab and click **Save**.

The browser shows the Index page with the changed value and updated rowVersion indicator. Note the updated rowVersion indicator, it's displayed on the second postback in the other tab.

Delete the test department from the second tab. A concurrency error is display with the current values from the DB. Clicking **Delete** deletes the entity, unless `RowVersion` has been updated.department has been deleted.

See [Inheritance](#) on how to inherit a data model.

## Additional resources

- [Concurrency Tokens in EF Core](#)
- [Handle concurrency in EF Core](#)

[PREVIOUS](#)

# ASP.NET Core MVC with EF Core - tutorial series

6/21/2018 • 2 minutes to read • [Edit Online](#)

This tutorial teaches ASP.NET Core MVC and Entity Framework Core with controllers and views. Razor Pages is a new alternative in ASP.NET Core 2.0, a page-based programming model that makes building web UI easier and more productive. We recommend the [Razor Pages](#) tutorial over the MVC version. The Razor Pages tutorial:

- Is easier to follow.
- Provides more EF Core best practices.
- Uses more efficient queries.
- Is more current with the latest API.
- Covers more features.
- Is the preferred approach for new application development.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub issue](#).

1. [Get started](#)
2. [Create, Read, Update, and Delete operations](#)
3. [Sorting, filtering, paging, and grouping](#)
4. [Migrations](#)
5. [Create a complex data model](#)
6. [Reading related data](#)
7. [Updating related data](#)
8. [Handle concurrency conflicts](#)
9. [Inheritance](#)
10. [Advanced topics](#)

# ASP.NET Core MVC with Entity Framework Core - Tutorial 1 of 10

6/28/2018 • 22 minutes to read • [Edit Online](#)

This tutorial has not been upgraded to ASP.NET Core 2.1. The ASP.NET Core 2.0 version of this tutorial is available by selecting **ASP.NET Core 2.0** above the table of contents or at the top of the page:

The ASP.NET Core 2.1 Razor Pages version of this tutorial has many improvements over the 2.0 version.

The 2.0 tutorial teaches ASP.NET Core MVC and Entity Framework Core with controllers and views. Razor Pages is a page-based programming model that makes building web UI easier and more productive. We recommend the [Razor Pages](#) tutorial over the MVC version. The Razor Pages tutorial:

- Is easier to follow. For example, the scaffolding code has been significantly simplified.
- Provides more EF Core best practices.
- Uses more efficient queries.
- Is more current with the latest API.
- Covers more features.
- Is the preferred approach for new application development.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub discussion](#).

By [Tom Dykstra](#) and [Rick Anderson](#)

This tutorial teaches ASP.NET Core MVC and Entity Framework Core with controllers and views. Razor Pages is a new alternative in ASP.NET Core 2.0, a page-based programming model that makes building web UI easier and more productive. We recommend the [Razor Pages](#) tutorial over the MVC version. The Razor Pages tutorial:

- Is easier to follow.
- Provides more EF Core best practices.
- Uses more efficient queries.
- Is more current with the latest API.
- Covers more features.
- Is the preferred approach for new application development.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub issue](#).

The Contoso University sample web application demonstrates how to create ASP.NET Core 2.0 MVC web applications using Entity Framework (EF) Core 2.0 and Visual Studio 2017.

The sample application is a web site for a fictional Contoso University. It includes functionality such as student admission, course creation, and instructor assignments. This is the first in a series of tutorials that explain how to build the Contoso University sample application from scratch.

[Download or view the completed application](#).

EF Core 2.0 is the latest version of EF but doesn't yet have all the features of EF 6.x. For information about how to choose between EF 6.x and EF Core, see [EF Core vs. EF6.x](#). If you choose EF 6.x, see [the previous version of this tutorial series](#).

## NOTE

For the ASP.NET Core 1.1 version of this tutorial, see the [VS 2017 Update 2 version of this tutorial in PDF format](#).

## Prerequisites

Install **one** of the following:

- CLI tooling: Windows, Linux, or macOS: [.NET Core SDK 2.0 or later](#)
- IDE/editor tooling
  - Windows: [Visual Studio for Windows](#)
    - **ASP.NET and web development** workload
    - **.NET Core cross-platform development** workload
  - Linux: [Visual Studio Code](#)
  - macOS: [Visual Studio for Mac](#)

## Troubleshooting

If you run into a problem you can't resolve, you can generally find the solution by comparing your code to the [completed project](#). For a list of common errors and how to solve them, see [the Troubleshooting section of the last tutorial in the series](#). If you don't find what you need there, you can post a question to StackOverflow.com for [ASP.NET Core](#) or [EF Core](#).

## TIP

This is a series of 10 tutorials, each of which builds on what is done in earlier tutorials. Consider saving a copy of the project after each successful tutorial completion. Then if you run into problems, you can start over from the previous tutorial instead of going back to the beginning of the whole series.

## The Contoso University web application

The application you'll be building in these tutorials is a simple university web site.

Users can view and update student, course, and instructor information. Here are a few of the screens you'll create.

Last Name	First Mid Name	Enrollment Date	
Alexander	Carson	9/1/2005 12:00:00 AM	Edit   Details   Delete
Alonso	Meredith	9/1/2002 12:00:00 AM	Edit   Details   Delete
Anand	Arturo	9/1/2003 12:00:00 AM	Edit   Details   Delete
Barzdukas	Gytis	9/1/2002 12:00:00 AM	Edit   Details   Delete

EnrollmentDate  
2005-09-01T00:00:00.000

FirstMidName  
Carson

Last Name  
Alexander

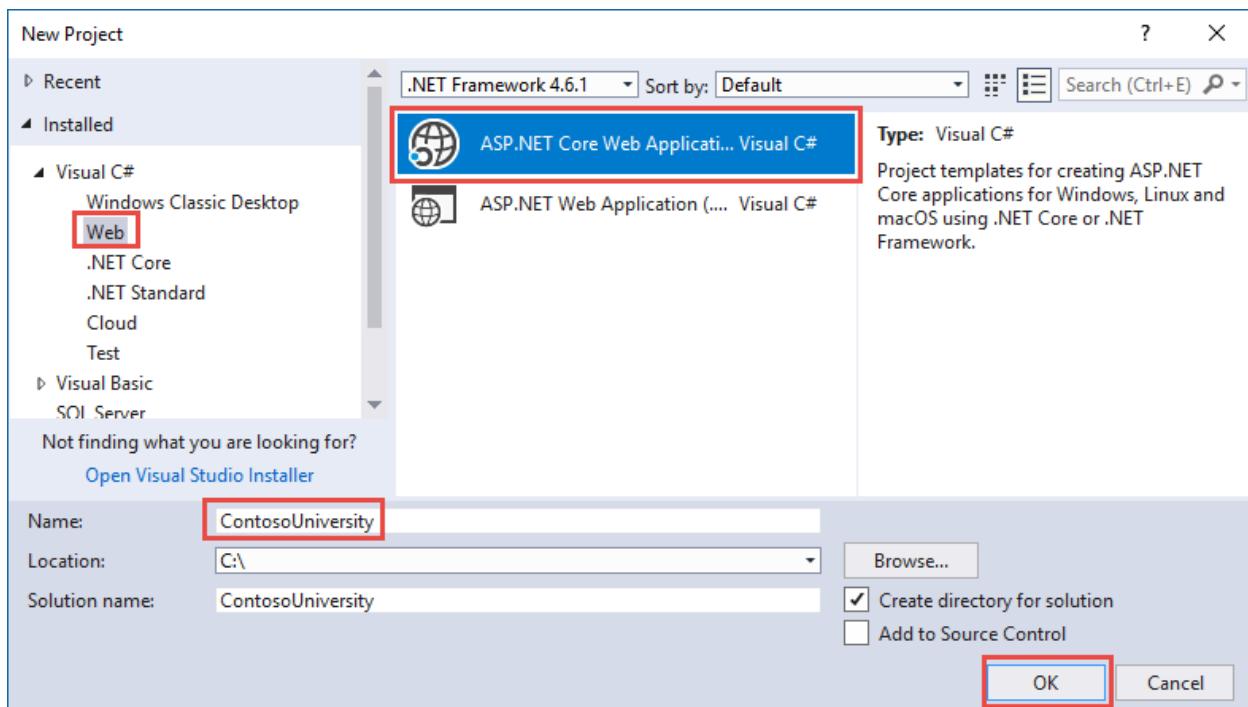
Save

The UI style of this site has been kept close to what's generated by the built-in templates, so that the tutorial can focus mainly on how to use the Entity Framework.

## Create an ASP.NET Core MVC web application

Open Visual Studio and create a new ASP.NET Core C# web project named "ContosoUniversity".

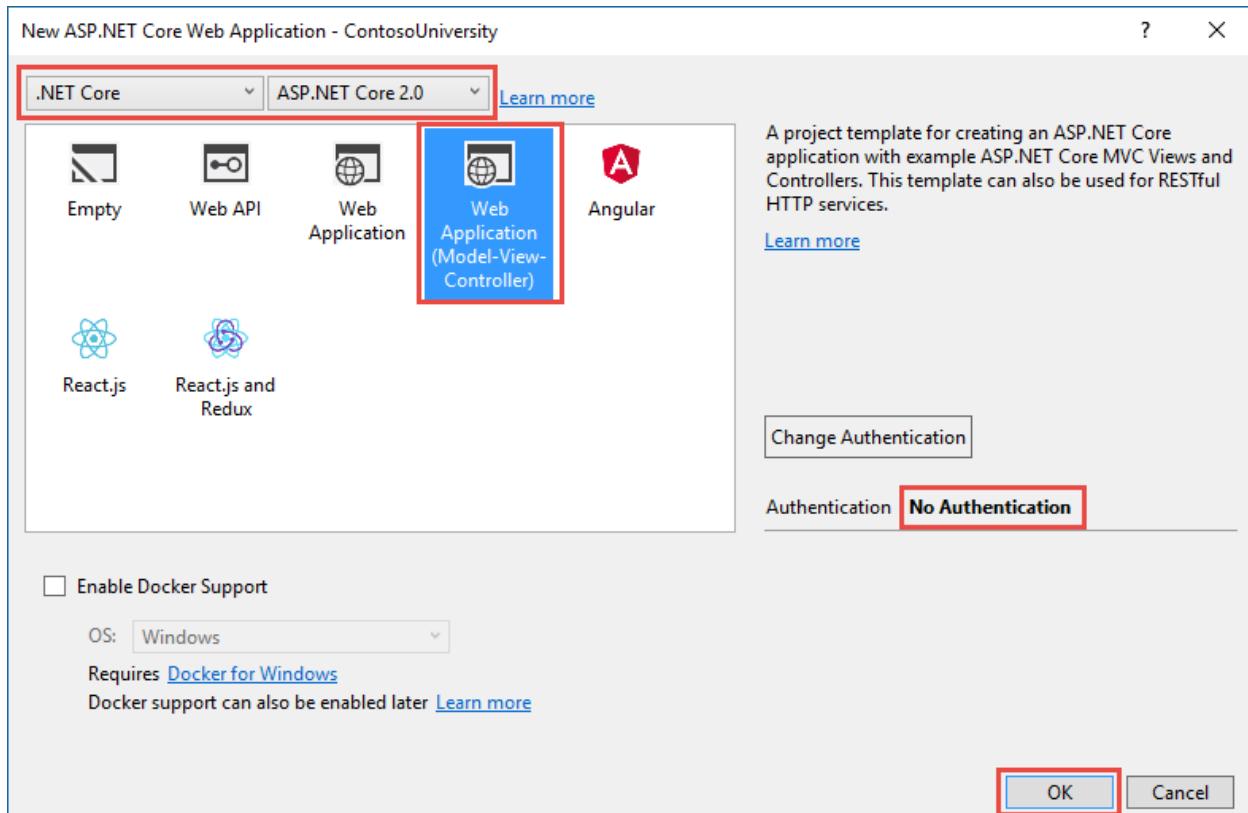
- From the **File** menu, select **New > Project**.
- From the left pane, select **Installed > Visual C# > Web**.
- Select the **ASP.NET Core Web Application** project template.
- Enter **ContosoUniversity** as the name and click **OK**.



- Wait for the **New ASP.NET Core Web Application (.NET Core)** dialog to appear
- Select **ASP.NET Core 2.0** and the **Web Application (Model-View-Controller)** template.

**Note:** This tutorial requires ASP.NET Core 2.0 and EF Core 2.0 or later -- make sure that **ASP.NET Core 1.1** isn't selected.

- Make sure **Authentication** is set to **No Authentication**.
- Click **OK**



## Set up the site style

A few simple changes will set up the site menu, layout, and home page.

Open Views/Shared/\_Layout.cshtml and make the following changes:

- Change each occurrence of "ContosoUniversity" to "Contoso University". There are three occurrences.
- Add menu entries for **Students**, **Courses**, **Instructors**, and **Departments**, and delete the **Contact** menu entry.

The changes are highlighted.

```
<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>@ViewData["Title"] - Contoso University</title>

    <environment names="Development">
        <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />
        <link rel="stylesheet" href="~/css/site.css" />
    </environment>
    <environment names="Staging,Production">
        <link rel="stylesheet" href="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/css/bootstrap.min.css"
              asp-fallback-href="~/lib/bootstrap/dist/css/bootstrap.min.css"
              asp-fallback-test-class="sr-only" asp-fallback-test-property="position" asp-fallback-test-
              value="absolute" />
        <link rel="stylesheet" href="~/css/site.min.css" asp-append-version="true" />
    </environment>

</head>
<body>
    <nav class="navbar navbar-inverse navbar-fixed-top">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-
collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a asp-area="" asp-controller="Home" asp-action="Index" class="navbar-brand">Contoso
University</a>
            </div>
            <div class="navbar-collapse collapse">
                <ul class="nav navbar-nav">
                    <li><a asp-area="" asp-controller="Home" asp-action="Index">Home</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="About">About</a></li>
                    <li><a asp-area="" asp-controller="Students" asp-action="Index">Students</a></li>
                    <li><a asp-area="" asp-controller="Courses" asp-action="Index">Courses</a></li>
                    <li><a asp-area="" asp-controller="Instructors" asp-action="Index">Instructors</a></li>
                    <li><a asp-area="" asp-controller="Departments" asp-action="Index">Departments</a></li>
                </ul>
            </div>
        </div>
    </nav>
    <div class="container body-content">
        @RenderBody()
        <hr />
        <footer>
            <p>&copy; 2017 - Contoso University</p>
        </footer>
    </div>

    <environment names="Development">
        <script src="~/lib/jquery/dist/jquery.js"></script>
        <script src="~/lib/bootstrap/dist/js/bootstrap.js"></script>
        <script src="~/js/site.js" asp-append-version="true"></script>
    </environment>

```

```

</environment>
<environment names="Staging,Production">
    <script src="https://ajax.aspnetcdn.com/ajax/jquery/jquery-2.2.0.min.js"
        asp-fallback-src="~/lib/jquery/dist/jquery.min.js"
        asp-fallback-test="window.jQuery"
        crossorigin="anonymous"
        integrity="sha384-K+ctZQ+LL8q6tP7I94W+qzQsfRV2a+AfhII9k8z8l9ggpc8X+Ytst4yBo/hH+8Fk">
    </script>
    <script src="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/bootstrap.min.js"
        asp-fallback-src="~/lib/bootstrap/dist/js/bootstrap.min.js"
        asp-fallback-test="window.jQuery && window.jQuery.fn && window.jQuery.fn.modal"
        crossorigin="anonymous"
        integrity="sha384-Tc5IQib027qvyyjSMfhjOMaLkfuvVxZXUPnCJA712mCWNIPG9mGCD8wGNicPD7Txa">
    </script>
    <script src="~/js/site.min.js" asp-append-version="true"></script>
</environment>

    @RenderSection("Scripts", required: false)
</body>
</html>

```

In *Views/Home/Index.cshtml*, replace the contents of the file with the following code to replace the text about ASP.NET and MVC with text about this application:

```

@{
    ViewData["Title"] = "Home Page";
}

<div class="jumbotron">
    <h1>Contoso University</h1>
</div>
<div class="row">
    <div class="col-md-4">
        <h2>Welcome to Contoso University</h2>
        <p>
            Contoso University is a sample application that
            demonstrates how to use Entity Framework Core in an
            ASP.NET Core MVC web application.
        </p>
    </div>
    <div class="col-md-4">
        <h2>Build it from scratch</h2>
        <p>You can build the application by following the steps in a series of tutorials.</p>
        <p><a class="btn btn-default" href="https://docs.asp.net/en/latest/data/ef-mvc/intro.html">See the
        tutorial &raquo;</a></p>
    </div>
    <div class="col-md-4">
        <h2>Download it</h2>
        <p>You can download the completed project from GitHub.</p>
        <p><a class="btn btn-default" href="https://github.com/aspnet/Docs/tree/master/aspnetcore/data/ef-
        mvc/intro/samples/cu-final">See project source code &raquo;</a></p>
    </div>
</div>

```

Press CTRL+F5 to run the project or choose **Debug > Start Without Debugging** from the menu. You see the home page with tabs for the pages you'll create in these tutorials.

The screenshot shows a web browser window with the title bar "Home Page - Contoso U X". The address bar displays "localhost:5813". The page content is the Contoso University homepage, featuring a large header "Contoso University", a sub-header "Welcome to Contoso University", a paragraph about the application, and sections for "Build it from scratch" and "Download it". Each section includes a button labeled "See the tutorial »" or "See project source code »". At the bottom, there is a copyright notice "© 2016 - Contoso University".

# Contoso University

## Welcome to Contoso University

Contoso University is a sample application that demonstrates how to use Entity Framework Core 1.0 in an ASP.NET Core MVC 1.0 web application.

### Build it from scratch

You can build the application by following the steps in a series of tutorials.

[See the tutorial »](#)

### Download it

You can download the completed project from GitHub.

[See project source code »](#)

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## Entity Framework Core NuGet packages

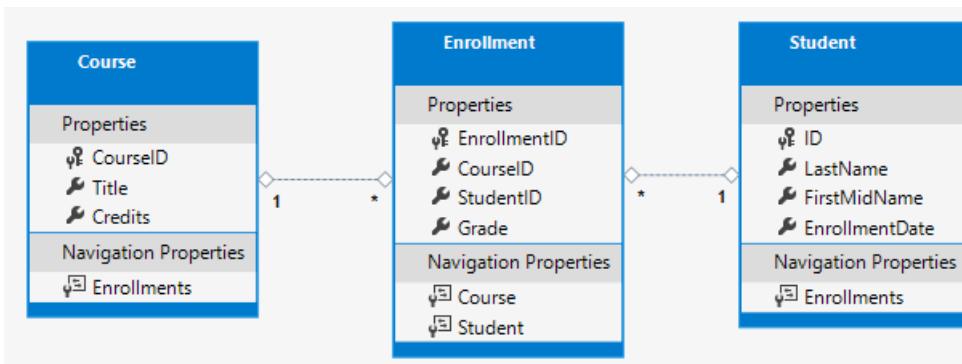
To add EF Core support to a project, install the database provider that you want to target. This tutorial uses SQL Server, and the provider package is [Microsoft.EntityFrameworkCore.SqlServer](#). This package is included in the [Microsoft.AspNetCore.All](#) metapackage, so you don't have to install it.

This package and its dependencies (`Microsoft.EntityFrameworkCore` and `Microsoft.EntityFrameworkCore.Relational`) provide runtime support for EF. You'll add a tooling package later, in the [Migrations](#) tutorial.

For information about other database providers that are available for Entity Framework Core, see [Database providers](#).

## Create the data model

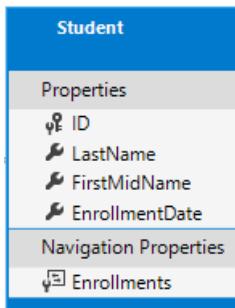
Next you'll create entity classes for the Contoso University application. You'll start with the following three entities.



There's a one-to-many relationship between `Student` and `Enrollment` entities, and there's a one-to-many relationship between `Course` and `Enrollment` entities. In other words, a student can be enrolled in any number of courses, and a course can have any number of students enrolled in it.

In the following sections you'll create a class for each one of these entities.

### The Student entity



In the `Models` folder, create a class file named `Student.cs` and replace the template code with the following code.

```

using System;
using System.Collections.Generic;

namespace ContosoUniversity.Models
{
    public class Student
    {
        public int ID { get; set; }
        public string LastName { get; set; }
        public string FirstMidName { get; set; }
        public DateTime EnrollmentDate { get; set; }

        public ICollection<Enrollment> Enrollments { get; set; }
    }
}

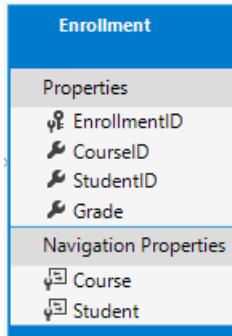
```

The `ID` property will become the primary key column of the database table that corresponds to this class. By default, the Entity Framework interprets a property that's named `ID` or `classnameID` as the primary key.

The `Enrollments` property is a navigation property. Navigation properties hold other entities that are related to this entity. In this case, the `Enrollments` property of a `student` entity will hold all of the `Enrollment` entities that are related to that `student` entity. In other words, if a given Student row in the database has two related Enrollment rows (rows that contain that student's primary key value in their `StudentID` foreign key column), that `Student` entity's `Enrollments` navigation property will contain those two `Enrollment` entities.

If a navigation property can hold multiple entities (as in many-to-many or one-to-many relationships), its type must be a list in which entries can be added, deleted, and updated, such as `ICollection<T>`. You can specify `ICollection<T>` or a type such as `List<T>` or `HashSet<T>`. If you specify `ICollection<T>`, EF creates a `HashSet<T>` collection by default.

## The Enrollment entity



In the *Models* folder, create *Enrollment.cs* and replace the existing code with the following code:

```
namespace ContosoUniversity.Models
{
    public enum Grade
    {
        A, B, C, D, F
    }

    public class Enrollment
    {
        public int EnrollmentID { get; set; }
        public int CourseID { get; set; }
        public int StudentID { get; set; }
        public Grade? Grade { get; set; }

        public Course Course { get; set; }
        public Student Student { get; set; }
    }
}
```

The `EnrollmentID` property will be the primary key; this entity uses the `classnameID` pattern instead of `ID` by itself as you saw in the `student` entity. Ordinarily you would choose one pattern and use it throughout your data model. Here, the variation illustrates that you can use either pattern. In a [later tutorial](#), you'll see how using ID without classname makes it easier to implement inheritance in the data model.

The `Grade` property is an `enum`. The question mark after the `Grade` type declaration indicates that the `Grade` property is nullable. A grade that's null is different from a zero grade -- null means a grade isn't known or hasn't been assigned yet.

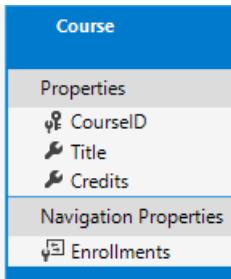
The `StudentID` property is a foreign key, and the corresponding navigation property is `Student`. An `Enrollment` entity is associated with one `Student` entity, so the property can only hold a single `student` entity (unlike the `Student.Enrollments` navigation property you saw earlier, which can hold multiple `Enrollment` entities).

The `CourseID` property is a foreign key, and the corresponding navigation property is `Course`. An `Enrollment` entity is associated with one `Course` entity.

Entity Framework interprets a property as a foreign key property if it's named

`<navigation property name><primary key property name>` (for example, `StudentID` for the `Student` navigation property since the `Student` entity's primary key is `ID`). Foreign key properties can also be named simply `<primary key property name>` (for example, `courseID` since the `Course` entity's primary key is `CourseID`).

## The Course entity



In the *Models* folder, create *Course.cs* and replace the existing code with the following code:

```
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Course
    {
        [DatabaseGenerated(DatabaseGeneratedOption.None)]
        public int CourseID { get; set; }
        public string Title { get; set; }
        public int Credits { get; set; }

        public ICollection<Enrollment> Enrollments { get; set; }
    }
}
```

The `Enrollments` property is a navigation property. A `Course` entity can be related to any number of `Enrollment` entities.

We'll say more about the `DatabaseGenerated` attribute in a [later tutorial](#) in this series. Basically, this attribute lets you enter the primary key for the course rather than having the database generate it.

## Create the Database Context

The main class that coordinates Entity Framework functionality for a given data model is the database context class. You create this class by deriving from the `Microsoft.EntityFrameworkCore.DbContext` class. In your code you specify which entities are included in the data model. You can also customize certain Entity Framework behavior. In this project, the class is named `SchoolContext`.

In the project folder, create a folder named *Data*.

In the *Data* folder create a new class file named *SchoolContext.cs*, and replace the template code with the following code:

```

using ContosoUniversity.Models;
using Microsoft.EntityFrameworkCore;

namespace ContosoUniversity.Data
{
    public class SchoolContext : DbContext
    {
        public SchoolContext(DbContextOptions<SchoolContext> options) : base(options)
        {

        }

        public DbSet<Course> Courses { get; set; }
        public DbSet<Enrollment> Enrollments { get; set; }
        public DbSet<Student> Students { get; set; }
    }
}

```

This code creates a `DbSet` property for each entity set. In Entity Framework terminology, an entity set typically corresponds to a database table, and an entity corresponds to a row in the table.

You could've omitted the `DbSet<Enrollment>` and `DbSet<Course>` statements and it would work the same. The Entity Framework would include them implicitly because the `Student` entity references the `Enrollment` entity and the `Enrollment` entity references the `Course` entity.

When the database is created, EF creates tables that have names the same as the `DbSet` property names. Property names for collections are typically plural (Students rather than Student), but developers disagree about whether table names should be pluralized or not. For these tutorials you'll override the default behavior by specifying singular table names in the `DbContext`. To do that, add the following highlighted code after the last `DbSet` property.

```

using ContosoUniversity.Models;
using Microsoft.EntityFrameworkCore;

namespace ContosoUniversity.Data
{
    public class SchoolContext : DbContext
    {
        public SchoolContext(DbContextOptions<SchoolContext> options) : base(options)
        {

        }

        public DbSet<Course> Courses { get; set; }
        public DbSet<Enrollment> Enrollments { get; set; }
        public DbSet<Student> Students { get; set; }

        protected override void OnModelCreating(ModelBuilder modelBuilder)
        {
            modelBuilder.Entity<Course>().ToTable("Course");
            modelBuilder.Entity<Enrollment>().ToTable("Enrollment");
            modelBuilder.Entity<Student>().ToTable("Student");
        }
    }
}

```

## Register the context with dependency injection

ASP.NET Core implements [dependency injection](#) by default. Services (such as the EF database context) are registered with dependency injection during application startup. Components that require these services (such as MVC controllers) are provided these services via constructor parameters. You'll see the controller constructor code that gets a context instance later in this tutorial.

To register `SchoolContext` as a service, open `Startup.cs`, and add the highlighted lines to the `ConfigureServices` method.

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<SchoolContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("DefaultConnection")));

    services.AddMvc();
}
```

The name of the connection string is passed in to the context by calling a method on a `DbContextOptionsBuilder` object. For local development, the [ASP.NET Core configuration system](#) reads the connection string from the `appsettings.json` file.

Add `using` statements for `ContosoUniversity.Data` and `Microsoft.EntityFrameworkCore` namespaces, and then build the project.

```
using ContosoUniversity.Data;
using Microsoft.EntityFrameworkCore;
```

Open the `appsettings.json` file and add a connection string as shown in the following example.

```
{
  "ConnectionStrings": {
    "DefaultConnection": "Server=(localdb)\\mssqllocaldb;Database=ContosoUniversity1;Trusted_Connection=True;MultipleActiveResultSets=true"
  },
  "Logging": {
    "IncludeScopes": false,
    "LogLevel": {
      "Default": "Warning"
    }
  }
}
```

## SQL Server Express LocalDB

The connection string specifies a SQL Server LocalDB database. LocalDB is a lightweight version of the SQL Server Express Database Engine and is intended for application development, not production use. LocalDB starts on demand and runs in user mode, so there's no complex configuration. By default, LocalDB creates `.mdf` database files in the `C:/Users/<user>` directory.

## Add code to initialize the database with test data

The Entity Framework will create an empty database for you. In this section, you write a method that's called after the database is created in order to populate it with test data.

Here you'll use the `EnsureCreated` method to automatically create the database. In a [later tutorial](#) you'll see how to handle model changes by using Code First Migrations to change the database schema instead of dropping and re-creating the database.

In the `Data` folder, create a new class file named `DbInitializer.cs` and replace the template code with the following code, which causes a database to be created when needed and loads test data into the new database.

```
using ContosoUniversity.Models;
using System;
using System.Linq;
```

```

namespace ContosoUniversity.Data
{
    public static class DbInitializer
    {
        public static void Initialize(SchoolContext context)
        {
            context.Database.EnsureCreated();

            // Look for any students.
            if (context.Students.Any())
            {
                return; // DB has been seeded
            }

            var students = new Student[]
            {
                new Student{FirstMidName="Carson",LastName="Alexander",EnrollmentDate=DateTime.Parse("2005-09-01")},
                new Student{FirstMidName="Meredith",LastName="Alonso",EnrollmentDate=DateTime.Parse("2002-09-01")},
                new Student{FirstMidName="Arturo",LastName="Anand",EnrollmentDate=DateTime.Parse("2003-09-01")},
                new Student{FirstMidName="Gytis",LastName="Barzdukas",EnrollmentDate=DateTime.Parse("2002-09-01")},
                new Student{FirstMidName="Yan",LastName="Li",EnrollmentDate=DateTime.Parse("2002-09-01")},
                new Student{FirstMidName="Peggy",LastName="Justice",EnrollmentDate=DateTime.Parse("2001-09-01")},
                new Student{FirstMidName="Laura",LastName="Norman",EnrollmentDate=DateTime.Parse("2003-09-01")},
                new Student{FirstMidName="Nino",LastName="Olivetto",EnrollmentDate=DateTime.Parse("2005-09-01")}
            };
            foreach (Student s in students)
            {
                context.Students.Add(s);
            }
            context.SaveChanges();

            var courses = new Course[]
            {
                new Course{CourseID=1050,Title="Chemistry",Credits=3},
                new Course{CourseID=4022,Title="Microeconomics",Credits=3},
                new Course{CourseID=4041,Title="Macroeconomics",Credits=3},
                new Course{CourseID=1045,Title="Calculus",Credits=4},
                new Course{CourseID=3141,Title="Trigonometry",Credits=4},
                new Course{CourseID=2021,Title="Composition",Credits=3},
                new Course{CourseID=2042,Title="Literature",Credits=4}
            };
            foreach (Course c in courses)
            {
                context.Courses.Add(c);
            }
            context.SaveChanges();

            var enrollments = new Enrollment[]
            {
                new Enrollment{StudentID=1,CourseID=1050,Grade=Grade.A},
                new Enrollment{StudentID=1,CourseID=4022,Grade=Grade.C},
                new Enrollment{StudentID=1,CourseID=4041,Grade=Grade.B},
                new Enrollment{StudentID=2,CourseID=1045,Grade=Grade.B},
                new Enrollment{StudentID=2,CourseID=3141,Grade=Grade.F},
                new Enrollment{StudentID=2,CourseID=2021,Grade=Grade.F},
                new Enrollment{StudentID=3,CourseID=1050},
                new Enrollment{StudentID=4,CourseID=1050},
                new Enrollment{StudentID=4,CourseID=4022,Grade=Grade.F},
                new Enrollment{StudentID=5,CourseID=4041,Grade=Grade.C},
                new Enrollment{StudentID=6,CourseID=1045},
                new Enrollment{StudentID=7,CourseID=3141,Grade=Grade.A},
            };
            foreach (Enrollment e in enrollments)
            {

```

```
        context.Enrollments.Add(e);
    }
    context.SaveChanges();
}
}
```

The code checks if there are any students in the database, and if not, it assumes the database is new and needs to be seeded with test data. It loads test data into arrays rather than `List<T>` collections to optimize performance.

In `Program.cs`, modify the `Main` method to do the following on application startup:

- Get a database context instance from the dependency injection container.
  - Call the seed method, passing to it the context.
  - Dispose the context when the seed method is done.

```
public static void Main(string[] args)
{
    var host = BuildWebHost(args);

    using (var scope = host.Services.CreateScope())
    {
        var services = scope.ServiceProvider;
        try
        {
            var context = services.GetRequiredService<SchoolContext>();
            DbInitializer.Initialize(context);
        }
        catch (Exception ex)
        {
            var logger = services.GetRequiredService<ILogger<Program>>();
            logger.LogError(ex, "An error occurred while seeding the database.");
        }
    }

    host.Run();
}
```

Add `using` statements:

```
using Microsoft.Extensions.DependencyInjection;
using ContosoUniversity.Data;
```

In older tutorials, you may see similar code in the `Configure` method in `Startup.cs`. We recommend that you use the `Configure` method only to set up the request pipeline. Application startup code belongs in the `Main` method.

Now the first time you run the application, the database will be created and seeded with test data. Whenever you change your data model, you can delete the database, update your seed method, and start afresh with a new database the same way. In later tutorials, you'll see how to modify the database when the data model changes, without deleting and re-creating it.

## Create a controller and views

Next, you'll use the scaffolding engine in Visual Studio to add an MVC controller and views that will use EF to query and save data.

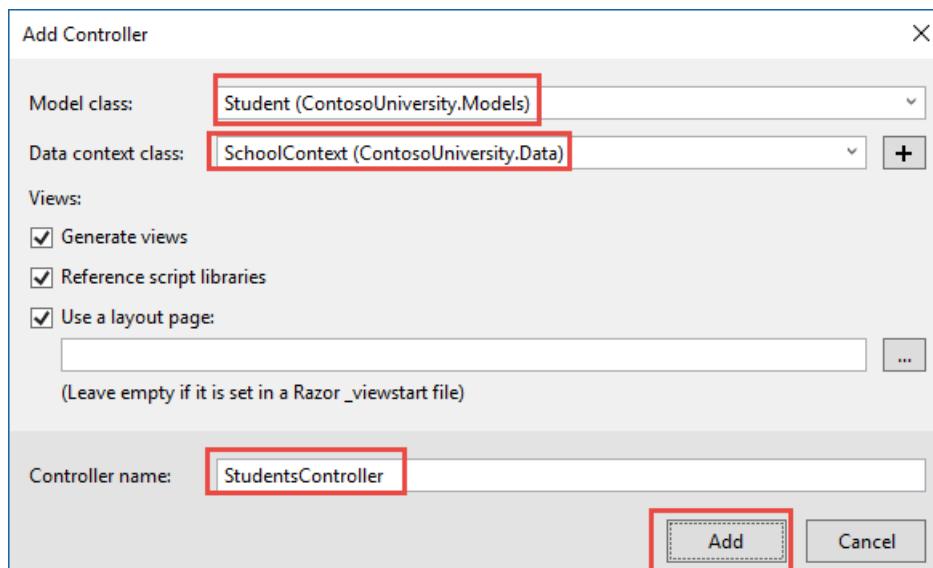
The automatic creation of CRUD action methods and views is known as scaffolding. Scaffolding differs from

code generation in that the scaffolded code is a starting point that you can modify to suit your own requirements, whereas you typically don't modify generated code. When you need to customize generated code, you use partial classes or you regenerate the code when things change.

- Right-click the **Controllers** folder in **Solution Explorer** and select **Add > New Scaffolded Item**.

If the **Add MVC Dependencies** dialog appears:

- [Update Visual Studio to the latest version](#). Visual Studio versions prior to 15.5 show this dialog.
- If you can't update, select **ADD**, and then follow the add controller steps again.
- In the **Add Scaffold** dialog box:
  - Select **MVC controller with views, using Entity Framework**.
  - Click **Add**.
- In the **Add Controller** dialog box:
  - In **Model class** select **Student**.
  - In **Data context class** select **SchoolContext**.
  - Accept the default **StudentsController** as the name.
  - Click **Add**.



When you click **Add**, the Visual Studio scaffolding engine creates a *StudentsController.cs* file and a set of views (*.cshtml* files) that work with the controller.

(The scaffolding engine can also create the database context for you if you don't create it manually first as you did earlier for this tutorial. You can specify a new context class in the **Add Controller** box by clicking the plus sign to the right of **Data context class**. Visual Studio will then create your `DbContext` class as well as the controller and views.)

You'll notice that the controller takes a `SchoolContext` as a constructor parameter.

```
namespace ContosoUniversity.Controllers
{
    public class StudentsController : Controller
    {
        private readonly SchoolContext _context;

        public StudentsController(SchoolContext context)
        {
            _context = context;
        }
    }
}
```

ASP.NET dependency injection will take care of passing an instance of `SchoolContext` into the controller. You configured that in the `Startup.cs` file earlier.

The controller contains an `Index` action method, which displays all students in the database. The method gets a list of students from the `Students` entity set by reading the `Students` property of the database context instance:

```
public async Task<IActionResult> Index()
{
    return View(await _context.Students.ToListAsync());
}
```

You'll learn about the asynchronous programming elements in this code later in the tutorial.

The `Views/Students/Index.cshtml` view displays this list in a table:

```

@model IEnumerable<ContosoUniversity.Models.Student>

 @{
     ViewData["Title"] = "Index";
 }

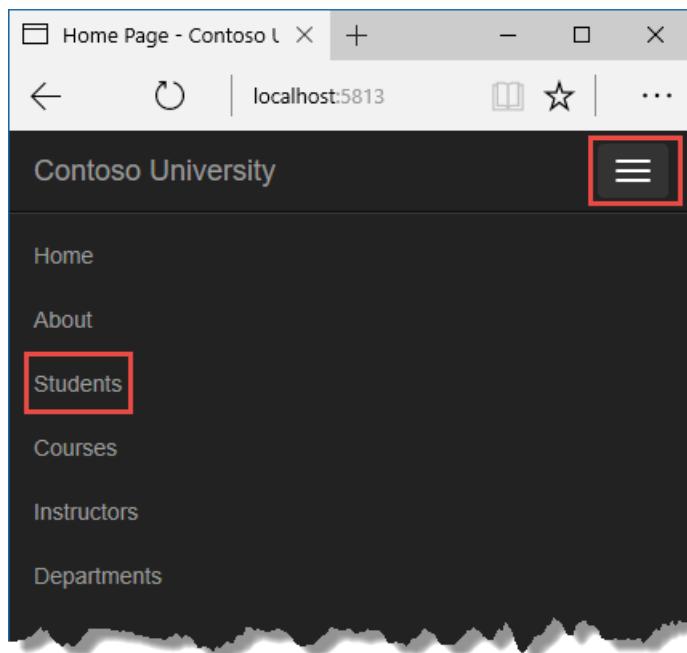
<h2>Index</h2>

<p>
    <a asp-action="Create">Create New</a>
</p>
<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.LastName)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.FirstMidName)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.EnrollmentDate)
            </th>
        <th></th>
    </tr>
    </thead>
    <tbody>
@foreach (var item in Model) {
    <tr>
        <td>
            @Html.DisplayFor(modelItem => item.LastName)
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.FirstMidName)
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.EnrollmentDate)
        </td>
        <td>
            <a asp-action="Edit" asp-route-id="@item.ID">Edit</a> |
            <a asp-action="Details" asp-route-id="@item.ID">Details</a> |
            <a asp-action="Delete" asp-route-id="@item.ID">Delete</a>
        </td>
    </tr>
}
    </tbody>
</table>

```

Press CTRL+F5 to run the project or choose **Debug > Start Without Debugging** from the menu.

Click the Students tab to see the test data that the `DbInitializer.Initialize` method inserted. Depending on how narrow your browser window is, you'll see the `Student` tab link at the top of the page or you'll have to click the navigation icon in the upper right corner to see the link.



Last Name	First Mid Name	Enrollment Date	Action
Alexander	Carson	9/1/2005 12:00:00 AM	Edit   Details   Delete
Alonso	Meredith	9/1/2002 12:00:00 AM	Edit   Details   Delete
Anand	Arturo	9/1/2003 12:00:00 AM	Edit   Details   Delete
Barzdukas	Gytis	9/1/2002 12:00:00 AM	Edit   Details   Delete

## View the Database

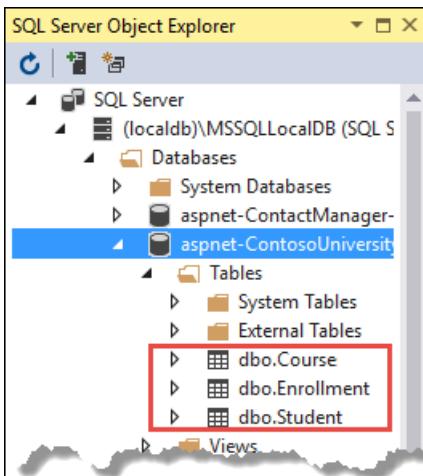
When you started the application, the `DbInitializer.Initialize` method calls `EnsureCreated`. EF saw that there was no database and so it created one, then the remainder of the `Initialize` method code populated the database with data. You can use **SQL Server Object Explorer** (SSOX) to view the database in Visual Studio.

Close the browser.

If the SSOX window isn't already open, select it from the **View** menu in Visual Studio.

In SSOX, click **(localdb)\MSSQLLocalDB > Databases**, and then click the entry for the database name that's in the connection string in your *appsettings.json* file.

Expand the **Tables** node to see the tables in your database.



Right-click the **Student** table and click **View Data** to see the columns that were created and the rows that were inserted into the table.

	ID	EnrollmentDate	FirstMidName	LastName
▶	1	9/1/2005 12:00:...	Carson	Alexander
	2	9/1/2002 12:00:...	Meredith	Alonso
	3	9/1/2003 12:00:...	Arturo	Anand
	4	9/1/2002 12:00:...	Gytis	Barzdukas
	5	9/1/2002 12:00:...	Yan	Li

The *.mdf* and *.ldf* database files are in the *C:\Users\* folder.

Because you're calling `EnsureCreated` in the initializer method that runs on app start, you could now make a change to the `Student` class, delete the database, run the application again, and the database would automatically be re-created to match your change. For example, if you add an `EmailAddress` property to the `Student` class, you'll see a new `EmailAddress` column in the re-created table.

## Conventions

The amount of code you had to write in order for the Entity Framework to be able to create a complete database for you is minimal because of the use of conventions, or assumptions that the Entity Framework makes.

- The names of `DbSet` properties are used as table names. For entities not referenced by a `Dbset` property, entity class names are used as table names.
- Entity property names are used for column names.
- Entity properties that are named `ID` or `classnameID` are recognized as primary key properties.
- A property is interpreted as a foreign key property if it's named (for example, `StudentID` for the `Student` navigation property since the `student` entity's primary key is `ID`). Foreign key properties can also be named simply (for example, `EnrollmentID` since the `Enrollment` entity's primary key is `EnrollmentID`).

Conventional behavior can be overridden. For example, you can explicitly specify table names, as you saw earlier in this tutorial. And you can set column names and set any property as primary key or foreign key, as you'll see in a [later tutorial](#) in this series.

## Asynchronous code

Asynchronous programming is the default mode for ASP.NET Core and EF Core.

A web server has a limited number of threads available, and in high load situations all of the available threads might be in use. When that happens, the server can't process new requests until the threads are freed up. With synchronous code, many threads may be tied up while they aren't actually doing any work because they're waiting for I/O to complete. With asynchronous code, when a process is waiting for I/O to complete, its thread is freed up for the server to use for processing other requests. As a result, asynchronous code enables server resources to be used more efficiently, and the server is enabled to handle more traffic without delays.

Asynchronous code does introduce a small amount of overhead at run time, but for low traffic situations the performance hit is negligible, while for high traffic situations, the potential performance improvement is substantial.

In the following code, the `async` keyword, `Task<T>` return value, `await` keyword, and `ToListAsync` method make the code execute asynchronously.

```
public async Task<IActionResult> Index()
{
    return View(await _context.Students.ToListAsync());
}
```

- The `async` keyword tells the compiler to generate callbacks for parts of the method body and to automatically create the `Task<IActionResult>` object that's returned.
- The return type `Task<IActionResult>` represents ongoing work with a result of type `IActionResult`.
- The `await` keyword causes the compiler to split the method into two parts. The first part ends with the operation that's started asynchronously. The second part is put into a callback method that's called when the operation completes.
- `ToListAsync` is the asynchronous version of the `ToList` extension method.

Some things to be aware of when you are writing asynchronous code that uses the Entity Framework:

- Only statements that cause queries or commands to be sent to the database are executed asynchronously. That includes, for example, `ToListAsync`, `SingleOrDefaultAsync`, and `SaveChangesAsync`. It doesn't include, for example, statements that just change an `IQueryable`, such as  
`var students = context.Students.Where(s => s.LastName == "Davolio")`.
- An EF context isn't thread safe: don't try to do multiple operations in parallel. When you call any async EF method, always use the `await` keyword.
- If you want to take advantage of the performance benefits of async code, make sure that any library packages that you're using (such as for paging), also use async if they call any Entity Framework methods that cause queries to be sent to the database.

For more information about asynchronous programming in .NET, see [Async Overview](#).

## Summary

You've now created a simple application that uses the Entity Framework Core and SQL Server Express LocalDB to store and display data. In the following tutorial, you'll learn how to perform basic CRUD (create, read, update, delete) operations.



# ASP.NET Core MVC with EF Core - CRUD - 2 of 10

6/28/2018 • 20 minutes to read • [Edit Online](#)

This tutorial has not been upgraded to ASP.NET Core 2.1. The ASP.NET Core 2.0 version of this tutorial is available by selecting **ASP.NET Core 2.0** above the table of contents or at the top of the page:

The ASP.NET Core 2.1 Razor Pages version of this tutorial has many improvements over the 2.0 version.

The 2.0 tutorial teaches ASP.NET Core MVC and Entity Framework Core with controllers and views. Razor Pages is a page-based programming model that makes building web UI easier and more productive. We recommend the [Razor Pages](#) tutorial over the MVC version. The Razor Pages tutorial:

- Is easier to follow. For example, the scaffolding code has been significantly simplified.
- Provides more EF Core best practices.
- Uses more efficient queries.
- Is more current with the latest API.
- Covers more features.
- Is the preferred approach for new application development.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub discussion](#).

By [Tom Dykstra](#) and [Rick Anderson](#)

The Contoso University sample web application demonstrates how to create ASP.NET Core MVC web applications using Entity Framework Core and Visual Studio. For information about the tutorial series, see [the first tutorial in the series](#).

In the previous tutorial, you created an MVC application that stores and displays data using the Entity Framework and SQL Server LocalDB. In this tutorial, you'll review and customize the CRUD (create, read, update, delete) code that the MVC scaffolding automatically creates for you in controllers and views.

## NOTE

It's a common practice to implement the repository pattern in order to create an abstraction layer between your controller and the data access layer. To keep these tutorials simple and focused on teaching how to use the Entity Framework itself, they don't use repositories. For information about repositories with EF, see [the last tutorial in this series](#).

In this tutorial, you'll work with the following web pages:

Details - Contoso Univ × +

localhost:5813/Students/Details/1

Contoso University Home About Students Courses Instructors Departments Register Log in

## Student

Last Name	Alexander	
First/Middle Name	Carson	
Enrollment Date	9/1/2005 12:00:00 AM	
Enrollments	Course Title	Grade
	Chemistry	A
	Microeconomics	C
	Macroeconomics	B

Create × + - □ ×

s/Create

Contoso University

## Create

### Student

Last Name

First/Middle Name

Enrollment Date

Create

A screenshot of a web browser window titled "Edit - c" showing the "Edit" view for a student. The URL is "localhost". The page has a header "Contoso University" and a navigation menu icon. The main content area is titled "Edit" and "Student". It contains three text input fields: "LastName" (value: Alexander), "FirstMidName" (value: Carson), and "EnrollmentDate" (value: 2005-09-01T00:00:00.000). Below the inputs is a "Save" button.

A screenshot of a web browser window titled "Delete" showing the "Delete" view for a student. The URL is "localhost". The page has a header "Contoso University" and a navigation menu icon. The main content area is titled "Delete" and "Student". It displays the student's details: "LastName" (Alexander), "FirstMidName" (Carson), and "EnrollmentDate" (9/2/2005 12:00:00 AM). At the bottom are two buttons: "Delete" and "Back to List".

## Customize the Details page

The scaffolded code for the Students Index page left out the `Enrollments` property, because that property holds a collection. In the **Details** page, you'll display the contents of the collection in an HTML table.

In `Controllers/StudentsController.cs`, the action method for the Details view uses the `SingleOrDefaultAsync` method to retrieve a single `Student` entity. Add code that calls `Include`, `ThenInclude`, and `AsNoTracking`.

methods, as shown in the following highlighted code.

```
public async Task<IActionResult> Details(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var student = await _context.Students
        .Include(s => s.Enrollments)
        .ThenInclude(e => e.Course)
        .AsNoTracking()
        .SingleOrDefaultAsync(m => m.ID == id);

    if (student == null)
    {
        return NotFound();
    }

    return View(student);
}
```

The `Include` and `ThenInclude` methods cause the context to load the `Student.Enrollments` navigation property, and within each enrollment the `Enrollment.Course` navigation property. You'll learn more about these methods in the [read related data](#) tutorial.

The `AsNoTracking` method improves performance in scenarios where the entities returned won't be updated in the current context's lifetime. You'll learn more about `AsNoTracking` at the end of this tutorial.

## Route data

The key value that's passed to the `Details` method comes from *route data*. Route data is data that the model binder found in a segment of the URL. For example, the default route specifies controller, action, and id segments:

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

In the following URL, the default route maps Instructor as the controller, Index as the action, and 1 as the id; these are route data values.

```
http://localhost:1230/Instructor/Index/1?courseID=2021
```

The last part of the URL ("?courseID=2021") is a query string value. The model binder will also pass the ID value to the `Details` method `id` parameter if you pass it as a query string value:

```
http://localhost:1230/Instructor/Index?id=1&CourseID=2021
```

In the Index page, hyperlink URLs are created by tag helper statements in the Razor view. In the following Razor code, the `id` parameter matches the default route, so `id` is added to the route data.

```
<a asp-action="Edit" asp-route-id="@item.ID">Edit</a>
```

This generates the following HTML when `item.ID` is 6:

```
<a href="/Students/Edit/6">Edit</a>
```

In the following Razor code, `studentID` doesn't match a parameter in the default route, so it's added as a query string.

```
<a asp-action="Edit" asp-route-studentID="@item.ID">Edit</a>
```

This generates the following HTML when `item.ID` is 6:

```
<a href="/Students/Edit?studentID=6">Edit</a>
```

For more information about tag helpers, see [Tag helpers in ASP.NET Core](#).

### Add enrollments to the Details view

Open `Views/Students/Details.cshtml`. Each field is displayed using `DisplayNameFor` and `DisplayFor` helpers, as shown in the following example:

```
<dt>
    @Html.DisplayNameFor(model => model.LastName)
</dt>
<dd>
    @Html.DisplayFor(model => model.LastName)
</dd>
```

After the last field and immediately before the closing `</dl>` tag, add the following code to display a list of enrollments:

```
<dt>
    @Html.DisplayNameFor(model => model.Enrollments)
</dt>
<dd>
    <table class="table">
        <tr>
            <th>Course Title</th>
            <th>Grade</th>
        </tr>
        @foreach (var item in Model.Enrollments)
        {
            <tr>
                <td>
                    @Html.DisplayFor(modelItem => item.Course.Title)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Grade)
                </td>
            </tr>
        }
    </table>
</dd>
```

If code indentation is wrong after you paste the code, press CTRL-K-D to correct it.

This code loops through the entities in the `Enrollments` navigation property. For each enrollment, it displays the course title and the grade. The course title is retrieved from the `Course` entity that's stored in the `Course` navigation property of the `Enrollments` entity.

Run the app, select the **Students** tab, and click the **Details** link for a student. You see the list of courses and grades for the selected student:

The screenshot shows a browser window titled "Details - Contoso Unive". The address bar displays "localhost:5813/Students/Details/1". The page header for "Contoso University" includes links for Home, About, Students, Courses, Instructors, Departments, Register, and Log in. The main content area is titled "Student". It shows a table with student information and enrollment details.

Last Name	Alexander
First/Middle Name	Carson
Enrollment Date	9/1/2005 12:00:00 AM
Enrollments	
Course Title	Grade
Chemistry	A
Microeconomics	C
Macroeconomics	B

## Update the Create page

In *StudentsController.cs*, modify the `HttpPost [Create]` method by adding a try-catch block and removing ID from the `Bind` attribute.

```
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Create(
    [Bind("EnrollmentDate,FirstMidName,LastName")] Student student)
{
    try
    {
        if (ModelState.IsValid)
        {
            _context.Add(student);
            await _context.SaveChangesAsync();
            return RedirectToAction(nameof(Index));
        }
    }
    catch (DbUpdateException /* ex */)
    {
        //Log the error (uncomment ex variable name and write a log.
        ModelState.AddModelError("", "Unable to save changes. " +
            "Try again, and if the problem persists " +
            "see your system administrator.");
    }
    return View(student);
}
```

This code adds the Student entity created by the ASP.NET MVC model binder to the Students entity set and then saves the changes to the database. (Model binder refers to the ASP.NET MVC functionality that makes it easier for you to work with data submitted by a form; a model binder converts posted form values to CLR types and

passes them to the action method in parameters. In this case, the model binder instantiates a Student entity for you using property values from the Form collection.)

You removed `ID` from the `Bind` attribute because ID is the primary key value which SQL Server will set automatically when the row is inserted. Input from the user doesn't set the ID value.

Other than the `Bind` attribute, the try-catch block is the only change you've made to the scaffolded code. If an exception that derives from `DbUpdateException` is caught while the changes are being saved, a generic error message is displayed. `DbUpdateException` exceptions are sometimes caused by something external to the application rather than a programming error, so the user is advised to try again. Although not implemented in this sample, a production quality application would log the exception. For more information, see the **Log for insight** section in [Monitoring and Telemetry \(Building Real-World Cloud Apps with Azure\)](#).

The `ValidateAntiForgeryToken` attribute helps prevent cross-site request forgery (CSRF) attacks. The token is automatically injected into the view by the [FormTagHelper](#) and is included when the form is submitted by the user. The token is validated by the `ValidateAntiForgeryToken` attribute. For more information about CSRF, see [Anti-Request Forgery](#).

### Security note about overposting

The `Bind` attribute that the scaffolded code includes on the `Create` method is one way to protect against overposting in create scenarios. For example, suppose the Student entity includes a `Secret` property that you don't want this web page to set.

```
public class Student
{
    public int ID { get; set; }
    public string LastName { get; set; }
    public string FirstMidName { get; set; }
    public DateTime EnrollmentDate { get; set; }
    public string Secret { get; set; }
}
```

Even if you don't have a `Secret` field on the web page, a hacker could use a tool such as Fiddler, or write some JavaScript, to post a `Secret` form value. Without the `Bind` attribute limiting the fields that the model binder uses when it creates a Student instance, the model binder would pick up that `Secret` form value and use it to create the Student entity instance. Then whatever value the hacker specified for the `Secret` form field would be updated in your database. The following image shows the Fiddler tool adding the `Secret` field (with the value "OverPost") to the posted form values.

The screenshot shows the Fiddler web debugger interface. At the top, there are tabs for Statistics, Inspectors, AutoResponder, Composer, Filters, Log, and Timeline. Below the tabs, a message says "Use this page to compose a Request. You can clone a prior request by dragging and dropping a session from the Web Sessions list." On the right side of the interface, there is a large red box around the "Execute" button. The main area shows a "Parsed" tab selected, with "Raw", "Scratchpad", and "Options" tabs below it. The "Raw" tab displays a POST request to "http://localhost:1236/Student/Create" over "HTTP/1.1". The "Request Headers" section includes fields like Host, User-Agent, Accept, Accept-Language, Accept-Encoding, Referer, Cookie, Connection, Content-Type, and Content-Length. The "Request Body" section shows the URL-encoded data: "s1&LastName=Smith&FirstName=Joe&EnrollmentDate=7%2F31%2F2013+4%3A58%3A23+PM&Secret=OverPost". A red box highlights the "Secret" parameter.

The value "OverPost" would then be successfully added to the `Secret` property of the inserted row, although you never intended that the web page be able to set that property.

You can prevent overposting in edit scenarios by reading the entity from the database first and then calling `TryUpdateModel`, passing in an explicit allowed properties list. That's the method used in these tutorials.

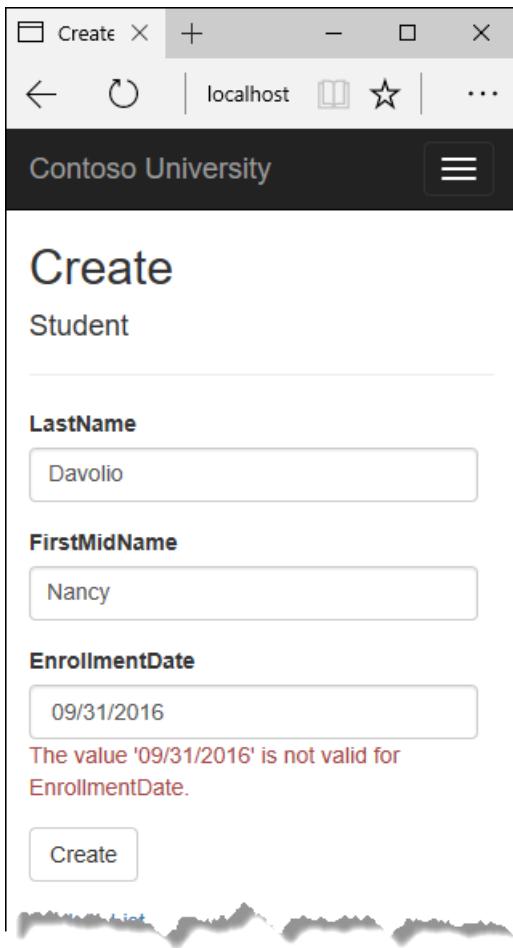
An alternative way to prevent overposting that's preferred by many developers is to use view models rather than entity classes with model binding. Include only the properties you want to update in the view model. Once the MVC model binder has finished, copy the view model properties to the entity instance, optionally using a tool such as AutoMapper. Use `_context.Entry` on the entity instance to set its state to `Unchanged`, and then set `Property("PropertyName").IsModified` to true on each entity property that's included in the view model. This method works in both edit and create scenarios.

### Test the Create page

The code in `Views/Students/Create.cshtml` uses `label`, `input`, and `span` (for validation messages) tag helpers for each field.

Run the app, select the **Students** tab, and click **Create New**.

Enter names and a date. Try entering an invalid date if your browser lets you do that. (Some browsers force you to use a date picker.) Then click **Create** to see the error message.



This is server-side validation that you get by default; in a later tutorial you'll see how to add attributes that will generate code for client-side validation also. The following highlighted code shows the model validation check in the `Create` method.

```
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Create(
    [Bind("EnrollmentDate,FirstMidName,LastName")] Student student)
{
    try
    {
        if (ModelState.IsValid)
        {
            _context.Add(student);
            await _context.SaveChangesAsync();
            return RedirectToAction(nameof(Index));
        }
    }
    catch (DbUpdateException /* ex */)
    {
        //Log the error (uncomment ex variable name and write a log.
        ModelState.AddModelError("", "Unable to save changes. " +
            "Try again, and if the problem persists " +
            "see your system administrator.");
    }
    return View(student);
}
```

Change the date to a valid value and click **Create** to see the new student appear in the **Index** page.

## Update the Edit page

In `StudentController.cs`, the `HttpGet` `Edit` method (the one without the `HttpPost` attribute) uses the

`SingleOrDefaultAsync` method to retrieve the selected Student entity, as you saw in the `Details` method. You don't need to change this method.

## Recommended `HttpPost Edit` code: Read and update

Replace the `HttpPost Edit` action method with the following code.

```
[HttpPost, ActionName("Edit")]
[ValidateAntiForgeryToken]
public async Task<IActionResult> EditPost(int? id)
{
    if (id == null)
    {
        return NotFound();
    }
    var studentToUpdate = await _context.Students.SingleOrDefault(s => s.ID == id);
    if (await TryUpdateModelAsync<Student>(
        studentToUpdate,
        "",
        s => s.FirstMidName, s => s.LastName, s => s.EnrollmentDate))
    {
        try
        {
            await _context.SaveChangesAsync();
            return RedirectToAction(nameof(Index));
        }
        catch (DbUpdateException /* ex */)
        {
            //Log the error (uncomment ex variable name and write a log.)
            ModelState.AddModelError("", "Unable to save changes. " +
                "Try again, and if the problem persists, " +
                "see your system administrator.");
        }
    }
    return View(studentToUpdate);
}
```

These changes implement a security best practice to prevent overposting. The scaffolder generated a `Bind` attribute and added the entity created by the model binder to the entity set with a `Modified` flag. That code isn't recommended for many scenarios because the `Bind` attribute clears out any pre-existing data in fields not listed in the `Include` parameter.

The new code reads the existing entity and calls `TryUpdateModel` to update fields in the retrieved entity [based on user input in the posted form data](#). The Entity Framework's automatic change tracking sets the `Modified` flag on the fields that are changed by form input. When the `SaveChanges` method is called, the Entity Framework creates SQL statements to update the database row. Concurrency conflicts are ignored, and only the table columns that were updated by the user are updated in the database. (A later tutorial shows how to handle concurrency conflicts.)

As a best practice to prevent overposting, the fields that you want to be updateable by the `Edit` page are whitelisted in the `TryUpdateModel` parameters. (The empty string preceding the list of fields in the parameter list is for a prefix to use with the form fields names.) Currently there are no extra fields that you're protecting, but listing the fields that you want the model binder to bind ensures that if you add fields to the data model in the future, they're automatically protected until you explicitly add them here.

As a result of these changes, the method signature of the `HttpPost Edit` method is the same as the `HttpGet Edit` method; therefore you've renamed the method `EditPost`.

## Alternative `HttpPost Edit` code: Create and attach

The recommended `HttpPost edit` code ensures that only changed columns get updated and preserves data in properties that you don't want included for model binding. However, the read-first approach requires an extra

database read, and can result in more complex code for handling concurrency conflicts. An alternative is to attach an entity created by the model binder to the EF context and mark it as modified. (Don't update your project with this code, it's only shown to illustrate an optional approach.)

```
public async Task<IActionResult> Edit(int id, [Bind("ID,EnrollmentDate,FirstMidName,LastName")] Student student)
{
    if (id != student.ID)
    {
        return NotFound();
    }
    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(student);
            await _context.SaveChangesAsync();
            return RedirectToAction(nameof(Index));
        }
        catch (DbUpdateException /* ex */)
        {
            //Log the error (uncomment ex variable name and write a log.)
            ModelState.AddModelError("", "Unable to save changes. " +
                "Try again, and if the problem persists, " +
                "see your system administrator.");
        }
    }
    return View(student);
}
```

You can use this approach when the web page UI includes all of the fields in the entity and can update any of them.

The scaffolded code uses the create-and-attach approach but only catches `DbUpdateConcurrencyException` exceptions and returns 404 error codes. The example shown catches any database update exception and displays an error message.

## Entity States

The database context keeps track of whether entities in memory are in sync with their corresponding rows in the database, and this information determines what happens when you call the `SaveChanges` method. For example, when you pass a new entity to the `Add` method, that entity's state is set to `Added`. Then when you call the `SaveChanges` method, the database context issues a SQL INSERT command.

An entity may be in one of the following states:

- `Added`. The entity doesn't yet exist in the database. The `SaveChanges` method issues an INSERT statement.
- `Unchanged`. Nothing needs to be done with this entity by the `SaveChanges` method. When you read an entity from the database, the entity starts out with this status.
- `Modified`. Some or all of the entity's property values have been modified. The `SaveChanges` method issues an UPDATE statement.
- `Deleted`. The entity has been marked for deletion. The `SaveChanges` method issues a DELETE statement.
- `Detached`. The entity isn't being tracked by the database context.

In a desktop application, state changes are typically set automatically. You read an entity and make changes to some of its property values. This causes its entity state to automatically be changed to `Modified`. Then when you call `SaveChanges`, the Entity Framework generates a SQL UPDATE statement that updates only the actual properties that you changed.

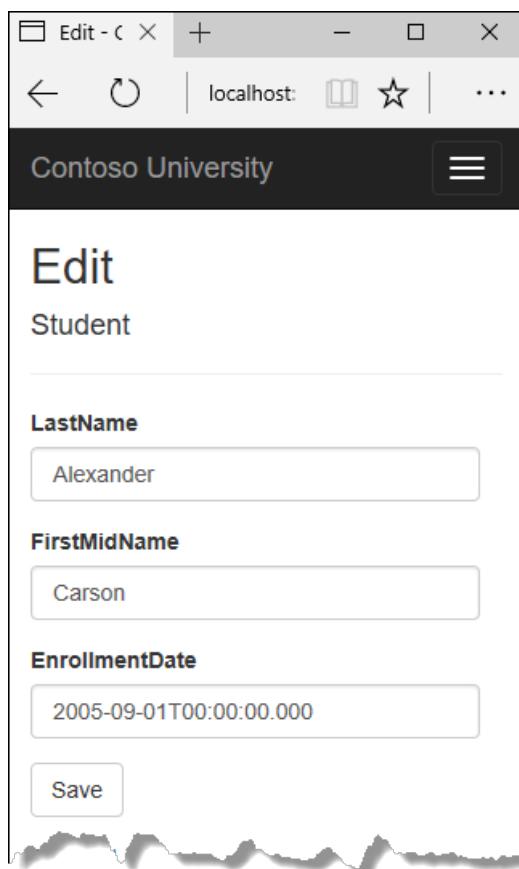
In a web app, the `DbContext` that initially reads an entity and displays its data to be edited is disposed after a page is rendered. When the `HttpPost Edit` action method is called, a new web request is made and you have a new instance of the `DbContext`. If you re-read the entity in that new context, you simulate desktop processing.

But if you don't want to do the extra read operation, you have to use the entity object created by the model binder. The simplest way to do this is to set the entity state to Modified as is done in the alternative `HttpPost Edit` code shown earlier. Then when you call `SaveChanges`, the Entity Framework updates all columns of the database row, because the context has no way to know which properties you changed.

If you want to avoid the read-first approach, but you also want the SQL UPDATE statement to update only the fields that the user actually changed, the code is more complex. You have to save the original values in some way (such as by using hidden fields) so that they're available when the `HttpPost Edit` method is called. Then you can create a Student entity using the original values, call the `Attach` method with that original version of the entity, update the entity's values to the new values, and then call `SaveChanges`.

## Test the Edit page

Run the app, select the **Students** tab, then click an **Edit** hyperlink.



Change some of the data and click **Save**. The **Index** page opens and you see the changed data.

## Update the Delete page

In `StudentController.cs`, the template code for the `HttpGet Delete` method uses the `SingleOrDefaultAsync` method to retrieve the selected Student entity, as you saw in the Details and Edit methods. However, to implement a custom error message when the call to `SaveChanges` fails, you'll add some functionality to this method and its corresponding view.

As you saw for update and create operations, delete operations require two action methods. The method that's called in response to a GET request displays a view that gives the user a chance to approve or cancel the delete operation. If the user approves it, a POST request is created. When that happens, the `HttpPost Delete` method is called and then that method actually performs the delete operation.

You'll add a try-catch block to the `HttpPost Delete` method to handle any errors that might occur when the database is updated. If an error occurs, the `HttpPost Delete` method calls the `HttpGet Delete` method, passing it a parameter that indicates that an error has occurred. The `HttpGet Delete` method then redisplays the confirmation page along with the error message, giving the user an opportunity to cancel or try again.

Replace the `HttpGet Delete` action method with the following code, which manages error reporting.

```
public async Task<IActionResult> Delete(int? id, bool? saveChangesError = false)
{
    if (id == null)
    {
        return NotFound();
    }

    var student = await _context.Students
        .AsNoTracking()
        .SingleOrDefaultAsync(m => m.ID == id);
    if (student == null)
    {
        return NotFound();
    }

    if (saveChangesError.GetValueOrDefault())
    {
        ViewData["ErrorMessage"] =
            "Delete failed. Try again, and if the problem persists " +
            "see your system administrator.";
    }

    return View(student);
}
```

This code accepts an optional parameter that indicates whether the method was called after a failure to save changes. This parameter is `false` when the `HttpGet Delete` method is called without a previous failure. When it's called by the `HttpPost Delete` method in response to a database update error, the parameter is `true` and an error message is passed to the view.

### The read-first approach to `HttpPost Delete`

Replace the `HttpPost Delete` action method (named `DeleteConfirmed`) with the following code, which performs the actual delete operation and catches any database update errors.

```

[HttpPost, ActionName("Delete")]
[ValidateAntiForgeryToken]
public async Task<IActionResult> DeleteConfirmed(int id)
{
    var student = await _context.Students
        .AsNoTracking()
        .SingleOrDefaultAsync(m => m.ID == id);
    if (student == null)
    {
        return RedirectToAction(nameof(Index));
    }

    try
    {
        _context.Students.Remove(student);
        await _context.SaveChangesAsync();
        return RedirectToAction(nameof(Index));
    }
    catch (DbUpdateException /* ex */)
    {
        //Log the error (uncomment ex variable name and write a log.)
        return RedirectToAction(nameof(Delete), new { id = id, saveChangesError = true });
    }
}

```

This code retrieves the selected entity, then calls the `Remove` method to set the entity's status to `Deleted`. When `SaveChanges` is called, a SQL DELETE command is generated.

### The create-and-attach approach to `HttpPost Delete`

If improving performance in a high-volume application is a priority, you could avoid an unnecessary SQL query by instantiating a Student entity using only the primary key value and then setting the entity state to `Deleted`. That's all that the Entity Framework needs in order to delete the entity. (Don't put this code in your project; it's here just to illustrate an alternative.)

```

[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> DeleteConfirmed(int id)
{
    try
    {
        Student studentToDelete = new Student() { ID = id };
        _context.Entry(studentToDelete).State = EntityState.Deleted;
        await _context.SaveChangesAsync();
        return RedirectToAction(nameof(Index));
    }
    catch (DbUpdateException /* ex */)
    {
        //Log the error (uncomment ex variable name and write a log.)
        return RedirectToAction(nameof(Delete), new { id = id, saveChangesError = true });
    }
}

```

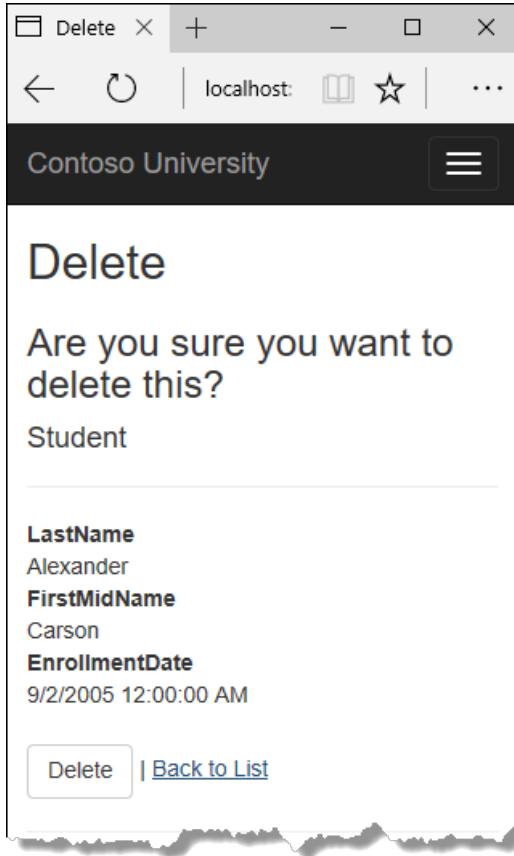
If the entity has related data that should also be deleted, make sure that cascade delete is configured in the database. With this approach to entity deletion, EF might not realize there are related entities to be deleted.

### Update the Delete view

In `Views/Student/Delete.cshtml`, add an error message between the h2 heading and the h3 heading, as shown in the following example:

```
<h2>Delete</h2>
<p class="text-danger">@ViewData["ErrorMessage"]</p>
<h3>Are you sure you want to delete this?</h3>
```

Run the app, select the **Students** tab, and click a **Delete** hyperlink:



Click **Delete**. The Index page is displayed without the deleted student. (You'll see an example of the error handling code in action in the concurrency tutorial.)

## Closing database connections

To free up the resources that a database connection holds, the context instance must be disposed as soon as possible when you are done with it. The ASP.NET Core built-in [dependency injection](#) takes care of that task for you.

In *Startup.cs*, you call the [AddDbContext extension method](#) to provision the `DbContext` class in the ASP.NET DI container. That method sets the service lifetime to `Scoped` by default. `Scoped` means the context object lifetime coincides with the web request life time, and the `Dispose` method will be called automatically at the end of the web request.

## Handling Transactions

By default the Entity Framework implicitly implements transactions. In scenarios where you make changes to multiple rows or tables and then call `SaveChanges`, the Entity Framework automatically makes sure that either all of your changes succeed or they all fail. If some changes are done first and then an error happens, those changes are automatically rolled back. For scenarios where you need more control -- for example, if you want to include operations done outside of Entity Framework in a transaction -- see [Transactions](#).

## No-tracking queries

When a database context retrieves table rows and creates entity objects that represent them, by default it keeps

track of whether the entities in memory are in sync with what's in the database. The data in memory acts as a cache and is used when you update an entity. This caching is often unnecessary in a web application because context instances are typically short-lived (a new one is created and disposed for each request) and the context that reads an entity is typically disposed before that entity is used again.

You can disable tracking of entity objects in memory by calling the `AsNoTracking` method. Typical scenarios in which you might want to do that include the following:

- During the context lifetime you don't need to update any entities, and you don't need EF to automatically load navigation properties with entities retrieved by separate queries. Frequently these conditions are met in a controller's `HttpGet` action methods.
- You are running a query that retrieves a large volume of data, and only a small portion of the returned data will be updated. It may be more efficient to turn off tracking for the large query, and run a query later for the few entities that need to be updated.
- You want to attach an entity in order to update it, but earlier you retrieved the same entity for a different purpose. Because the entity is already being tracked by the database context, you can't attach the entity that you want to change. One way to handle this situation is to call `AsNoTracking` on the earlier query.

For more information, see [Tracking vs. No-Tracking](#).

## Summary

You now have a complete set of pages that perform simple CRUD operations for Student entities. In the next tutorial you'll expand the functionality of the **Index** page by adding sorting, filtering, and paging.

[PREVIOUS](#)

[NEXT](#)

# ASP.NET Core MVC with EF Core - Sort, Filter, Paging - 3 of 10

6/28/2018 • 15 minutes to read • [Edit Online](#)

This tutorial has not been upgraded to ASP.NET Core 2.1. The ASP.NET Core 2.0 version of this tutorial is available by selecting **ASP.NET Core 2.0** above the table of contents or at the top of the page:

The ASP.NET Core 2.1 Razor Pages version of this tutorial has many improvements over the 2.0 version.

The 2.0 tutorial teaches ASP.NET Core MVC and Entity Framework Core with controllers and views. Razor Pages is a page-based programming model that makes building web UI easier and more productive. We recommend the [Razor Pages](#) tutorial over the MVC version. The Razor Pages tutorial:

- Is easier to follow. For example, the scaffolding code has been significantly simplified.
- Provides more EF Core best practices.
- Uses more efficient queries.
- Is more current with the latest API.
- Covers more features.
- Is the preferred approach for new application development.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub discussion](#).

By [Tom Dykstra](#) and [Rick Anderson](#)

The Contoso University sample web application demonstrates how to create ASP.NET Core MVC web applications using Entity Framework Core and Visual Studio. For information about the tutorial series, see [the first tutorial in the series](#).

In the previous tutorial, you implemented a set of web pages for basic CRUD operations for Student entities. In this tutorial you'll add sorting, filtering, and paging functionality to the Students Index page. You'll also create a page that does simple grouping.

The following illustration shows what the page will look like when you're done. The column headings are links that the user can click to sort by that column. Clicking a column heading repeatedly toggles between ascending and descending sort order.

The screenshot shows a browser window with the title "Index - Contoso University". The address bar says "localhost:5813/Student". The main content is titled "Contoso University" with a three-line menu icon. Below it is the word "Index". A "Create New" link is visible. A search bar with placeholder "Find by name:" and a "Search" button is present. Below the search is a table header with columns "Last Name", "First Name", and "Enrollment Date". Three student records are listed:

Last Name	First Name	Enrollment Date	
Alexander	Carson	9/1/2005 12:00:00 AM	Edit   Details   Delete
Alonso	Meredith	9/1/2002 12:00:00 AM	Edit   Details   Delete
Anand	Arturo	9/1/2003 12:00:00 AM	Edit   Details   Delete

At the bottom are "Previous" and "Next" navigation buttons.

## Add Column Sort Links to the Students Index Page

To add sorting to the Student Index page, you'll change the `Index` method of the Students controller and add code to the Student Index view.

### Add sorting Functionality to the Index method

In `StudentsController.cs`, replace the `Index` method with the following code:

```
public async Task<IActionResult> Index(string sortOrder)
{
    ViewData["NameSortParm"] = String.IsNullOrEmpty(sortOrder) ? "name_desc" : "";
    ViewData["DateSortParm"] = sortOrder == "Date" ? "date_desc" : "Date";
    var students = from s in _context.Students
                  select s;
    switch (sortOrder)
    {
        case "name_desc":
            students = students.OrderByDescending(s => s.LastName);
            break;
        case "Date":
            students = students.OrderBy(s => s.EnrollmentDate);
            break;
        case "date_desc":
            students = students.OrderByDescending(s => s.EnrollmentDate);
            break;
        default:
            students = students.OrderBy(s => s.LastName);
            break;
    }
    return View(await students.AsNoTracking().ToListAsync());
}
```

This code receives a `sortOrder` parameter from the query string in the URL. The query string value is provided by ASP.NET Core MVC as a parameter to the action method. The parameter will be a string that's either "Name" or "Date", optionally followed by an underscore and the string "desc" to specify descending order. The default sort order is ascending.

The first time the Index page is requested, there's no query string. The students are displayed in ascending order by last name, which is the default as established by the fall-through case in the `switch` statement. When the user clicks a column heading hyperlink, the appropriate `sortOrder` value is provided in the query string.

The two `ViewData` elements (`NameSortParm` and `DateSortParm`) are used by the view to configure the column heading hyperlinks with the appropriate query string values.

```
public async Task<IActionResult> Index(string sortOrder)
{
    ViewData["NameSortParm"] = String.IsNullOrEmpty(sortOrder) ? "name_desc" : "";
    ViewData["DateSortParm"] = sortOrder == "Date" ? "date_desc" : "Date";
    var students = from s in _context.Students
                  select s;
    switch (sortOrder)
    {
        case "name_desc":
            students = students.OrderByDescending(s => s.LastName);
            break;
        case "Date":
            students = students.OrderBy(s => s.EnrollmentDate);
            break;
        case "date_desc":
            students = students.OrderByDescending(s => s.EnrollmentDate);
            break;
        default:
            students = students.OrderBy(s => s.LastName);
            break;
    }
    return View(await students.AsNoTracking().ToListAsync());
}
```

These are ternary statements. The first one specifies that if the `sortOrder` parameter is null or empty, `NameSortParm` should be set to "name\_desc"; otherwise, it should be set to an empty string. These two statements enable the view to set the column heading hyperlinks as follows:

CURRENT SORT ORDER	LAST NAME HYPERLINK	DATE HYPERLINK
Last Name ascending	descending	ascending
Last Name descending	ascending	ascending
Date ascending	ascending	descending
Date descending	ascending	ascending

The method uses LINQ to Entities to specify the column to sort by. The code creates an `IQueryable` variable before the `switch` statement, modifies it in the `switch` statement, and calls the `ToToListAsync` method after the `switch` statement. When you create and modify `IQueryable` variables, no query is sent to the database. The query isn't executed until you convert the `IQueryable` object into a collection by calling a method such as `ToToListAsync`. Therefore, this code results in a single query that's not executed until the `return View` statement.

This code could get verbose with a large number of columns. [The last tutorial in this series](#) shows how to write code that lets you pass the name of the `OrderBy` column in a string variable.

### Add column heading hyperlinks to the Student Index view

Replace the code in `Views/Students/Index.cshtml`, with the following code to add column heading hyperlinks. The changed lines are highlighted.

```

@model IEnumerable<ContosoUniversity.Models.Student>

 @{
     ViewData["Title"] = "Index";
 }

<h2>Index</h2>

<p>
    <a asp-action="Create">Create New</a>
</p>
<table class="table">
    <thead>
        <tr>
            <th>
                <a asp-action="Index" asp-route-
sortOrder="@ViewData["NameSortParm"]">@Html.DisplayNameFor(model => model.LastName)</a>
            </th>
            <th>
                @Html.DisplayNameFor(model => model.FirstMidName)
            </th>
            <th>
                <a asp-action="Index" asp-route-
sortOrder="@ViewData["DateSortParm"]">@Html.DisplayNameFor(model => model.EnrollmentDate)</a>
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
@foreach (var item in Model) {
        <tr>
            <td>
                @Html.DisplayFor(modelItem => item.LastName)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.FirstMidName)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.EnrollmentDate)
            </td>
            <td>
                <a asp-action="Edit" asp-route-id="@item.ID">Edit</a> |
                <a asp-action="Details" asp-route-id="@item.ID">Details</a> |
                <a asp-action="Delete" asp-route-id="@item.ID">Delete</a>
            </td>
        </tr>
}
    </tbody>
</table>

```

This code uses the information in `ViewData` properties to set up hyperlinks with the appropriate query string values.

Run the app, select the **Students** tab, and click the **Last Name** and **Enrollment Date** column headings to verify that sorting works.

Last Name	First Mid Name	Enrollment Date	
Alexander	Carson	9/2/2005 12:00:00 AM	Edit   Details   Delete
Alonso	Meredith	9/1/2002 12:00:00 AM	Edit   Details   Delete
Anand	Arturo	9/1/2003 12:00:00 AM	Edit   Details   Delete
Barzdukas	Gytis	9/1/2002 12:00:00 AM	Edit   Details   Delete

## Add a Search Box to the Students Index page

To add filtering to the Students Index page, you'll add a text box and a submit button to the view and make corresponding changes in the `Index` method. The text box will let you enter a string to search for in the first name and last name fields.

### Add filtering functionality to the Index method

In `StudentsController.cs`, replace the `Index` method with the following code (the changes are highlighted).

```
public async Task<IActionResult> Index(string sortOrder, string searchString)
{
    ViewData["NameSortParm"] = String.IsNullOrEmpty(sortOrder) ? "name_desc" : "";
    ViewData["DateSortParm"] = sortOrder == "Date" ? "date_desc" : "Date";
    ViewData["CurrentFilter"] = searchString;

    var students = from s in _context.Students
                  select s;
    if (!String.IsNullOrEmpty(searchString))
    {
        students = students.Where(s => s.LastName.Contains(searchString)
                           || s.FirstMidName.Contains(searchString));
    }
    switch (sortOrder)
    {
        case "name_desc":
            students = students.OrderByDescending(s => s.LastName);
            break;
        case "Date":
            students = students.OrderBy(s => s.EnrollmentDate);
            break;
        case "date_desc":
            students = students.OrderByDescending(s => s.EnrollmentDate);
            break;
        default:
            students = students.OrderBy(s => s.LastName);
            break;
    }
    return View(await students.AsNoTracking().ToListAsync());
}
```

You've added a `searchString` parameter to the `Index` method. The search string value is received from a text box that you'll add to the Index view. You've also added to the LINQ statement a where clause that selects only students whose first name or last name contains the search string. The statement that adds the where clause is executed only if there's a value to search for.

#### NOTE

Here you are calling the `Where` method on an `IQueryable` object, and the filter will be processed on the server. In some scenarios you might be calling the `Where` method as an extension method on an in-memory collection. (For example, suppose you change the reference to `_context.Students` so that instead of an EF `DbSet` it references a repository method that returns an `IEnumerable` collection.) The result would normally be the same but in some cases may be different.

For example, the .NET Framework implementation of the `Contains` method performs a case-sensitive comparison by default, but in SQL Server this is determined by the collation setting of the SQL Server instance. That setting defaults to case-insensitive. You could call the `ToUpper` method to make the test explicitly case-insensitive: `Where(s => s.LastName.ToUpper().Contains(searchString.ToUpper()))`. That would ensure that results stay the same if you change the code later to use a repository which returns an `IEnumerable` collection instead of an `IQueryable` object. (When you call the `Contains` method on an `IEnumerable` collection, you get the .NET Framework implementation; when you call it on an `IQueryable` object, you get the database provider implementation.) However, there's a performance penalty for this solution. The `ToUpper` code would put a function in the WHERE clause of the TSQL SELECT statement. That would prevent the optimizer from using an index. Given that SQL is mostly installed as case-insensitive, it's best to avoid the `ToUpper` code until you migrate to a case-sensitive data store.

## Add a Search Box to the Student Index View

In `Views/Student/Index.cshtml`, add the highlighted code immediately before the opening table tag in order to create a caption, a text box, and a **Search** button.

```
<p>
    <a asp-action="Create">Create New</a>
</p>

<form asp-action="Index" method="get">
    <div class="form-actions no-color">
        <p>
            Find by name: <input type="text" name="SearchString" value="@ViewData["currentFilter"]" />
            <input type="submit" value="Search" class="btn btn-default" /> |
            <a asp-action="Index">Back to Full List</a>
        </p>
    </div>
</form>

<table class="table">
```

This code uses the `<form>` tag helper to add the search text box and button. By default, the `<form>` tag helper submits form data with a POST, which means that parameters are passed in the HTTP message body and not in the URL as query strings. When you specify HTTP GET, the form data is passed in the URL as query strings, which enables users to bookmark the URL. The W3C guidelines recommend that you should use GET when the action doesn't result in an update.

Run the app, select the **Students** tab, enter a search string, and click Search to verify that filtering is working.

Last Name	First Mid Name	Enrollment Date	
Alexander	Carson	9/2/2005 12:00:00 AM	Edit   Details   Delete
Anand	Arturo	9/1/2003 12:00:00 AM	Edit   Details   Delete
Li	Yan	9/1/2002 12:00:00 AM	Edit   Details   Delete
Norman	Laura	9/1/2003 12:00:00 AM	Edit   Details   Delete

Notice that the URL contains the search string.

```
http://localhost:5813/Students?SearchString=an
```

If you bookmark this page, you'll get the filtered list when you use the bookmark. Adding `method="get"` to the `form` tag is what caused the query string to be generated.

At this stage, if you click a column heading sort link you'll lose the filter value that you entered in the **Search** box. You'll fix that in the next section.

## Add paging functionality to the Students Index page

To add paging to the Students Index page, you'll create a `PaginatedList` class that uses `Skip` and `Take` statements to filter data on the server instead of always retrieving all rows of the table. Then you'll make additional changes in the `Index` method and add paging buttons to the `Index` view. The following illustration shows the paging buttons.

The screenshot shows a web browser window with the title "Index - Contoso Univers" and the URL "localhost:5813/Student". The page header includes a back arrow, forward arrow, refresh button, and a search bar with placeholder "Find by name:" and a "Search" button. Below the header is a navigation menu with three horizontal bars. The main content area is titled "Index" and contains a "Create New" link. A search bar with placeholder "Find by name:" and a "Search" button is followed by a link "Back to Full List". A table lists student information with columns "Last Name", "First Name", and "Enrollment Date". The data rows are:

Last Name	First Name	Enrollment Date	
Alexander	Carson	9/1/2005 12:00:00 AM	Edit   Details   Delete
Alonso	Meredith	9/1/2002 12:00:00 AM	Edit   Details   Delete
Anand	Arturo	9/1/2003 12:00:00 AM	Edit   Details   Delete

At the bottom of the page are "Previous" and "Next" navigation buttons.

In the project folder, create `PaginatedList.cs`, and then replace the template code with the following code.

```

using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.EntityFrameworkCore;

namespace ContosoUniversity
{
    public class PaginatedList<T> : List<T>
    {
        public int PageIndex { get; private set; }
        public int TotalPages { get; private set; }

        public PaginatedList(List<T> items, int count, int pageIndex, int pageSize)
        {
            PageIndex = pageIndex;
            TotalPages = (int)Math.Ceiling(count / (double)pageSize);

            this.AddRange(items);
        }

        public bool HasPreviousPage
        {
            get
            {
                return (PageIndex > 1);
            }
        }

        public bool HasNextPage
        {
            get
            {
                return (PageIndex < TotalPages);
            }
        }

        public static async Task<PaginatedList<T>> CreateAsync(IQueryable<T> source, int pageIndex, int pageSize)
        {
            var count = await source.CountAsync();
            var items = await source.Skip((pageIndex - 1) * pageSize).Take(pageSize).ToListAsync();
            return new PaginatedList<T>(items, count, pageIndex, pageSize);
        }
    }
}

```

The `CreateAsync` method in this code takes page size and page number and applies the appropriate `skip` and `Take` statements to the `IQueryable`. When `ToListAsync` is called on the `IQueryable`, it will return a List containing only the requested page. The properties `HasPreviousPage` and `HasNextPage` can be used to enable or disable **Previous** and **Next** paging buttons.

A `CreateAsync` method is used instead of a constructor to create the `PaginatedList<T>` object because constructors can't run asynchronous code.

## Add paging functionality to the Index method

In `StudentsController.cs`, replace the `Index` method with the following code.

```

public async Task<IActionResult> Index(
    string sortOrder,
    string currentFilter,
    string searchString,
    int? page)
{
    ViewData["CurrentSort"] = sortOrder;
    ViewData["NameSortParm"] = String.IsNullOrEmpty(sortOrder) ? "name_desc" : "";
    ViewData["DateSortParm"] = sortOrder == "Date" ? "date_desc" : "Date";

    if (searchString != null)
    {
        page = 1;
    }
    else
    {
        searchString = currentFilter;
    }

    ViewData["CurrentFilter"] = searchString;

    var students = from s in _context.Students
                  select s;
    if (!String.IsNullOrEmpty(searchString))
    {
        students = students.Where(s => s.LastName.Contains(searchString)
                           || s.FirstMidName.Contains(searchString));
    }
    switch (sortOrder)
    {
        case "name_desc":
            students = students.OrderByDescending(s => s.LastName);
            break;
        case "Date":
            students = students.OrderBy(s => s.EnrollmentDate);
            break;
        case "date_desc":
            students = students.OrderByDescending(s => s.EnrollmentDate);
            break;
        default:
            students = students.OrderBy(s => s.LastName);
            break;
    }

    int pageSize = 3;
    return View(await PaginatedList<Student>.CreateAsync(students.AsNoTracking(), page ?? 1, pageSize));
}

```

This code adds a page number parameter, a current sort order parameter, and a current filter parameter to the method signature.

```

public async Task<IActionResult> Index(
    string sortOrder,
    string currentFilter,
    string searchString,
    int? page)

```

The first time the page is displayed, or if the user hasn't clicked a paging or sorting link, all the parameters will be null. If a paging link is clicked, the page variable will contain the page number to display.

The `viewData` element named CurrentSort provides the view with the current sort order, because this must be included in the paging links in order to keep the sort order the same while paging.

The `viewData` element named `CurrentFilter` provides the view with the current filter string. This value must be included in the paging links in order to maintain the filter settings during paging, and it must be restored to the text box when the page is redisplayed.

If the search string is changed during paging, the page has to be reset to 1, because the new filter can result in different data to display. The search string is changed when a value is entered in the text box and the Submit button is pressed. In that case, the `searchString` parameter isn't null.

```
if (searchString != null)
{
    page = 1;
}
else
{
    searchString = currentFilter;
}
```

At the end of the `Index` method, the `PaginatedList.CreateAsync` method converts the student query to a single page of students in a collection type that supports paging. That single page of students is then passed to the view.

```
return View(await PaginatedList<Student>.CreateAsync(students.AsNoTracking(), page ?? 1, pageSize));
```

The `PaginatedList.CreateAsync` method takes a page number. The two question marks represent the null-coalescing operator. The null-coalescing operator defines a default value for a nullable type; the expression `(page ?? 1)` means return the value of `page` if it has a value, or return 1 if `page` is null.

## Add paging links to the Student Index view

In `Views/Students/Index.cshtml`, replace the existing code with the following code. The changes are highlighted.

```
@model PaginatedList<ContosoUniversity.Models.Student>

@{
    ViewData["Title"] = "Index";
}



## Index



Create New



<form asp-action="Index" method="get">
    <div class="form-actions no-color">
        <p>
            Find by name: <input type="text" name="SearchString" value="@ViewData["currentFilter"]" />
            <input type="submit" value="Search" class="btn btn-default" /> |
            <a href="#">Back to Full List

    <tr>
        <th>
            <a href="#" asp-route-sortOrder="@ViewData["NameSortParm]" asp-route-currentFilter="@ViewData["CurrentFilter"]">Last Name</a>
        </th>
        <th>
            First Name
        </th>
    </tr>

    <tr>
        <td>
            <a href="#" asp-route-sortOrder="@ViewData["NameSortParm]" asp-route-currentFilter="@ViewData["CurrentFilter"]">Last Name</a>
        </td>
        <td>
            First Name
        </td>
    </tr>

```

```


| <a asp-action="Index" asp-route-currentfilter="@ViewData[" asp-route-sortorder="@ViewData[" currentfilter"]"="" datesortparm]"="" href="#">Enrollment Date</a> |  |  |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|
|                                                                                                                                                                |  |  |  |



@foreach (var item in Model)
    {
        <tr>
            <td>
                @Html.DisplayFor(modelItem => item.LastName)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.FirstMidName)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.EnrollmentDate)
            </td>
            <td>
                <a href="#" asp-action="Edit" asp-route-id="@item.ID">Edit</a> | 
                <a href="#" asp-action="Details" asp-route-id="@item.ID">Details</a> | 
                <a href="#" asp-action="Delete" asp-route-id="@item.ID">Delete</a>
            </td>
        </tr>
    }



@{
        var prevDisabled = !Model.HasPreviousPage ? "disabled" : "";
        var nextDisabled = !Model.HasNextPage ? "disabled" : "";
    }



Previous
  

Next


```

The `@model` statement at the top of the page specifies that the view now gets a `PaginatedList<T>` object instead of a `List<T>` object.

The column header links use the query string to pass the current search string to the controller so that the user can sort within filter results:

```

<a href="#" asp-action="Index" asp-route-sortOrder="@ViewData["DateSortParm]" asp-route-currentFilter="@ViewData["CurrentFilter"]">Enrollment Date

```

The paging buttons are displayed by tag helpers:

```

<a asp-action="Index"
asp-route-sortOrder="@ViewData["CurrentSort"]"
asp-route-page="@(ModelPageIndex - 1)"
asp-route-currentFilter="@ViewData["CurrentFilter"]"
class="btn btn-default @prevDisabled">
Previous
</a>

```

Run the app and go to the Students page.

Last Name	First Name	Enrollment Date	
Alexander	Carson	9/1/2005 12:00:00 AM	Edit   Details   Delete
Alonso	Meredith	9/1/2002 12:00:00 AM	Edit   Details   Delete
Anand	Arturo	9/1/2003 12:00:00 AM	Edit   Details   Delete

Click the paging links in different sort orders to make sure paging works. Then enter a search string and try paging again to verify that paging also works correctly with sorting and filtering.

## Create an About page that shows Student statistics

For the Contoso University website's **About** page, you'll display how many students have enrolled for each enrollment date. This requires grouping and simple calculations on the groups. To accomplish this, you'll do the following:

- Create a view model class for the data that you need to pass to the view.
- Modify the About method in the Home controller.
- Modify the About view.

### Create the view model

Create a *SchoolViewModels* folder in the *Models* folder.

In the new folder, add a class file *EnrollmentDateGroup.cs* and replace the template code with the following code:

```

using System;
using System.ComponentModel.DataAnnotations;

namespace ContosoUniversity.Models.SchoolViewModels
{
    public class EnrollmentDateGroup
    {
        [DataType(DataType.Date)]
        public DateTime? EnrollmentDate { get; set; }

        public int StudentCount { get; set; }
    }
}

```

## Modify the Home Controller

In *HomeController.cs*, add the following using statements at the top of the file:

```

using Microsoft.EntityFrameworkCore;
using ContosoUniversity.Data;
using ContosoUniversity.Models.SchoolViewModels;

```

Add a class variable for the database context immediately after the opening curly brace for the class, and get an instance of the context from ASP.NET Core DI:

```

public class HomeController : Controller
{
    private readonly SchoolContext _context;

    public HomeController(SchoolContext context)
    {
        _context = context;
    }
}

```

Replace the `About` method with the following code:

```

public async Task<ActionResult> About()
{
    IQueryable<EnrollmentDateGroup> data =
        from student in _context.Students
        group student by student.EnrollmentDate into dateGroup
        select new EnrollmentDateGroup()
    {
        EnrollmentDate = dateGroup.Key,
        StudentCount = dateGroup.Count()
    };
    return View(await data.AsNoTracking().ToListAsync());
}

```

The LINQ statement groups the student entities by enrollment date, calculates the number of entities in each group, and stores the results in a collection of `EnrollmentDateGroup` view model objects.

### NOTE

In the 1.0 version of Entity Framework Core, the entire result set is returned to the client, and grouping is done on the client. In some scenarios this could create performance problems. Be sure to test performance with production volumes of data, and if necessary use raw SQL to do the grouping on the server. For information about how to use raw SQL, see [the last tutorial in this series](#).

## Modify the About View

Replace the code in the `Views/Home/About.cshtml` file with the following code:

```
@model IEnumerable<ContosoUniversity.Models.SchoolViewModels.EnrollmentDateGroup>

@{
    ViewData["Title"] = "Student Body Statistics";
}



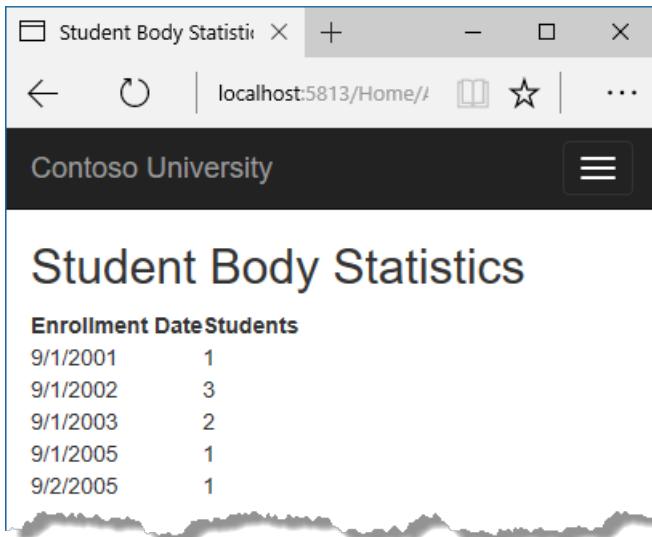
## Student Body Statistics



| Enrollment Date | Students |
|-----------------|----------|
|-----------------|----------|


```

Run the app and go to the About page. The count of students for each enrollment date is displayed in a table.



## Summary

In this tutorial, you've seen how to perform sorting, filtering, paging, and grouping. In the next tutorial, you'll learn how to handle data model changes by using migrations.

[PREVIOUS](#)

[NEXT](#)

# ASP.NET Core MVC with EF Core - Migrations - 4 of 10

6/28/2018 • 8 minutes to read • [Edit Online](#)

This tutorial has not been upgraded to ASP.NET Core 2.1. The ASP.NET Core 2.0 version of this tutorial is available by selecting **ASP.NET Core 2.0** above the table of contents or at the top of the page:

The ASP.NET Core 2.1 Razor Pages version of this tutorial has many improvements over the 2.0 version.

The 2.0 tutorial teaches ASP.NET Core MVC and Entity Framework Core with controllers and views. Razor Pages is a page-based programming model that makes building web UI easier and more productive. We recommend the [Razor Pages](#) tutorial over the MVC version. The Razor Pages tutorial:

- Is easier to follow. For example, the scaffolding code has been significantly simplified.
- Provides more EF Core best practices.
- Uses more efficient queries.
- Is more current with the latest API.
- Covers more features.
- Is the preferred approach for new application development.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub discussion](#).

By [Tom Dykstra](#) and [Rick Anderson](#)

The Contoso University sample web application demonstrates how to create ASP.NET Core MVC web applications using Entity Framework Core and Visual Studio. For information about the tutorial series, see [the first tutorial in the series](#).

In this tutorial, you start using the EF Core migrations feature for managing data model changes. In later tutorials, you'll add more migrations as you change the data model.

## Introduction to migrations

When you develop a new application, your data model changes frequently, and each time the model changes, it gets out of sync with the database. You started these tutorials by configuring the Entity Framework to create the database if it doesn't exist. Then each time you change the data model -- add, remove, or change entity classes or change your DbContext class -- you can delete the database and EF creates a new one that matches the model, and seeds it with test data.

This method of keeping the database in sync with the data model works well until you deploy the application to production. When the application is running in production it's usually storing data that you want to keep, and you don't want to lose everything each time you make a change such as adding a new column. The EF Core Migrations feature solves this problem by enabling EF to update the database schema instead of creating a new database.

## Entity Framework Core NuGet packages for migrations

To work with migrations, you can use the **Package Manager Console** (PMC) or the command-line interface (CLI). These tutorials show how to use CLI commands. Information about the PMC is at [the end of this tutorial](#).

The EF tools for the command-line interface (CLI) are provided in [Microsoft.EntityFrameworkCore.Tools.DotNet](#).

To install this package, add it to the `DotNetCliToolReference` collection in the `.csproj` file, as shown. **Note:** You have to install this package by editing the `.csproj` file; you can't use the `install-package` command or the package manager GUI. You can edit the `.csproj` file by right-clicking the project name in **Solution Explorer** and selecting **Edit ContosoUniversity.csproj**.

```
<ItemGroup>
  <DotNetCliToolReference Include="Microsoft.EntityFrameworkCore.Tools.DotNet" Version="2.0.0" />
  <DotNetCliToolReference Include="Microsoft.VisualStudio.Web.CodeGeneration.Tools" Version="2.0.0" />
</ItemGroup>
```

(The version numbers in this example were current when the tutorial was written.)

## Change the connection string

In the `appsettings.json` file, change the name of the database in the connection string to `ContosoUniversity2` or some other name that you haven't used on the computer you're using.

```
{
  "ConnectionStrings": {
    "DefaultConnection": "Server=(localdb)\\mssqllocaldb;Database=ContosoUniversity2;Trusted_Connection=True;MultipleActiveResultSets=true"
  },
}
```

This change sets up the project so that the first migration will create a new database. This isn't required to get started with migrations, but you'll see later why it's a good idea.

### NOTE

As an alternative to changing the database name, you can delete the database. Use **SQL Server Object Explorer** (SSOX) or the `database drop` CLI command:

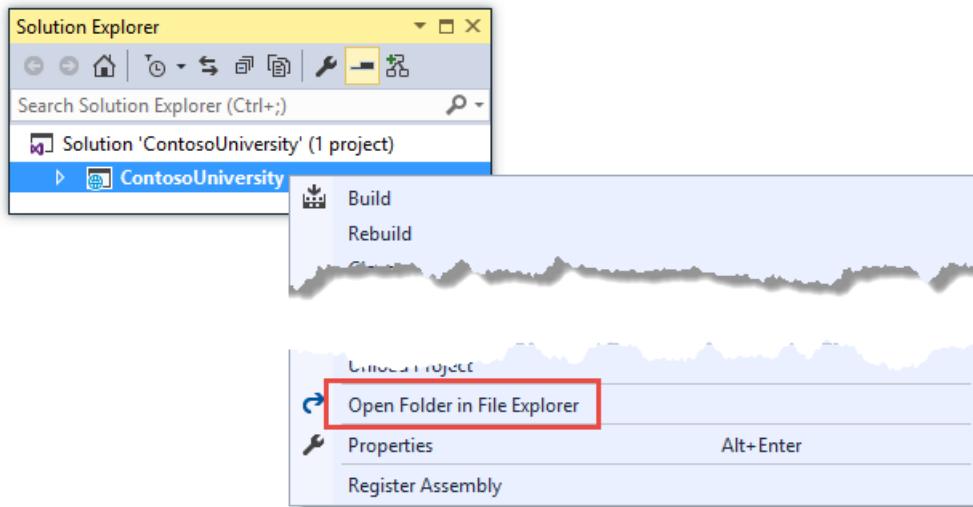
```
dotnet ef database drop
```

The following section explains how to run CLI commands.

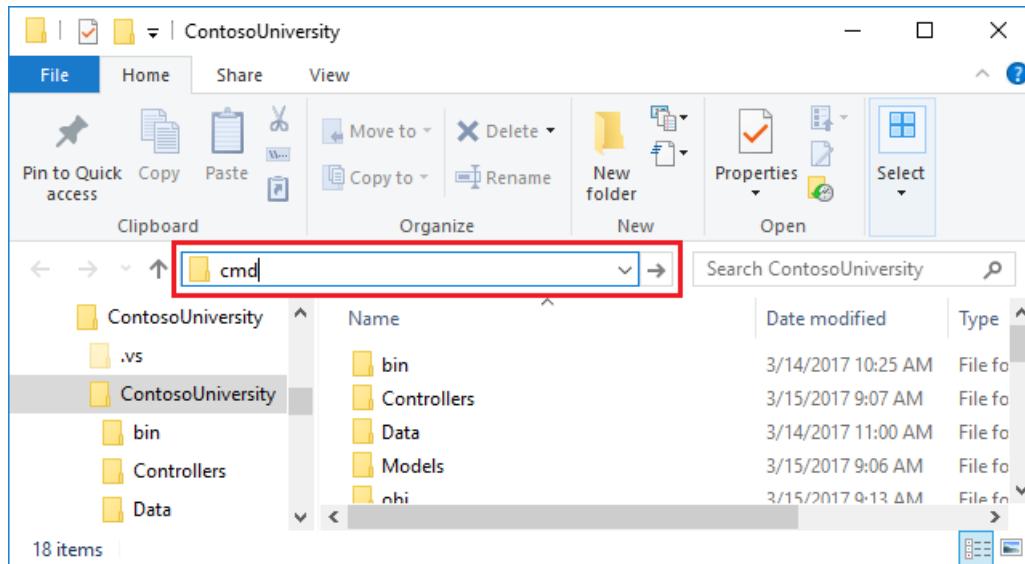
## Create an initial migration

Save your changes and build the project. Then open a command window and navigate to the project folder. Here's a quick way to do that:

- In **Solution Explorer**, right-click the project and choose **Open in File Explorer** from the context menu.



- Enter "cmd" in the address bar and press Enter.



Enter the following command in the command window:

```
dotnet ef migrations add InitialCreate
```

You see output like the following in the command window:

```
info: Microsoft.AspNetCore.DataProtection.KeyManagement.XmlKeyManager[0]
User profile is available. Using 'C:\Users\username\AppData\Local\ASP.NET\DataProtection-Keys' as key
repository and Windows DPAPI to encrypt keys at rest.
info: Microsoft.EntityFrameworkCore.Infrastructure[100403]
Entity Framework Core 2.0.0-rtm-26452 initialized 'SchoolContext' using provider
'Microsoft.EntityFrameworkCore.SqlServer' with options: None
Done. To undo this action, use 'ef migrations remove'
```

#### NOTE

If you see an error message *No executable found matching command "dotnet-ef"*, see [this blog post](#) for help troubleshooting.

If you see an error message "*cannot access the file ... ContosoUniversity.dll because it is being used by another process.*", find the IIS Express icon in the Windows System Tray, and right-click it, then click **ContosoUniversity > Stop Site**.

## Examine the Up and Down methods

When you executed the `migrations add` command, EF generated the code that will create the database from scratch. This code is in the *Migrations* folder, in the file named `<timestamp>_InitialCreate.cs`. The `Up` method of the `InitialCreate` class creates the database tables that correspond to the data model entity sets, and the `Down` method deletes them, as shown in the following example.

```
public partial class InitialCreate : Migration
{
    protected override void Up(MigrationBuilder migrationBuilder)
    {
        migrationBuilder.CreateTable(
            name: "Course",
            columns: table => new
            {
                CourseID = table.Column<int>(nullable: false),
                Credits = table.Column<int>(nullable: false),
                Title = table.Column<string>(nullable: true)
            },
            constraints: table =>
            {
                table.PrimaryKey("PK_Course", x => x.CourseID);
            });
    }

    // Additional code not shown
}

protected override void Down(MigrationBuilder migrationBuilder)
{
    migrationBuilder.DropTable(
        name: "Enrollment");
    // Additional code not shown
}
```

Migrations calls the `Up` method to implement the data model changes for a migration. When you enter a command to roll back the update, Migrations calls the `Down` method.

This code is for the initial migration that was created when you entered the `migrations add InitialCreate` command. The migration name parameter ("InitialCreate" in the example) is used for the file name and can be whatever you want. It's best to choose a word or phrase that summarizes what is being done in the migration. For example, you might name a later migration "AddDepartmentTable".

If you created the initial migration when the database already exists, the database creation code is generated but it doesn't have to run because the database already matches the data model. When you deploy the app to another environment where the database doesn't exist yet, this code will run to create your database, so it's a good idea to test it first. That's why you changed the name of the database in the connection string earlier -- so that migrations can create a new one from scratch.

## The data model snapshot

Migrations creates a *snapshot* of the current database schema in `Migrations/SchoolContextModelSnapshot.cs`. When you add a migration, EF determines what changed by comparing the data model to the snapshot file.

When deleting a migration, use the `dotnet ef migrations remove` command. `dotnet ef migrations remove` deletes the migration and ensures the snapshot is correctly reset.

See [EF Core Migrations in Team Environments](#) for more information about how the snapshot file is used.

## Apply the migration to the database

In the command window, enter the following command to create the database and tables in it.

```
dotnet ef database update
```

The output from the command is similar to the `migrations add` command, except that you see logs for the SQL commands that set up the database. Most of the logs are omitted in the following sample output. If you prefer not to see this level of detail in log messages, you can change the log level in the `appsettings.Development.json` file. For more information, see [Introduction to logging](#).

```
info: Microsoft.AspNetCore.DataProtection.KeyManagement.XmlKeyManager[0]
User profile is available. Using 'C:\Users\username\AppData\Local\ASP.NET\DataProtection-Keys' as key
repository and Windows DPAPI to encrypt keys at rest.
info: Microsoft.EntityFrameworkCore.Infrastructure[100403]
Entity Framework Core 2.0.0-rtm-26452 initialized 'SchoolContext' using provider
'Microsoft.EntityFrameworkCore.SqlServer' with options: None
info: Microsoft.EntityFrameworkCore.Database.Command[200101]
Executed DbCommand (467ms) [Parameters=[], CommandType='Text', CommandTimeout='60']
CREATE DATABASE [ContosoUniversity2];
info: Microsoft.EntityFrameworkCore.Database.Command[200101]
Executed DbCommand (20ms) [Parameters=[], CommandType='Text', CommandTimeout='30']
CREATE TABLE [__EFMigrationsHistory] (
[MigrationId] nvarchar(150) NOT NULL,
[ProductVersion] nvarchar(32) NOT NULL,
CONSTRAINT [PK__EFMigrationsHistory] PRIMARY KEY ([MigrationId])
);

<logs omitted for brevity>

info: Microsoft.EntityFrameworkCore.Database.Command[200101]
Executed DbCommand (3ms) [Parameters=[], CommandType='Text', CommandTimeout='30']
INSERT INTO [__EFMigrationsHistory] ([MigrationId], [ProductVersion])
VALUES (N'20170816151242_InitialCreate', N'2.0.0-rtm-26452');
Done.
```

Use **SQL Server Object Explorer** to inspect the database as you did in the first tutorial. You'll notice the addition of an `__EFMigrationsHistory` table that keeps track of which migrations have been applied to the database. View the data in that table and you'll see one row for the first migration. (The last log in the preceding CLI output example shows the `INSERT` statement that creates this row.)

Run the application to verify that everything still works the same as before.

The screenshot shows a web browser window with the title "Index - Contoso University". The address bar indicates the URL is "localhost:5813/Student". The main content area is titled "Contoso University" and features a heading "Index". Below the heading is a "Create New" link. A search bar with the placeholder "Find by name:" and a "Search" button is present. A "Back to Full List" link is also visible. The data is presented in a table format with three columns: "Last Name", "First Name", and "Enrollment Date". The table contains three rows of data:

Last Name	First Name	Enrollment Date
Alexander	Carson	9/1/2005 12:00:00 AM
Alonso	Meredith	9/1/2002 12:00:00 AM
Anand	Arturo	9/1/2003 12:00:00 AM

Each row has "Edit | Details | Delete" links. At the bottom of the table are "Previous" and "Next" navigation buttons.

## Command-line interface (CLI) vs. Package Manager Console (PMC)

The EF tooling for managing migrations is available from .NET Core CLI commands or from PowerShell cmdlets in the Visual Studio **Package Manager Console** (PMC) window. This tutorial shows how to use the CLI, but you can use the PMC if you prefer.

The EF commands for the PMC commands are in the [Microsoft.EntityFrameworkCore.Tools](#) package. This package is already included in the [Microsoft.AspNetCore.All](#) metapackage, so you don't have to install it.

**Important:** This isn't the same package as the one you install for the CLI by editing the `.csproj` file. The name of this one ends in `Tools`, unlike the CLI package name which ends in `Tools.DotNet`.

For more information about the CLI commands, see [.NET Core CLI](#).

For more information about the PMC commands, see [Package Manager Console \(Visual Studio\)](#).

## Summary

In this tutorial, you've seen how to create and apply your first migration. In the next tutorial, you'll begin looking at more advanced topics by expanding the data model. Along the way you'll create and apply additional migrations.

[PREVIOUS](#) [NEXT](#)

# ASP.NET Core MVC with EF Core - Data Model - 5 of 10

6/28/2018 • 31 minutes to read • [Edit Online](#)

This tutorial has not been upgraded to ASP.NET Core 2.1. The ASP.NET Core 2.0 version of this tutorial is available by selecting **ASP.NET Core 2.0** above the table of contents or at the top of the page:

The ASP.NET Core 2.1 Razor Pages version of this tutorial has many improvements over the 2.0 version.

The 2.0 tutorial teaches ASP.NET Core MVC and Entity Framework Core with controllers and views. Razor Pages is a page-based programming model that makes building web UI easier and more productive. We recommend the [Razor Pages](#) tutorial over the MVC version. The Razor Pages tutorial:

- Is easier to follow. For example, the scaffolding code has been significantly simplified.
- Provides more EF Core best practices.
- Uses more efficient queries.
- Is more current with the latest API.
- Covers more features.
- Is the preferred approach for new application development.

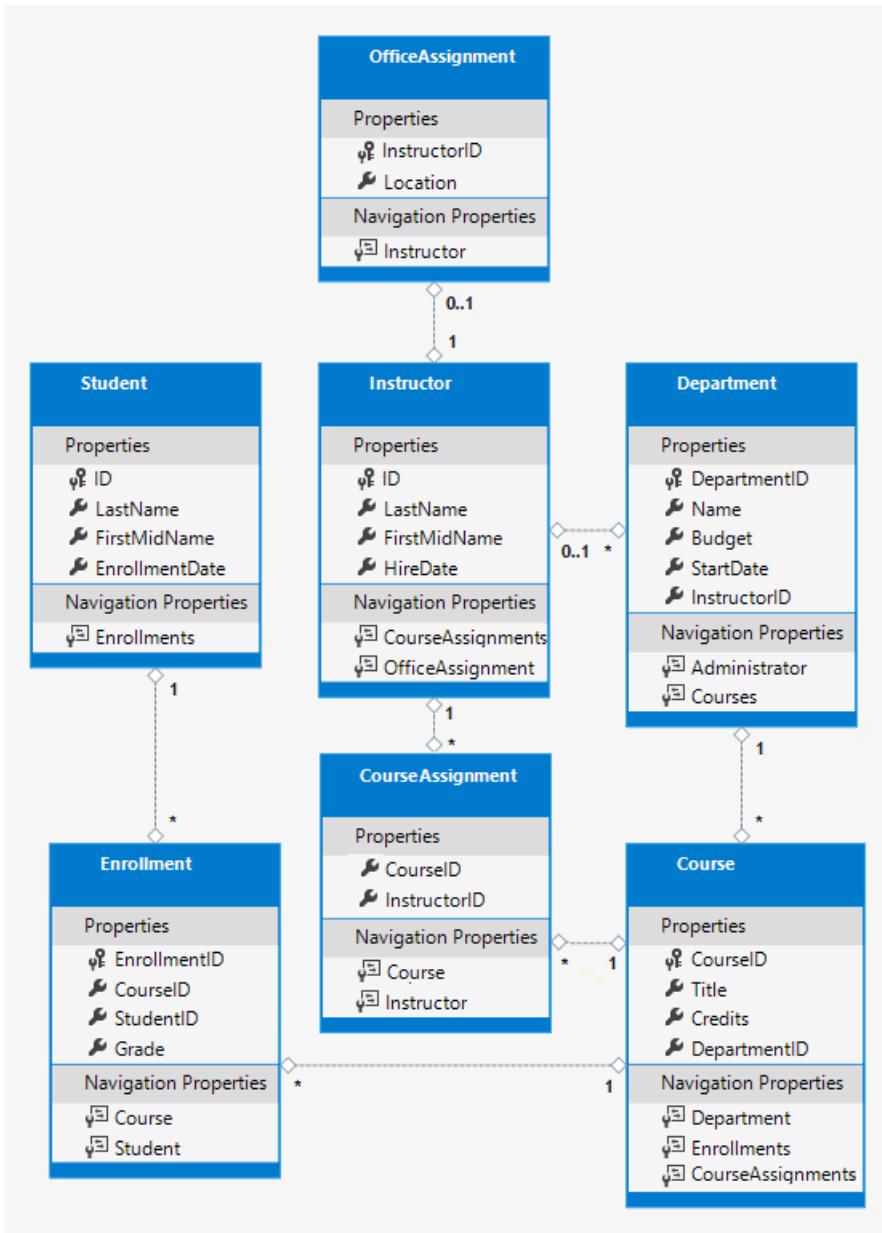
If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub discussion](#).

By [Tom Dykstra](#) and [Rick Anderson](#)

The Contoso University sample web application demonstrates how to create ASP.NET Core MVC web applications using Entity Framework Core and Visual Studio. For information about the tutorial series, see [the first tutorial in the series](#).

In the previous tutorials, you worked with a simple data model that was composed of three entities. In this tutorial, you'll add more entities and relationships and you'll customize the data model by specifying formatting, validation, and database mapping rules.

When you're finished, the entity classes will make up the completed data model that's shown in the following illustration:



## Customize the Data Model by Using Attributes

In this section you'll see how to customize the data model by using attributes that specify formatting, validation, and database mapping rules. Then in several of the following sections you'll create the complete School data model by adding attributes to the classes you already created and creating new classes for the remaining entity types in the model.

### The `DataType` attribute

For student enrollment dates, all of the web pages currently display the time along with the date, although all you care about for this field is the date. By using data annotation attributes, you can make one code change that will fix the display format in every view that shows the data. To see an example of how to do that, you'll add an attribute to the `EnrollmentDate` property in the `Student` class.

In `Models/Student.cs`, add a `using` statement for the `System.ComponentModel.DataAnnotations` namespace and add `DataType` and `DisplayFormat` attributes to the `EnrollmentDate` property, as shown in the following example:

```

using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;

namespace ContosoUniversity.Models
{
    public class Student
    {
        public int ID { get; set; }
        public string LastName { get; set; }
        public string FirstMidName { get; set; }
        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        public DateTime EnrollmentDate { get; set; }

        public ICollection<Enrollment> Enrollments { get; set; }
    }
}

```

The `DataType` attribute is used to specify a data type that's more specific than the database intrinsic type. In this case we only want to keep track of the date, not the date and time. The `DataType` Enumeration provides for many data types, such as Date, Time, PhoneNumber, Currency, EmailAddress, and more. The `DataType` attribute can also enable the application to automatically provide type-specific features. For example, a `mailto:` link can be created for `DataType.EmailAddress`, and a date selector can be provided for `DataType.Date` in browsers that support HTML5. The `DataType` attribute emits HTML 5 `data-` (pronounced data dash) attributes that HTML 5 browsers can understand. The `DataType` attributes don't provide any validation.

`DataType.Date` doesn't specify the format of the date that's displayed. By default, the data field is displayed according to the default formats based on the server's `CultureInfo`.

The `DisplayFormat` attribute is used to explicitly specify the date format:

```
[DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
```

The `ApplyFormatInEditMode` setting specifies that the formatting should also be applied when the value is displayed in a text box for editing. (You might not want that for some fields -- for example, for currency values, you might not want the currency symbol in the text box for editing.)

You can use the `DisplayFormat` attribute by itself, but it's generally a good idea to use the `DataType` attribute also. The `DataType` attribute conveys the semantics of the data as opposed to how to render it on a screen, and provides the following benefits that you don't get with `DisplayFormat`:

- The browser can enable HTML5 features (for example to show a calendar control, the locale-appropriate currency symbol, email links, some client-side input validation, etc.).
- By default, the browser will render data using the correct format based on your locale.

For more information, see the [<input> tag helper documentation](#).

Run the app, go to the Students Index page and notice that times are no longer displayed for the enrollment dates. The same will be true for any view that uses the Student model.

Last Name	First Name	Enrollment Date	
Alexander	Carson	2005-09-01	Edit   Details   Delete
Alonso	Meredith	2002-09-01	Edit   Details   Delete
Anand	Arturo	2003-09-01	Edit   Details   Delete

## The StringLength attribute

You can also specify data validation rules and validation error messages using attributes. The `StringLength` attribute sets the maximum length in the database and provides client side and server side validation for ASP.NET MVC. You can also specify the minimum string length in this attribute, but the minimum value has no impact on the database schema.

Suppose you want to ensure that users don't enter more than 50 characters for a name. To add this limitation, add `StringLength` attributes to the `LastName` and `FirstMidName` properties, as shown in the following example:

```
using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;

namespace ContosoUniversity.Models
{
    public class Student
    {
        public int ID { get; set; }
        [StringLength(50)]
        public string LastName { get; set; }
        [StringLength(50, ErrorMessage = "First name cannot be longer than 50 characters.")]
        public string FirstMidName { get; set; }
        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        public DateTime EnrollmentDate { get; set; }

        public ICollection<Enrollment> Enrollments { get; set; }
    }
}
```

The `StringLength` attribute won't prevent a user from entering white space for a name. You can use the `RegularExpression` attribute to apply restrictions to the input. For example, the following code requires the first character to be upper case and the remaining characters to be alphabetical:

```
[RegularExpression(@"^([A-Z]+[a-zA-Z'''\s-]*)$")]
```

The `MaxLength` attribute provides functionality similar to the `StringLength` attribute but doesn't provide client side validation.

The database model has now changed in a way that requires a change in the database schema. You'll use migrations to update the schema without losing any data that you may have added to the database by using the application UI.

Save your changes and build the project. Then open the command window in the project folder and enter the following commands:

```
dotnet ef migrations add MaxLengthOnNames
```

```
dotnet ef database update
```

The `migrations add` command warns that data loss may occur, because the change makes the maximum length shorter for two columns. Migrations creates a file named `<timeStamp>_MaxLengthOnNames.cs`. This file contains code in the `Up` method that will update the database to match the current data model. The `database update` command ran that code.

The timestamp prefixed to the migrations file name is used by Entity Framework to order the migrations. You can create multiple migrations before running the update-database command, and then all of the migrations are applied in the order in which they were created.

Run the app, select the **Students** tab, click **Create New**, and enter either name longer than 50 characters. When you click **Create**, client side validation shows an error message.

The screenshot shows a browser window with the following details:

- Title Bar:** Create - Contoso University
- Address Bar:** localhost:5813/Student
- Page Title:** Contoso University
- Form Title:** Create
- Form Fields:**
  - Last Name:** Davolio very long last name longer than !  
Error: The field LastName must be a string with a maximum length of 50.
  - First Mid Name:** Nancy very long first name longer than 5  
Error: First name cannot be longer than 50 characters.
  - Enrollment Date:** 2/15/2017
- Buttons:** Create

## The Column attribute

You can also use attributes to control how your classes and properties are mapped to the database. Suppose you had used the name `FirstMidName` for the first-name field because the field might also contain a middle name. But you want the database column to be named `FirstName`, because users who will be writing ad-hoc queries against the database are accustomed to that name. To make this mapping, you can use the `Column` attribute.

The `Column` attribute specifies that when the database is created, the column of the `Student` table that maps to the `FirstMidName` property will be named `FirstName`. In other words, when your code refers to `Student.FirstMidName`, the data will come from or be updated in the `FirstName` column of the `Student` table. If you don't specify column names, they're given the same name as the property name.

In the `Student.cs` file, add a `using` statement for `System.ComponentModel.DataAnnotations.Schema` and add the column name attribute to the `FirstMidName` property, as shown in the following highlighted code:

```
using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Student
    {
        public int ID { get; set; }
        [StringLength(50)]
        public string LastName { get; set; }
        [StringLength(50, ErrorMessage = "First name cannot be longer than 50 characters.")]  

        [Column("FirstName")]
        public string FirstMidName { get; set; }
        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        public DateTime EnrollmentDate { get; set; }

        public ICollection<Enrollment> Enrollments { get; set; }
    }
}
```

The addition of the `Column` attribute changes the model backing the `SchoolContext`, so it won't match the database.

Save your changes and build the project. Then open the command window in the project folder and enter the following commands to create another migration:

```
dotnet ef migrations add ColumnFirstName
```

```
dotnet ef database update
```

In **SQL Server Object Explorer**, open the Student table designer by double-clicking the **Student** table.

	Name	Data Type	Allow Nulls
ID	int		
EnrollmentDate	datetime2(7)		
FirstName	nvarchar(50)	<input checked="" type="checkbox"/>	
LastName	nvarchar(50)	<input checked="" type="checkbox"/>	

Keys (1)  
PK\_Students (Primary Key, Clu)  
Check Constraints (0)  
Indexes (0)  
Foreign Keys (0)  
Triggers (0)

Design    T-SQL

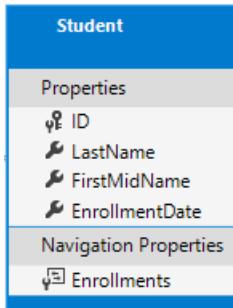
```
1  CREATE TABLE [dbo].[Students] (
2      [ID]           INT            IDENTITY (1, 1) NOT NULL,
3      [EnrollmentDate] DATETIME2 (7) NOT NULL,
4      [FirstName]      NVARCHAR (50) NULL,
5      [LastName]       NVARCHAR (50) NULL,
6      CONSTRAINT [PK_Students] PRIMARY KEY CLUSTERED ([ID] ASC)
7  );
8
```

Before you applied the first two migrations, the name columns were of type nvarchar(MAX). They're now nvarchar(50) and the column name has changed from FirstMidName to FirstName.

**NOTE**

If you try to compile before you finish creating all of the entity classes in the following sections, you might get compiler errors.

## Final changes to the Student entity



In *Models/Student.cs*, replace the code you added earlier with the following code. The changes are highlighted.

```

using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Student
    {
        public int ID { get; set; }

        [Required]
        [StringLength(50)]
        [Display(Name = "Last Name")]
        public string LastName { get; set; }

        [Required]
        [StringLength(50, ErrorMessage = "First name cannot be longer than 50 characters.")]
        [Column("FirstName")]
        [Display(Name = "First Name")]
        public string FirstMidName { get; set; }

        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        [Display(Name = "Enrollment Date")]
        public DateTime EnrollmentDate { get; set; }

        [Display(Name = "Full Name")]
        public string FullName
        {
            get
            {
                return LastName + ", " + FirstMidName;
            }
        }
    }

    public ICollection<Enrollment> Enrollments { get; set; }
}
}

```

## The Required attribute

The `Required` attribute makes the name properties required fields. The `Required` attribute isn't needed for non-nullable types such as value types (DateTime, int, double, float, etc.). Types that can't be null are automatically treated as required fields.

You could remove the `Required` attribute and replace it with a minimum length parameter for the `StringLength` attribute:

```

[Display(Name = "Last Name")]
[StringLength(50, MinimumLength=1)]
public string LastName { get; set; }

```

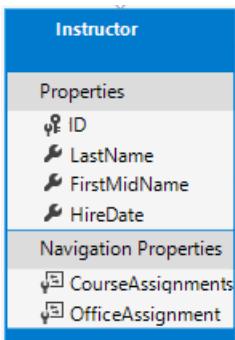
## The Display attribute

The `Display` attribute specifies that the caption for the text boxes should be "First Name", "Last Name", "Full Name", and "Enrollment Date" instead of the property name in each instance (which has no space dividing the words).

## The FullName calculated property

`FullName` is a calculated property that returns a value that's created by concatenating two other properties. Therefore it has only a get accessor, and no `FullName` column will be generated in the database.

# Create the Instructor Entity



Create `Models/Instructor.cs`, replacing the template code with the following code:

```

using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Instructor
    {
        public int ID { get; set; }

        [Required]
        [Display(Name = "Last Name")]
        [StringLength(50)]
        public string LastName { get; set; }

        [Required]
        [Column("FirstName")]
        [Display(Name = "First Name")]
        [StringLength(50)]
        public string FirstMidName { get; set; }

        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        [Display(Name = "Hire Date")]
        public DateTime HireDate { get; set; }

        [Display(Name = "Full Name")]
        public string FullName
        {
            get { return LastName + ", " + FirstMidName; }
        }

        public ICollection<CourseAssignment> CourseAssignments { get; set; }
        public OfficeAssignment OfficeAssignment { get; set; }
    }
}

```

Notice that several properties are the same in the Student and Instructor entities. In the [Implementing Inheritance](#) tutorial later in this series, you'll refactor this code to eliminate the redundancy.

You can put multiple attributes on one line, so you could also write the `HireDate` attributes as follows:

```
[DataType(DataType.Date),Display(Name = "Hire Date"),DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
```

## The `CourseAssignments` and `OfficeAssignment` navigation properties

The `CourseAssignments` and `OfficeAssignment` properties are navigation properties.

An instructor can teach any number of courses, so `CourseAssignments` is defined as a collection.

```
public ICollection<CourseAssignment> CourseAssignments { get; set; }
```

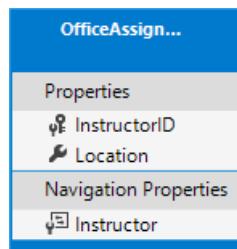
If a navigation property can hold multiple entities, its type must be a list in which entries can be added, deleted, and updated. You can specify `ICollection<T>` or a type such as `List<T>` or `HashSet<T>`. If you specify `ICollection<T>`, EF creates a `HashSet<T>` collection by default.

The reason why these are `CourseAssignment` entities is explained below in the section about many-to-many relationships.

Contoso University business rules state that an instructor can only have at most one office, so the `OfficeAssignment` property holds a single `OfficeAssignment` entity (which may be null if no office is assigned).

```
public OfficeAssignment OfficeAssignment { get; set; }
```

## Create the `OfficeAssignment` entity



Create `Models/OfficeAssignment.cs` with the following code:

```
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class OfficeAssignment
    {
        [Key]
        public int InstructorID { get; set; }
        [StringLength(50)]
        [Display(Name = "Office Location")]
        public string Location { get; set; }

        public Instructor Instructor { get; set; }
    }
}
```

### The `Key` attribute

There's a one-to-zero-or-one relationship between the `Instructor` and the `OfficeAssignment` entities. An office assignment only exists in relation to the instructor it's assigned to, and therefore its primary key is also its foreign key to the `Instructor` entity. But the Entity Framework can't automatically recognize `InstructorID` as the primary key of this entity because its name doesn't follow the `ID` or `classnameID` naming convention. Therefore, the `Key` attribute is used to identify it as the key:

```
[Key]
public int InstructorID { get; set; }
```

You can also use the `Key` attribute if the entity does have its own primary key but you want to name the property something other than `classnameID` or `ID`.

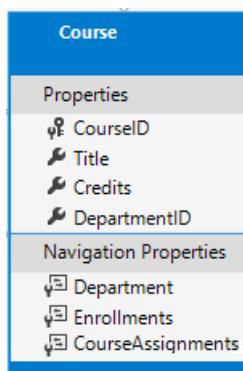
By default, EF treats the key as non-database-generated because the column is for an identifying relationship.

### The Instructor navigation property

The Instructor entity has a nullable `OfficeAssignment` navigation property (because an instructor might not have an office assignment), and the OfficeAssignment entity has a non-nullable `Instructor` navigation property (because an office assignment can't exist without an instructor -- `InstructorID` is non-nullable). When an Instructor entity has a related OfficeAssignment entity, each entity will have a reference to the other one in its navigation property.

You could put a `[Required]` attribute on the Instructor navigation property to specify that there must be a related instructor, but you don't have to do that because the `InstructorID` foreign key (which is also the key to this table) is non-nullable.

## Modify the Course Entity



In `Models/Course.cs`, replace the code you added earlier with the following code. The changes are highlighted.

```
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Course
    {
        [DatabaseGenerated(DatabaseGeneratedOption.None)]
        [Display(Name = "Number")]
        public int CourseID { get; set; }

        [StringLength(50, MinimumLength = 3)]
        public string Title { get; set; }

        [Range(0, 5)]
        public int Credits { get; set; }

        public int DepartmentID { get; set; }

        public Department Department { get; set; }
        public ICollection<Enrollment> Enrollments { get; set; }
        public ICollection<CourseAssignment> CourseAssignments { get; set; }
    }
}
```

The course entity has a foreign key property `DepartmentID` which points to the related Department entity and it has a `Department` navigation property.

The Entity Framework doesn't require you to add a foreign key property to your data model when you have a navigation property for a related entity. EF automatically creates foreign keys in the database wherever they're needed and creates [shadow properties](#) for them. But having the foreign key in the data model can make updates simpler and more efficient. For example, when you fetch a course entity to edit, the Department entity is null if you don't load it, so when you update the course entity, you would have to first fetch the Department entity.

When the foreign key property `DepartmentID` is included in the data model, you don't need to fetch the Department entity before you update.

### The `DatabaseGenerated` attribute

The `DatabaseGenerated` attribute with the `None` parameter on the `CourseID` property specifies that primary key values are provided by the user rather than generated by the database.

```
[DatabaseGenerated(DatabaseGeneratedOption.None)]
[Display(Name = "Number")]
public int CourseID { get; set; }
```

By default, Entity Framework assumes that primary key values are generated by the database. That's what you want in most scenarios. However, for Course entities, you'll use a user-specified course number such as a 1000 series for one department, a 2000 series for another department, and so on.

The `DatabaseGenerated` attribute can also be used to generate default values, as in the case of database columns used to record the date a row was created or updated. For more information, see [Generated Properties](#).

### Foreign key and navigation properties

The foreign key properties and navigation properties in the Course entity reflect the following relationships:

A course is assigned to one department, so there's a `DepartmentID` foreign key and a `Department` navigation property for the reasons mentioned above.

```
public int DepartmentID { get; set; }
public Department Department { get; set; }
```

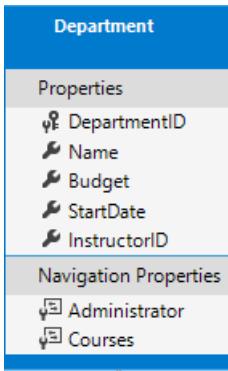
A course can have any number of students enrolled in it, so the `Enrollments` navigation property is a collection:

```
public ICollection<Enrollment> Enrollments { get; set; }
```

A course may be taught by multiple instructors, so the `CourseAssignments` navigation property is a collection (the type `CourseAssignment` is explained [later](#)):

```
public ICollection<CourseAssignment> CourseAssignments { get; set; }
```

## Create the Department entity



Create *Models/Department.cs* with the following code:

```

using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Department
    {
        public int DepartmentID { get; set; }

        [StringLength(50, MinimumLength = 3)]
        public string Name { get; set; }

        [DataType(DataType.Currency)]
        [Column(TypeName = "money")]
        public decimal Budget { get; set; }

        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        [Display(Name = "Start Date")]
        public DateTime StartDate { get; set; }

        public int? InstructorID { get; set; }

        public Instructor Administrator { get; set; }
        public ICollection<Course> Courses { get; set; }
    }
}

```

### The Column attribute

Earlier you used the `Column` attribute to change column name mapping. In the code for the `Department` entity, the `Column` attribute is being used to change SQL data type mapping so that the column will be defined using the SQL Server `money` type in the database:

```

[Column(TypeName="money")]
public decimal Budget { get; set; }

```

Column mapping is generally not required, because the Entity Framework chooses the appropriate SQL Server data type based on the CLR type that you define for the property. The CLR `decimal` type maps to a SQL Server `decimal` type. But in this case you know that the column will be holding currency amounts, and the `money` data type is more appropriate for that.

### Foreign key and navigation properties

The foreign key and navigation properties reflect the following relationships:

A department may or may not have an administrator, and an administrator is always an instructor. Therefore the `InstructorID` property is included as the foreign key to the Instructor entity, and a question mark is added after the `int` type designation to mark the property as nullable. The navigation property is named `Administrator` but holds an Instructor entity:

```
public int? InstructorID { get; set; }
public Instructor Administrator { get; set; }
```

A department may have many courses, so there's a `Courses` navigation property:

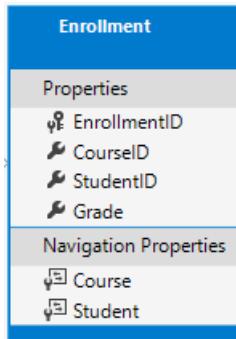
```
public ICollection<Course> Courses { get; set; }
```

#### NOTE

By convention, the Entity Framework enables cascade delete for non-nullable foreign keys and for many-to-many relationships. This can result in circular cascade delete rules, which will cause an exception when you try to add a migration. For example, if you didn't define the `Department.InstructorID` property as nullable, EF would configure a cascade delete rule to delete the instructor when you delete the department, which isn't what you want to have happen. If your business rules required the `InstructorID` property to be non-nullable, you would have to use the following fluent API statement to disable cascade delete on the relationship:

```
modelBuilder.Entity<Department>()
    .HasOne(d => d.Administrator)
    .WithMany()
    .OnDelete(DeleteBehavior.Restrict)
```

## Modify the Enrollment entity



In `Models/Enrollment.cs`, replace the code you added earlier with the following code:

```

using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public enum Grade
    {
        A, B, C, D, F
    }

    public class Enrollment
    {
        public int EnrollmentID { get; set; }
        public int CourseID { get; set; }
        public int StudentID { get; set; }
        [DisplayFormat(NullDisplayText = "No grade")]
        public Grade? Grade { get; set; }

        public Course Course { get; set; }
        public Student Student { get; set; }
    }
}

```

## Foreign key and navigation properties

The foreign key properties and navigation properties reflect the following relationships:

An enrollment record is for a single course, so there's a `CourseID` foreign key property and a `Course` navigation property:

```

public int CourseID { get; set; }
public Course Course { get; set; }

```

An enrollment record is for a single student, so there's a `StudentID` foreign key property and a `Student` navigation property:

```

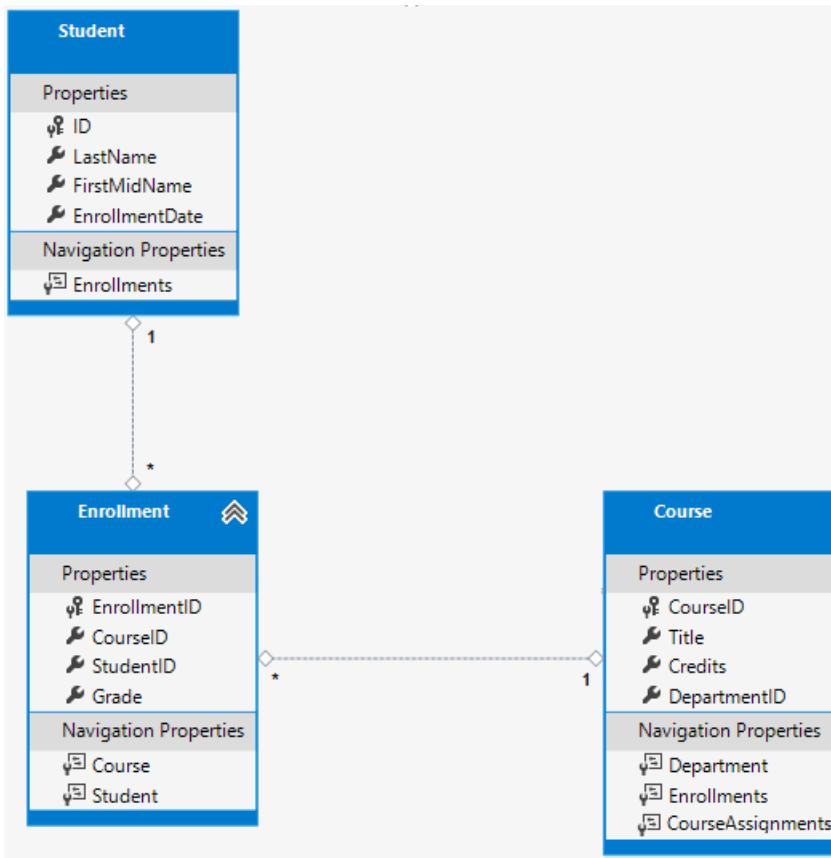
public int StudentID { get; set; }
public Student Student { get; set; }

```

## Many-to-Many Relationships

There's a many-to-many relationship between the `Student` and `Course` entities, and the `Enrollment` entity functions as a many-to-many join table *with payload* in the database. "With payload" means that the `Enrollment` table contains additional data besides foreign keys for the joined tables (in this case, a primary key and a `Grade` property).

The following illustration shows what these relationships look like in an entity diagram. (This diagram was generated using the Entity Framework Power Tools for EF 6.x; creating the diagram isn't part of the tutorial, it's just being used here as an illustration.)

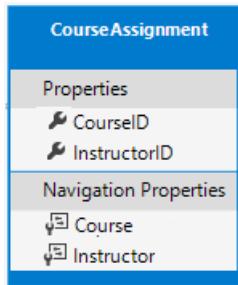


Each relationship line has a 1 at one end and an asterisk (\*) at the other, indicating a one-to-many relationship.

If the Enrollment table didn't include grade information, it would only need to contain the two foreign keys CourseID and StudentID. In that case, it would be a many-to-many join table without payload (or a pure join table) in the database. The Instructor and Course entities have that kind of many-to-many relationship, and your next step is to create an entity class to function as a join table without payload.

(EF 6.x supports implicit join tables for many-to-many relationships, but EF Core doesn't. For more information, see the [discussion in the EF Core GitHub repository](#).)

## The CourseAssignment entity



Create `Models/CourseAssignment.cs` with the following code:

```
using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class CourseAssignment
    {
        public int InstructorID { get; set; }
        public int CourseID { get; set; }
        public Instructor Instructor { get; set; }
        public Course Course { get; set; }
    }
}
```

## Join entity names

A join table is required in the database for the Instructor-to-Courses many-to-many relationship, and it has to be represented by an entity set. It's common to name a join entity `EntityName1EntityName2`, which in this case would be `CourseInstructor`. However, we recommend that you choose a name that describes the relationship. Data models start out simple and grow, with no-payload joins frequently getting payloads later. If you start with a descriptive entity name, you won't have to change the name later. Ideally, the join entity would have its own natural (possibly single word) name in the business domain. For example, Books and Customers could be linked through Ratings. For this relationship, `CourseAssignment` is a better choice than `CourseInstructor`.

## Composite key

Since the foreign keys are not nullable and together uniquely identify each row of the table, there's no need for a separate primary key. The `InstructorID` and `CourseID` properties should function as a composite primary key. The only way to identify composite primary keys to EF is by using the *fluent API* (it can't be done by using attributes). You'll see how to configure the composite primary key in the next section.

The composite key ensures that while you can have multiple rows for one course, and multiple rows for one instructor, you can't have multiple rows for the same instructor and course. The `Enrollment` join entity defines its own primary key, so duplicates of this sort are possible. To prevent such duplicates, you could add a unique index on the foreign key fields, or configure `Enrollment` with a primary composite key similar to `CourseAssignment`. For more information, see [Indexes](#).

## Update the database context

Add the following highlighted code to the `Data/SchoolContext.cs` file:

```

using ContosoUniversity.Models;
using Microsoft.EntityFrameworkCore;

namespace ContosoUniversity.Data
{
    public class SchoolContext : DbContext
    {
        public SchoolContext(DbContextOptions<SchoolContext> options) : base(options)
        {}

        public DbSet<Course> Courses { get; set; }
        public DbSet<Enrollment> Enrollments { get; set; }
        public DbSet<Student> Students { get; set; }
        public DbSet<Department> Departments { get; set; }
        public DbSet<Instructor> Instructors { get; set; }
        public DbSet<OfficeAssignment> OfficeAssignments { get; set; }
        public DbSet<CourseAssignment> CourseAssignments { get; set; }

        protected override void OnModelCreating(ModelBuilder modelBuilder)
        {
            modelBuilder.Entity<Course>().ToTable("Course");
            modelBuilder.Entity<Enrollment>().ToTable("Enrollment");
            modelBuilder.Entity<Student>().ToTable("Student");
            modelBuilder.Entity<Department>().ToTable("Department");
            modelBuilder.Entity<Instructor>().ToTable("Instructor");
            modelBuilder.Entity<OfficeAssignment>().ToTable("OfficeAssignment");
            modelBuilder.Entity<CourseAssignment>().ToTable("CourseAssignment");

            modelBuilder.Entity<CourseAssignment>()
                .HasKey(c => new { c.CourseID, c.InstructorID });
        }
    }
}

```

This code adds the new entities and configures the `CourseAssignment` entity's composite primary key.

## Fluent API alternative to attributes

The code in the `OnModelCreating` method of the `DbContext` class uses the *fluent API* to configure EF behavior. The API is called "fluent" because it's often used by stringing a series of method calls together into a single statement, as in this example from the [EF Core documentation](#):

```

protected override void OnModelCreating(ModelBuilder modelBuilder)
{
    modelBuilder.Entity<Blog>()
        .Property(b => b.Url)
        .IsRequired();
}

```

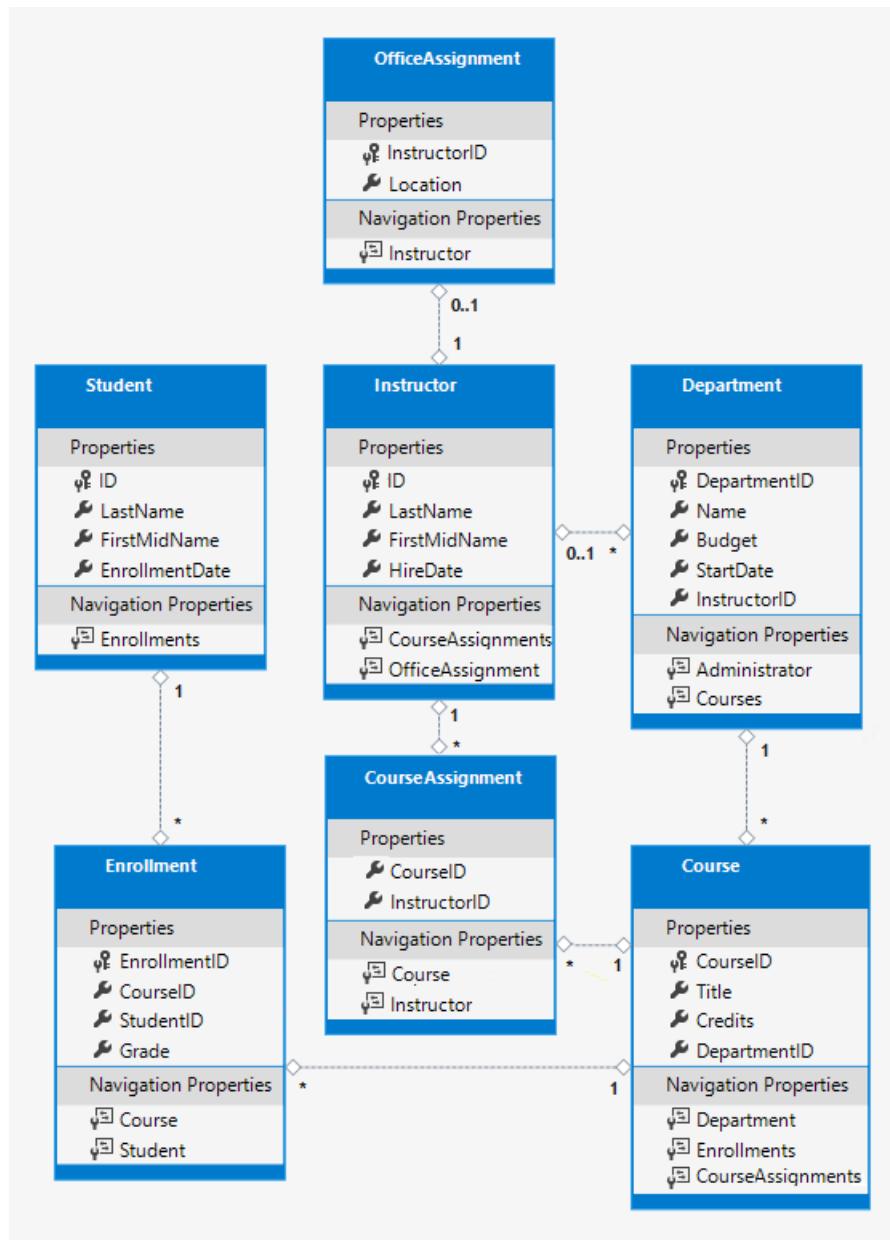
In this tutorial, you're using the fluent API only for database mapping that you can't do with attributes. However, you can also use the fluent API to specify most of the formatting, validation, and mapping rules that you can do by using attributes. Some attributes such as `MinLength` can't be applied with the fluent API. As mentioned previously, `MinLength` doesn't change the schema, it only applies a client and server side validation rule.

Some developers prefer to use the fluent API exclusively so that they can keep their entity classes "clean." You can mix attributes and fluent API if you want, and there are a few customizations that can only be done by using fluent API, but in general the recommended practice is to choose one of these two approaches and use that consistently as much as possible. If you do use both, note that wherever there's a conflict, Fluent API overrides attributes.

For more information about attributes vs. fluent API, see [Methods of configuration](#).

## Entity Diagram Showing Relationships

The following illustration shows the diagram that the Entity Framework Power Tools create for the completed School model.



Besides the one-to-many relationship lines (1 to \*), you can see here the one-to-zero-or-one relationship line (1 to 0..1) between the Instructor and OfficeAssignment entities and the zero-or-one-to-many relationship line (0..1 to \*) between the Instructor and Department entities.

## Seed the Database with Test Data

Replace the code in the *Data/DbInitializer.cs* file with the following code in order to provide seed data for the new entities you've created.

```
using System;
using System.Linq;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using ContosoUniversity.Models;

namespace ContosoUniversity.Data
```

```

    {

        public static class DbInitializer
        {
            public static void Initialize(SchoolContext context)
            {
                //context.Database.EnsureCreated();

                // Look for any students.
                if (context.Students.Any())
                {
                    return; // DB has been seeded
                }

                var students = new Student[]
                {
                    new Student { FirstMidName = "Carson", LastName = "Alexander",
                        EnrollmentDate = DateTime.Parse("2010-09-01") },
                    new Student { FirstMidName = "Meredith", LastName = "Alonso",
                        EnrollmentDate = DateTime.Parse("2012-09-01") },
                    new Student { FirstMidName = "Arturo", LastName = "Anand",
                        EnrollmentDate = DateTime.Parse("2013-09-01") },
                    new Student { FirstMidName = "Gytis", LastName = "Barzdukas",
                        EnrollmentDate = DateTime.Parse("2012-09-01") },
                    new Student { FirstMidName = "Yan", LastName = "Li",
                        EnrollmentDate = DateTime.Parse("2012-09-01") },
                    new Student { FirstMidName = "Peggy", LastName = "Justice",
                        EnrollmentDate = DateTime.Parse("2011-09-01") },
                    new Student { FirstMidName = "Laura", LastName = "Norman",
                        EnrollmentDate = DateTime.Parse("2013-09-01") },
                    new Student { FirstMidName = "Nino", LastName = "Olivetto",
                        EnrollmentDate = DateTime.Parse("2005-09-01") }
                };

                foreach (Student s in students)
                {
                    context.Students.Add(s);
                }
                context.SaveChanges();

                var instructors = new Instructor[]
                {
                    new Instructor { FirstMidName = "Kim", LastName = "Abercrombie",
                        HireDate = DateTime.Parse("1995-03-11") },
                    new Instructor { FirstMidName = "Fadi", LastName = "Fakhouri",
                        HireDate = DateTime.Parse("2002-07-06") },
                    new Instructor { FirstMidName = "Roger", LastName = "Harui",
                        HireDate = DateTime.Parse("1998-07-01") },
                    new Instructor { FirstMidName = "Candace", LastName = "Kapoor",
                        HireDate = DateTime.Parse("2001-01-15") },
                    new Instructor { FirstMidName = "Roger", LastName = "Zheng",
                        HireDate = DateTime.Parse("2004-02-12") }
                };

                foreach (Instructor i in instructors)
                {
                    context.Instructors.Add(i);
                }
                context.SaveChanges();

                var departments = new Department[]
                {
                    new Department { Name = "English", Budget = 350000,
                        StartDate = DateTime.Parse("2007-09-01"),
                        InstructorID = instructors.Single( i => i.LastName == "Abercrombie").ID },
                    new Department { Name = "Mathematics", Budget = 100000,
                        StartDate = DateTime.Parse("2007-09-01"),
                        InstructorID = instructors.Single( i => i.LastName == "Fakhouri").ID },
                    new Department { Name = "Engineering", Budget = 350000,
                        StartDate = DateTime.Parse("2007-09-01") }
                };
            }
        }
    }
}

```

```

        StartDate = DateTime.Parse("2007-09-01"),
        InstructorID = instructors.Single(i => i.LastName == "Harui").ID },
    new Department { Name = "Economics", Budget = 100000,
        StartDate = DateTime.Parse("2007-09-01"),
        InstructorID = instructors.Single(i => i.LastName == "Kapoor").ID }
};

foreach (Department d in departments)
{
    context.Departments.Add(d);
}
context.SaveChanges();

var courses = new Course[]
{
    new Course {CourseID = 1050, Title = "Chemistry", Credits = 3,
        DepartmentID = departments.Single(s => s.Name == "Engineering").DepartmentID
    },
    new Course {CourseID = 4022, Title = "Microeconomics", Credits = 3,
        DepartmentID = departments.Single(s => s.Name == "Economics").DepartmentID
    },
    new Course {CourseID = 4041, Title = "Macroeconomics", Credits = 3,
        DepartmentID = departments.Single(s => s.Name == "Economics").DepartmentID
    },
    new Course {CourseID = 1045, Title = "Calculus", Credits = 4,
        DepartmentID = departments.Single(s => s.Name == "Mathematics").DepartmentID
    },
    new Course {CourseID = 3141, Title = "Trigonometry", Credits = 4,
        DepartmentID = departments.Single(s => s.Name == "Mathematics").DepartmentID
    },
    new Course {CourseID = 2021, Title = "Composition", Credits = 3,
        DepartmentID = departments.Single(s => s.Name == "English").DepartmentID
    },
    new Course {CourseID = 2042, Title = "Literature", Credits = 4,
        DepartmentID = departments.Single(s => s.Name == "English").DepartmentID
    },
};

foreach (Course c in courses)
{
    context.Courses.Add(c);
}
context.SaveChanges();

var officeAssignments = new OfficeAssignment[]
{
    new OfficeAssignment {
        InstructorID = instructors.Single(i => i.LastName == "Fakhouri").ID,
        Location = "Smith 17"
    },
    new OfficeAssignment {
        InstructorID = instructors.Single(i => i.LastName == "Harui").ID,
        Location = "Gowan 27"
    },
    new OfficeAssignment {
        InstructorID = instructors.Single(i => i.LastName == "Kapoor").ID,
        Location = "Thompson 304"
    }
};

foreach (OfficeAssignment o in officeAssignments)
{
    context.OfficeAssignments.Add(o);
}
context.SaveChanges();

var courseInstructors = new CourseAssignment[]
{
    new CourseAssignment {
        CourseID = courses.Single(c => c.Title == "Chemistry").CourseID,
        InstructorID = instructors.Single(i => i.LastName == "Kapoor").ID
    },
    new CourseAssignment {

```

```

new CourseAssignment {
    CourseID = courses.Single(c => c.Title == "Chemistry" ).CourseID,
    InstructorID = instructors.Single(i => i.LastName == "Harui").ID
},
new CourseAssignment {
    CourseID = courses.Single(c => c.Title == "Microeconomics" ).CourseID,
    InstructorID = instructors.Single(i => i.LastName == "Zheng").ID
},
new CourseAssignment {
    CourseID = courses.Single(c => c.Title == "Macroeconomics" ).CourseID,
    InstructorID = instructors.Single(i => i.LastName == "Zheng").ID
},
new CourseAssignment {
    CourseID = courses.Single(c => c.Title == "Calculus" ).CourseID,
    InstructorID = instructors.Single(i => i.LastName == "Fakhouri").ID
},
new CourseAssignment {
    CourseID = courses.Single(c => c.Title == "Trigonometry" ).CourseID,
    InstructorID = instructors.Single(i => i.LastName == "Harui").ID
},
new CourseAssignment {
    CourseID = courses.Single(c => c.Title == "Composition" ).CourseID,
    InstructorID = instructors.Single(i => i.LastName == "Abercrombie").ID
},
new CourseAssignment {
    CourseID = courses.Single(c => c.Title == "Literature" ).CourseID,
    InstructorID = instructors.Single(i => i.LastName == "Abercrombie").ID
},
};

foreach (CourseAssignment ci in courseInstructors)
{
    context.CourseAssignments.Add(ci);
}
context.SaveChanges();

var enrollments = new Enrollment[]
{
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Alexander").ID,
        CourseID = courses.Single(c => c.Title == "Chemistry" ).CourseID,
        Grade = Grade.A
    },
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Alexander").ID,
        CourseID = courses.Single(c => c.Title == "Microeconomics" ).CourseID,
        Grade = Grade.C
    },
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Alexander").ID,
        CourseID = courses.Single(c => c.Title == "Macroeconomics" ).CourseID,
        Grade = Grade.B
    },
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Alonso").ID,
        CourseID = courses.Single(c => c.Title == "Calculus" ).CourseID,
        Grade = Grade.B
    },
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Alonso").ID,
        CourseID = courses.Single(c => c.Title == "Trigonometry" ).CourseID,
        Grade = Grade.B
    },
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Alonso").ID,
        CourseID = courses.Single(c => c.Title == "Composition" ).CourseID,
        Grade = Grade.B
    },
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Alonso").ID,
        CourseID = courses.Single(c => c.Title == "Composition" ).CourseID,
        Grade = Grade.B
    }
};

```

```

        StudentID = students.Single(s => s.LastName == "Anand").ID,
        CourseID = courses.Single(c => c.Title == "Chemistry" ).CourseID
    },
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Anand").ID,
        CourseID = courses.Single(c => c.Title == "Microeconomics").CourseID,
        Grade = Grade.B
    },
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Barzdukas").ID,
        CourseID = courses.Single(c => c.Title == "Chemistry").CourseID,
        Grade = Grade.B
    },
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Li").ID,
        CourseID = courses.Single(c => c.Title == "Composition").CourseID,
        Grade = Grade.B
    },
    new Enrollment {
        StudentID = students.Single(s => s.LastName == "Justice").ID,
        CourseID = courses.Single(c => c.Title == "Literature").CourseID,
        Grade = Grade.B
    }
}
};

foreach (Enrollment e in enrollments)
{
    var enrollmentInDataBase = context.Enrollments.Where(
        s =>
            s.Student.ID == e.StudentID &&
            s.Course.CourseID == e.CourseID).SingleOrDefault();
    if (enrollmentInDataBase == null)
    {
        context.Enrollments.Add(e);
    }
}
context.SaveChanges();
}
}
}

```

As you saw in the first tutorial, most of this code simply creates new entity objects and loads sample data into properties as required for testing. Notice how the many-to-many relationships are handled: the code creates relationships by creating entities in the `Enrollments` and `courseAssignment` join entity sets.

## Add a migration

Save your changes and build the project. Then open the command window in the project folder and enter the `migrations add` command (don't do the update-database command yet):

```
dotnet ef migrations add ComplexDataModel
```

You get a warning about possible data loss.

An operation was scaffolded that may result in the loss of data. Please review the migration for accuracy.  
Done. To undo this action, use 'ef migrations remove'

If you tried to run the `database update` command at this point (don't do it yet), you would get the following error:

The ALTER TABLE statement conflicted with the FOREIGN KEY constraint "FK\_dbo.Course\_dbo.Department\_DepartmentID". The conflict occurred in database "ContosoUniversity",

```
| table "dbo.Department", column 'DepartmentID'.
```

Sometimes when you execute migrations with existing data, you need to insert stub data into the database to satisfy foreign key constraints. The generated code in the `Up` method adds a non-nullable `DepartmentID` foreign key to the `Course` table. If there are already rows in the `Course` table when the code runs, the `AddColumn` operation fails because SQL Server doesn't know what value to put in the column that can't be null. For this tutorial you'll run the migration on a new database, but in a production application you'd have to make the migration handle existing data, so the following directions show an example of how to do that.

To make this migration work with existing data you have to change the code to give the new column a default value, and create a stub department named "Temp" to act as the default department. As a result, existing `Course` rows will all be related to the "Temp" department after the `Up` method runs.

- Open the `{timestamp}_ComplexDataModel.cs` file.
- Comment out the line of code that adds the `DepartmentID` column to the `Course` table.

```
migrationBuilder.AlterColumn<string>(
    name: "Title",
    table: "Course",
    maxLength: 50,
    nullable: true,
    oldClrType: typeof(string),
    oldNullable: true);

//migrationBuilder.AddColumn<int>(
//    name: "DepartmentID",
//    table: "Course",
//    nullable: false,
//    defaultValue: 0);
```

- Add the following highlighted code after the code that creates the `Department` table:

```

migrationBuilder.CreateTable(
    name: "Department",
    columns: table => new
    {
        DepartmentID = table.Column<int>(nullable: false)
            .Annotation("SqlServer:ValueGenerationStrategy", "IdentityColumn"),
        Budget = table.Column<decimal>(type: "money", nullable: false),
        InstructorID = table.Column<int>(nullable: true),
        Name = table.Column<string>(maxLength: 50, nullable: true),
        StartDate = table.Column<DateTime>(nullable: false)
    },
    constraints: table =>
    {
        table.PrimaryKey("PK_Department", x => x.DepartmentID);
        table.ForeignKey(
            name: "FK_Department_Instructor_InstructorID",
            column: x => x.InstructorID,
            principalTable: "Instructor",
            principalColumn: "ID",
            onDelete: ReferentialAction.Restrict);
    });
}

migrationBuilder.Sql("INSERT INTO dbo.Department (Name, Budget, StartDate) VALUES ('Temp', 0.00, GETDATE());");
// Default value for FK points to department created above, with
// defaultValue changed to 1 in following AddColumn statement.

migrationBuilder.AddColumn<int>(
    name: "DepartmentID",
    table: "Course",
    nullable: false,
    defaultValue: 1);

```

In a production application, you would write code or scripts to add Department rows and relate Course rows to the new Department rows. You would then no longer need the "Temp" department or the default value on the Course.DepartmentID column.

Save your changes and build the project.

## Change the connection string and update the database

You now have new code in the `DbInitializer` class that adds seed data for the new entities to an empty database. To make EF create a new empty database, change the name of the database in the connection string in `appsettings.json` to ContosoUniversity3 or some other name that you haven't used on the computer you're using.

```
{
  "ConnectionStrings": {
    "DefaultConnection": "Server=(localdb)\\mssqllocaldb;Database=ContosoUniversity3;Trusted_Connection=True;MultipleActiveResultSets=true"
  },
}
```

Save your change to `appsettings.json`.

#### NOTE

As an alternative to changing the database name, you can delete the database. Use **SQL Server Object Explorer** (SSOX) or the `database drop` CLI command:

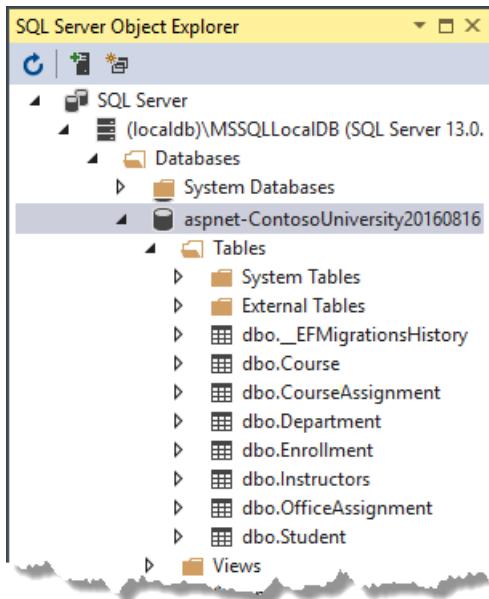
```
dotnet ef database drop
```

After you have changed the database name or deleted the database, run the `database update` command in the command window to execute the migrations.

```
dotnet ef database update
```

Run the app to cause the `DbInitializer.Initialize` method to run and populate the new database.

Open the database in SSOX as you did earlier, and expand the **Tables** node to see that all of the tables have been created. (If you still have SSOX open from the earlier time, click the **Refresh** button.)



Run the app to trigger the initializer code that seeds the database.

Right-click the **CourseAssignment** table and select **View Data** to verify that it has data in it.

	CourseID	InstructorID
▶	2021	1
	2042	1
	1045	2
	1050	3
	3141	3
	1050	4
	4022	5
*	4041	5
*	NULL	NULL

## Summary

You now have a more complex data model and corresponding database. In the following tutorial, you'll learn more about how to access related data.

[PREVIOUS](#) [NEXT](#)

# ASP.NET Core MVC with EF Core - Read Related Data - 6 of 10

7/14/2018 • 15 minutes to read • [Edit Online](#)

This tutorial has not been upgraded to ASP.NET Core 2.1. The ASP.NET Core 2.0 version of this tutorial is available by selecting **ASP.NET Core 2.0** above the table of contents or at the top of the page:

The ASP.NET Core 2.1 Razor Pages version of this tutorial has many improvements over the 2.0 version.

The 2.0 tutorial teaches ASP.NET Core MVC and Entity Framework Core with controllers and views. Razor Pages is a page-based programming model that makes building web UI easier and more productive. We recommend the [Razor Pages](#) tutorial over the MVC version. The Razor Pages tutorial:

- Is easier to follow. For example, the scaffolding code has been significantly simplified.
- Provides more EF Core best practices.
- Uses more efficient queries.
- Is more current with the latest API.
- Covers more features.
- Is the preferred approach for new application development.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub discussion](#).

By [Tom Dykstra](#) and [Rick Anderson](#)

The Contoso University sample web application demonstrates how to create ASP.NET Core MVC web applications using Entity Framework Core and Visual Studio. For information about the tutorial series, see [the first tutorial in the series](#).

In the previous tutorial, you completed the School data model. In this tutorial, you'll read and display related data -- that is, data that the Entity Framework loads into navigation properties.

The following illustrations show the pages that you'll work with.

The screenshot shows a browser window with the title bar "Courses - Contoso Univ". The address bar shows "localhost:5813/Courses". The main content area displays a table titled "Courses" with three rows of data. The columns are "Number", "Title", "Credits", and "Department". The first row contains "1045", "Calculus", "4", and "Mathematics". The second row contains "1050", "Chemistry", "3", and "Engineering". The third row contains "2021", "Composition", "3", and "English". Each row has "Edit | Details | Delete" links in the last column. The browser interface includes standard controls like back, forward, and search, along with a menu icon and a three-dot ellipsis.

Number	Title	Credits	Department	
1045	Calculus	4	Mathematics	Edit   Details   Delete
1050	Chemistry	3	Engineering	Edit   Details   Delete
2021	Composition	3	English	Edit   Details   Delete

Instructors					
<a href="#">Create New</a>					
Last Name	First Name	Hire Date	Office	Courses	
Abercrombie	Kim	1995-03-11		2021 Composition 2042 Literature	<a href="#">Select</a>   <a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Fakhouri	Fadi	2002-07-06	Smith 17	1045 Calculus	<a href="#">Select</a>   <a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Harui	Roger	1998-07-01	Gowan 27	1050 Chemistry 3141 Trigonometry	<a href="#">Select</a>   <a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

### Courses Taught by Selected Instructor

	Number	Title	Department
<a href="#">Select</a>	2021	Composition	English
<a href="#">Select</a>	2042	Literature	English

### Students Enrolled in Selected Course

Name	Grade
Alonso, Meredith	B
Li, Yan	B

## Eager, explicit, and lazy Loading of related data

There are several ways that Object-Relational Mapping (ORM) software such as Entity Framework can load related data into the navigation properties of an entity:

- Eager loading. When the entity is read, related data is retrieved along with it. This typically results in a single join query that retrieves all of the data that's needed. You specify eager loading in Entity Framework Core by using the `Include` and `ThenInclude` methods.

```
var departments = _context.Departments.Include(d => d.Courses);
foreach (Department d in departments)
{
    foreach(Course c in d.Courses)
    {
        courseList.Add(d.Name + c.Title);
    }
}
```

Query: all Departments and related Courses

Query: all Department entities  
and related Course entities

You can retrieve some of the data in separate queries, and EF "fixes up" the navigation properties. That is, EF automatically adds the separately retrieved entities where they belong in navigation properties of previously

retrieved entities. For the query that retrieves related data, you can use the `Load` method instead of a method that returns a list or object, such as `ToList` or `Single`.

```
var departments = _context.Departments;
foreach (Department d in departments)
{
    _context.Courses.Where(c => c.DepartmentID == d.DepartmentID).Load();
    foreach (Course c in d.Courses)
    {
        courseList.Add(d.Name + c.Title);
    }
}
```

Query: all Department rows

Query: Course rows related to Department d

- Explicit loading. When the entity is first read, related data isn't retrieved. You write code that retrieves the related data if it's needed. As in the case of eager loading with separate queries, explicit loading results in multiple queries sent to the database. The difference is that with explicit loading, the code specifies the navigation properties to be loaded. In Entity Framework Core 1.1 you can use the `Load` method to do explicit loading. For example:

```
var departments = _context.Departments;
foreach (Department d in departments)
{
    _context.Entry(d).Collection(p => p.Courses).Load();
    foreach (Course c in d.Courses)
    {
        courseList.Add(d.Name + c.Title);
    }
}
```

Query: all Department rows

Query: Course rows related to Department d

- Lazy loading. When the entity is first read, related data isn't retrieved. However, the first time you attempt to access a navigation property, the data required for that navigation property is automatically retrieved. A query is sent to the database each time you try to get data from a navigation property for the first time. Entity Framework Core 1.0 doesn't support lazy loading.

### Performance considerations

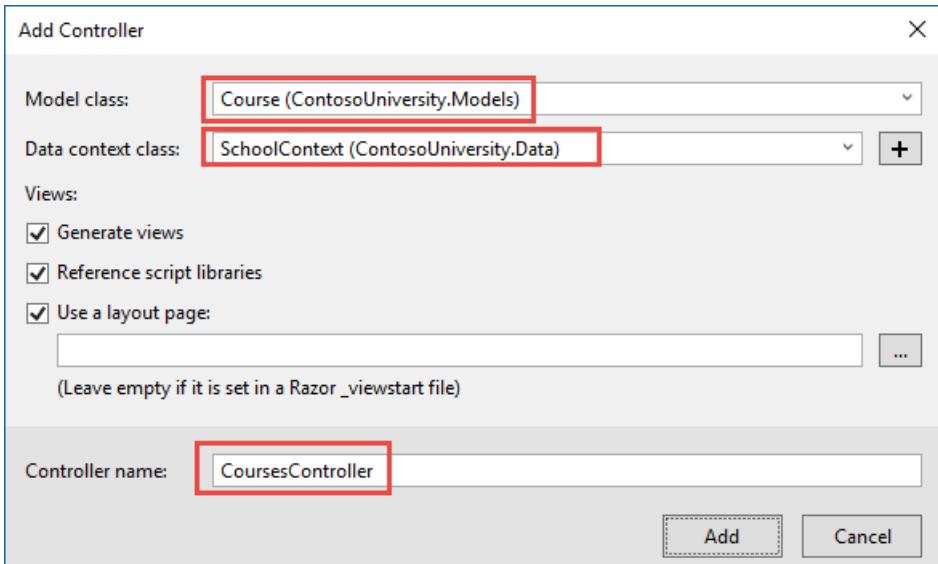
If you know you need related data for every entity retrieved, eager loading often offers the best performance, because a single query sent to the database is typically more efficient than separate queries for each entity retrieved. For example, suppose that each department has ten related courses. Eager loading of all related data would result in just a single (join) query and a single round trip to the database. A separate query for courses for each department would result in eleven round trips to the database. The extra round trips to the database are especially detrimental to performance when latency is high.

On the other hand, in some scenarios separate queries is more efficient. Eager loading of all related data in one query might cause a very complex join to be generated, which SQL Server can't process efficiently. Or if you need to access an entity's navigation properties only for a subset of a set of the entities you're processing, separate queries might perform better because eager loading of everything up front would retrieve more data than you need. If performance is critical, it's best to test performance both ways in order to make the best choice.

## Create a Courses page that displays Department name

The Course entity includes a navigation property that contains the Department entity of the department that the course is assigned to. To display the name of the assigned department in a list of courses, you need to get the `Name` property from the `Department` entity that's in the `Course.Department` navigation property.

Create a controller named `CoursesController` for the `Course` entity type, using the same options for the **MVC Controller with views, using Entity Framework** scaffolder that you did earlier for the `Students` controller, as shown in the following illustration:



Open `CoursesController.cs` and examine the `Index` method. The automatic scaffolding has specified eager loading for the `Department` navigation property by using the `Include` method.

Replace the `Index` method with the following code that uses a more appropriate name for the `IQueryable` that returns `Course` entities (`courses` instead of `schoolContext`):

```
public async Task<IActionResult> Index()
{
    var courses = _context.Courses
        .Include(c => c.Department)
        .AsNoTracking();
    return View(await courses.ToListAsync());
}
```

Open `Views/Courses/Index.cshtml` and replace the template code with the following code. The changes are highlighted:

```

@model IEnumerable<ContosoUniversity.Models.Course>

 @{
     ViewData["Title"] = "Courses";
 }

<h2>Courses</h2>

<p>
    <a asp-action="Create">Create New</a>
</p>
<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.CourseID)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Credits)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Department)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model)
        {
            <tr>
                <td>
                    @Html.DisplayFor(modelItem => item.CourseID)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Title)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Credits)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Department.Name)
                </td>
                <td>
                    <a asp-action="Edit" asp-route-id="@item.CourseID">Edit</a> |
                    <a asp-action="Details" asp-route-id="@item.CourseID">Details</a> |
                    <a asp-action="Delete" asp-route-id="@item.CourseID">Delete</a>
                </td>
            </tr>
        }
    </tbody>
</table>

```

You've made the following changes to the scaffolded code:

- Changed the heading from Index to Courses.
- Added a **Number** column that shows the `CourseID` property value. By default, primary keys aren't scaffolded because normally they're meaningless to end users. However, in this case the primary key is meaningful and you want to show it.
- Changed the **Department** column to display the department name. The code displays the `Name` property of the Department entity that's loaded into the `Department` navigation property:

```
@Html.DisplayFor(modelItem => item.Department.Name)
```

Run the app and select the **Courses** tab to see the list with department names.

Number	Title	Credits	Department	
1045	Calculus	4	Mathematics	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
1050	Chemistry	3	Engineering	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
2021	Composition	3	English	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

## Create an Instructors page that shows Courses and Enrollments

In this section, you'll create a controller and view for the Instructor entity in order to display the Instructors page:

The screenshot shows a web application interface for Contoso University. At the top, there's a header bar with a back/forward button, refresh icon, address bar (localhost:5813/Instructors/Index/1?), and a menu icon.

## Instructors

[Create New](#)

Last Name	First Name	Hire Date	Office	Courses	
Abercrombie	Kim	1995-03-11		2021 Composition 2042 Literature	<a href="#">Select</a>   <a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Fakhouri	Fadi	2002-07-06	Smith 17	1045 Calculus	<a href="#">Select</a>   <a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Harui	Roger	1998-07-01	Gowan 27	1050 Chemistry 3141 Trigonometry	<a href="#">Select</a>   <a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

## Courses Taught by Selected Instructor

Number	Title	Department
Select 2021	Composition	English
Select 2042	Literature	English

## Students Enrolled in Selected Course

Name	Grade
Alonso, Meredith	B
Li, Yan	B

This page reads and displays related data in the following ways:

- The list of instructors displays related data from the OfficeAssignment entity. The Instructor and OfficeAssignment entities are in a one-to-zero-or-one relationship. You'll use eager loading for the OfficeAssignment entities. As explained earlier, eager loading is typically more efficient when you need the related data for all retrieved rows of the primary table. In this case, you want to display office assignments for all displayed instructors.
- When the user selects an instructor, related Course entities are displayed. The Instructor and Course entities are in a many-to-many relationship. You'll use eager loading for the Course entities and their related Department entities. In this case, separate queries might be more efficient because you need courses only for the selected instructor. However, this example shows how to use eager loading for navigation properties within entities that are themselves in navigation properties.
- When the user selects a course, related data from the Enrollments entity set is displayed. The Course and Enrollment entities are in a one-to-many relationship. You'll use separate queries for Enrollment entities and their related Student entities.

## Create a view model for the Instructor Index view

The Instructors page shows data from three different tables. Therefore, you'll create a view model that includes three properties, each holding the data for one of the tables.

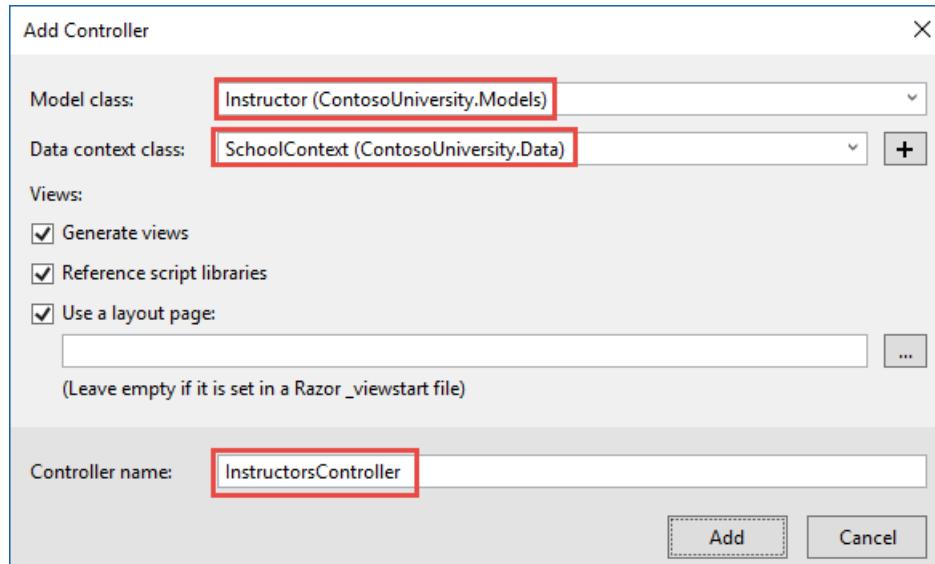
In the *SchoolViewModels* folder, create *InstructorIndexData.cs* and replace the existing code with the following code:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;

namespace ContosoUniversity.Models.SchoolViewModels
{
    public class InstructorIndexData
    {
        public IEnumerable<Instructor> Instructors { get; set; }
        public IEnumerable<Course> Courses { get; set; }
        public IEnumerable<Enrollment> Enrollments { get; set; }
    }
}
```

## Create the Instructor controller and views

Create an Instructors controller with EF read/write actions as shown in the following illustration:



Open *InstructorsController.cs* and add a using statement for the *ViewModels* namespace:

```
using ContosoUniversity.Models.SchoolViewModels;
```

Replace the Index method with the following code to do eager loading of related data and put it in the view model.

```

public async Task<IActionResult> Index(int? id, int? courseID)
{
    var viewModel = new InstructorIndexData();
    viewModel.Instructors = await _context.Instructors
        .Include(i => i.OfficeAssignment)
        .Include(i => i.CourseAssignments)
        .ThenInclude(i => i.Course)
        .ThenInclude(i => i.Enrollments)
        .ThenInclude(i => i.Student)
        .Include(i => i.CourseAssignments)
        .ThenInclude(i => i.Course)
        .ThenInclude(i => i.Department)
        .AsNoTracking()
        .OrderBy(i => i.LastName)
        .ToListAsync();

    if (id != null)
    {
        ViewData["InstructorID"] = id.Value;
        Instructor instructor = viewModel.Instructors.Where(
            i => i.ID == id.Value).Single();
        viewModel.Courses = instructor.CourseAssignments.Select(s => s.Course);
    }

    if (courseID != null)
    {
        ViewData["CourseID"] = courseID.Value;
        viewModel.Enrollments = viewModel.Courses.Where(
            x => x.CourseID == courseID).Single().Enrollments;
    }

    return View(viewModel);
}

```

The method accepts optional route data (`id`) and a query string parameter (`courseID`) that provide the ID values of the selected instructor and selected course. The parameters are provided by the **Select** hyperlinks on the page.

The code begins by creating an instance of the view model and putting in it the list of instructors. The code specifies eager loading for the `Instructor.OfficeAssignment` and the `Instructor.CourseAssignments` navigation properties. Within the `CourseAssignments` property, the `Course` property is loaded, and within that, the `Enrollments` and `Department` properties are loaded, and within each `Enrollment` entity the `Student` property is loaded.

```

viewModel.Instructors = await _context.Instructors
    .Include(i => i.OfficeAssignment)
    .Include(i => i.CourseAssignments)
    .ThenInclude(i => i.Course)
    .ThenInclude(i => i.Enrollments)
    .ThenInclude(i => i.Student)
    .Include(i => i.CourseAssignments)
    .ThenInclude(i => i.Course)
    .ThenInclude(i => i.Department)
    .AsNoTracking()
    .OrderBy(i => i.LastName)
    .ToListAsync();

```

Since the view always requires the `OfficeAssignment` entity, it's more efficient to fetch that in the same query. Course entities are required when an instructor is selected in the web page, so a single query is better than multiple queries only if the page is displayed more often with a course selected than without.

The code repeats `CourseAssignments` and `Course` because you need two properties from `Course`. The first string

of `ThenInclude` calls gets `CourseAssignment.Course`, `Course.Enrollments`, and `Enrollment.Student`.

```
viewModel.Instructors = await _context.Instructors
    .Include(i => i.OfficeAssignment)
    .Include(i => i.CourseAssignments)
    .ThenInclude(i => i.Course)
        .ThenInclude(i => i.Enrollments)
            .ThenInclude(i => i.Student)
    .Include(i => i.CourseAssignments)
        .ThenInclude(i => i.Course)
            .ThenInclude(i => i.Department)
    .AsNoTracking()
    .OrderBy(i => i.LastName)
    .ToListAsync();
```

At that point in the code, another `ThenInclude` would be for navigation properties of `Student`, which you don't need. But calling `Include` starts over with `Instructor` properties, so you have to go through the chain again, this time specifying `Course.Department` instead of `Course.Enrollments`.

```
viewModel.Instructors = await _context.Instructors
    .Include(i => i.OfficeAssignment)
    .Include(i => i.CourseAssignments)
    .ThenInclude(i => i.Course)
        .ThenInclude(i => i.Enrollments)
            .ThenInclude(i => i.Student)
    .Include(i => i.CourseAssignments)
        .ThenInclude(i => i.Course)
            .ThenInclude(i => i.Department)
    .AsNoTracking()
    .OrderBy(i => i.LastName)
    .ToListAsync();
```

The following code executes when an instructor was selected. The selected instructor is retrieved from the list of instructors in the view model. The view model's `Courses` property is then loaded with the Course entities from that instructor's `CourseAssignments` navigation property.

```
if (id != null)
{
    ViewData["InstructorID"] = id.Value;
    Instructor instructor = viewModel.Instructors.Where(
        i => i.ID == id.Value).Single();
    viewModel.Courses = instructor.CourseAssignments.Select(s => s.Course);
}
```

The `Where` method returns a collection, but in this case the criteria passed to that method result in only a single Instructor entity being returned. The `Single` method converts the collection into a single Instructor entity, which gives you access to that entity's `CourseAssignments` property. The `CourseAssignments` property contains `CourseAssignment` entities, from which you want only the related `Course` entities.

You use the `Single` method on a collection when you know the collection will have only one item. The `Single` method throws an exception if the collection passed to it's empty or if there's more than one item. An alternative is `SingleOrDefault`, which returns a default value (null in this case) if the collection is empty. However, in this case that would still result in an exception (from trying to find a `Courses` property on a null reference), and the exception message would less clearly indicate the cause of the problem. When you call the `Single` method, you can also pass in the `Where` condition instead of calling the `Where` method separately:

```
.Single(i => i.ID == id.Value)
```

Instead of:

```
.Where(i => i.ID == id.Value).Single()
```

Next, if a course was selected, the selected course is retrieved from the list of courses in the view model. Then the view model's `Enrollments` property is loaded with the Enrollment entities from that course's `Enrollments` navigation property.

```
if (courseID != null)
{
    ViewData["CourseID"] = courseID.Value;
    viewModel.Enrollments = viewModel.Courses.Where(
        x => x.CourseID == courseID).Single().Enrollments;
}
```

### Modify the Instructor Index view

In `Views/Instructors/Index.cshtml`, replace the template code with the following code. The changes are highlighted.

```

@model ContosoUniversity.Models.SchoolViewModels.InstructorIndexData

 @{
     ViewData["Title"] = "Instructors";
 }

<h2>Instructors</h2>

<p>
    <a asp-action="Create">Create New</a>
</p>
<table class="table">
    <thead>
        <tr>
            <th>Last Name</th>
            <th>First Name</th>
            <th>Hire Date</th>
            <th>Office</th>
            <th>Courses</th>
            <th></th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model.Instructors)
        {
            string selectedRow = "";
            if (item.ID == (int?)ViewData["InstructorID"])
            {
                selectedRow = "success";
            }
            <tr class="@selectedRow">
                <td>
                    @Html.DisplayFor(modelItem => item.LastName)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.FirstMidName)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.HireDate)
                </td>
                <td>
                    @if (item.OfficeAssignment != null)
                    {
                        @item.OfficeAssignment.Location
                    }
                </td>
                <td>
                    @{
                        foreach (var course in item.CourseAssignments)
                        {
                            @course.Course.CourseID @: @course.Course.Title <br />
                        }
                    }
                </td>
                <td>
                    <a asp-action="Index" asp-route-id="@item.ID">Select</a> |
                    <a asp-action="Edit" asp-route-id="@item.ID">Edit</a> |
                    <a asp-action="Details" asp-route-id="@item.ID">Details</a> |
                    <a asp-action="Delete" asp-route-id="@item.ID">Delete</a>
                </td>
            </tr>
        }
    </tbody>
</table>

```

You've made the following changes to the existing code:

- Changed the model class to `InstructorIndexData`.
- Changed the page title from **Index** to **Instructors**.
- Added an **Office** column that displays `item.OfficeAssignment.Location` only if `item.OfficeAssignment` isn't null. (Because this is a one-to-zero-or-one relationship, there might not be a related OfficeAssignment entity.)

```
@if (item.OfficeAssignment != null)
{
    item.OfficeAssignment.Location
}
```

- Added a **Courses** column that displays courses taught by each instructor. See [Explicit Line Transition with @:](#) for more about this razor syntax.
- Added code that dynamically adds `class="success"` to the `tr` element of the selected instructor. This sets a background color for the selected row using a Bootstrap class.

```
string selectedRow = "";
if (item.ID == (int?)ViewData["InstructorID"])
{
    selectedRow = "success";
}
<tr class="@selectedRow">
```

- Added a new hyperlink labeled **Select** immediately before the other links in each row, which causes the selected instructor's ID to be sent to the `Index` method.

```
<a asp-action="Index" asp-route-id="@item.ID">Select</a> |
```

Run the app and select the **Instructors** tab. The page displays the Location property of related OfficeAssignment entities and an empty table cell when there's no related OfficeAssignment entity.

Last Name	First Name	Hire Date	Office	Courses
Abercrombie	Kim	1995-03-11		2021 Composition 2042 Literature <a href="#">Select</a>   <a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Fakhouri	Fadi	2002-07-06	Smith 17	1045 Calculus <a href="#">Select</a>   <a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

In the `Views/Instructors/Index.cshtml` file, after the closing table element (at the end of the file), add the following code. This code displays a list of courses related to an instructor when an instructor is selected.

```

@if (Model.Courses != null)
{
    <h3>Courses Taught by Selected Instructor</h3>
    <table class="table">
        <tr>
            <th></th>
            <th>Number</th>
            <th>Title</th>
            <th>Department</th>
        </tr>

        @foreach (var item in Model.Courses)
        {
            string selectedRow = "";
            if (item.CourseID == (int?)ViewData["CourseID"])
            {
                selectedRow = "success";
            }
            <tr class="@selectedRow">
                <td>
                    @Html.ActionLink("Select", "Index", new { courseID = item.CourseID })
                </td>
                <td>
                    @item.CourseID
                </td>
                <td>
                    @item.Title
                </td>
                <td>
                    @item.Department.Name
                </td>
            </tr>
        }
    </table>
}

```

This code reads the `Courses` property of the view model to display a list of courses. It also provides a **Select** hyperlink that sends the ID of the selected course to the `Index` action method.

Refresh the page and select an instructor. Now you see a grid that displays courses assigned to the selected instructor, and for each course you see the name of the assigned department.

Last Name	First Name	Hire Date	Office	Courses
Abercrombie	Kim	1995-03-11	Smith 17	2021 Composition 2042 Literature
Fakhouri	Fadi	2002-07-06		1045 Calculus

## Courses Taught by Selected Instructor

	Number	Title	Department
Select	2021	Composition	English
Select	2042	Literature	English

After the code block you just added, add the following code. This displays a list of the students who are enrolled in a course when that course is selected.

```
@if (Model.Enrollments != null)
{
    <h3>
        Students Enrolled in Selected Course
    </h3>
    <table class="table">
        <tr>
            <th>Name</th>
            <th>Grade</th>
        </tr>
        @foreach (var item in Model.Enrollments)
        {
            <tr>
                <td>
                    @item.Student.FullName
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Grade)
                </td>
            </tr>
        }
    </table>
}
```

This code reads the `Enrollments` property of the view model in order to display a list of students enrolled in the course.

Refresh the page again and select an instructor. Then select a course to see the list of enrolled students and their

grades.

Last Name	First Name	Hire Date	Office	Courses
Abercrombie	Kim	1995-03-11		2021 Composition 2042 Literature <a href="#">Select</a>   <a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Fakhouri	Fadi	2002-07-06	Smith 17	1045 Calculus <a href="#">Select</a>   <a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Harui	Roger	1998-07-01	Gowan 27	1050 Chemistry 3141 Trigonometry <a href="#">Select</a>   <a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

### Courses Taught by Selected Instructor

Number	Title	Department
Select	2021	Composition English
Select	2042	Literature English

### Students Enrolled in Selected Course

Name	Grade
Alonso, Meredith	B
Li, Yan	B

## Explicit loading

When you retrieved the list of instructors in `InstructorsController.cs`, you specified eager loading for the `CourseAssignments` navigation property.

Suppose you expected users to only rarely want to see enrollments in a selected instructor and course. In that case, you might want to load the enrollment data only if it's requested. To see an example of how to do explicit loading, replace the `Index` method with the following code, which removes eager loading for `Enrollments` and loads that property explicitly. The code changes are highlighted.

```

public async Task<IActionResult> Index(int? id, int? courseID)
{
    var viewModel = new InstructorIndexData();
    viewModel.Instructors = await _context.Instructors
        .Include(i => i.OfficeAssignment)
        .Include(i => i.CourseAssignments)
        .ThenInclude(i => i.Course)
        .ThenInclude(i => i.Department)
        .OrderBy(i => i.LastName)
        .ToListAsync();

    if (id != null)
    {
        ViewData["InstructorID"] = id.Value;
        Instructor instructor = viewModel.Instructors.Where(
            i => i.ID == id.Value).Single();
        viewModel.Courses = instructor.CourseAssignments.Select(s => s.Course);
    }

    if (courseID != null)
    {
        ViewData["CourseID"] = courseID.Value;
        var selectedCourse = viewModel.Courses.Where(x => x.CourseID == courseID).Single();
        await _context.Entry(selectedCourse).Collection(x => x.Enrollments).LoadAsync();
        foreach (Enrollment enrollment in selectedCourse.Enrollments)
        {
            await _context.Entry(enrollment).Reference(x => x.Student).LoadAsync();
        }
        viewModel.Enrollments = selectedCourse.Enrollments;
    }

    return View(viewModel);
}

```

The new code drops the `ThenInclude` method calls for enrollment data from the code that retrieves instructor entities. If an instructor and course are selected, the highlighted code retrieves Enrollment entities for the selected course, and Student entities for each Enrollment.

Run the app, go to the Instructors Index page now and you'll see no difference in what's displayed on the page, although you've changed how the data is retrieved.

## Summary

You've now used eager loading with one query and with multiple queries to read related data into navigation properties. In the next tutorial you'll learn how to update related data.

[PREVIOUS](#) [NEXT](#)

# ASP.NET Core MVC with EF Core - Update Related Data - 7 of 10

6/28/2018 • 19 minutes to read • [Edit Online](#)

This tutorial has not been upgraded to ASP.NET Core 2.1. The ASP.NET Core 2.0 version of this tutorial is available by selecting **ASP.NET Core 2.0** above the table of contents or at the top of the page:

The ASP.NET Core 2.1 Razor Pages version of this tutorial has many improvements over the 2.0 version.

The 2.0 tutorial teaches ASP.NET Core MVC and Entity Framework Core with controllers and views. Razor Pages is a page-based programming model that makes building web UI easier and more productive. We recommend the [Razor Pages](#) tutorial over the MVC version. The Razor Pages tutorial:

- Is easier to follow. For example, the scaffolding code has been significantly simplified.
- Provides more EF Core best practices.
- Uses more efficient queries.
- Is more current with the latest API.
- Covers more features.
- Is the preferred approach for new application development.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub discussion](#).

By [Tom Dykstra](#) and [Rick Anderson](#)

The Contoso University sample web application demonstrates how to create ASP.NET Core MVC web applications using Entity Framework Core and Visual Studio. For information about the tutorial series, see [the first tutorial in the series](#).

In the previous tutorial you displayed related data; in this tutorial you'll update related data by updating foreign key fields and navigation properties.

The following illustrations show some of the pages that you'll work with.

Edit - Coi X + - □ ×

← ⏪ | localhost:58 | ⚡ | ...

Contoso University ⓖ

# Edit

Course

---

**Number**  
1000

**Title**  
 ×

**Credits**

**Department**  
 ▼



The screenshot shows a web browser window titled "Edit - Contoso University". The address bar indicates the URL is "localhost:5813/Instruct". The main content area is titled "Edit" and has a sub-section "Instructor". It contains several input fields: "Last Name" with the value "Abercrombie", "First Name" with the value "Kim", "Hire Date" with the value "3/11/1995", and "Office Location" with the value "44/3P". Below these are several checkboxes for course selection, grouped into three columns. The first column has checkboxes for "1000 Algebra 2" (unchecked) and "2021 Composition" (checked). The second column has checkboxes for "1045 Calculus" (unchecked) and "2042 Literature" (checked). The third column has checkboxes for "1050 Chemistry" (unchecked), "3141 Trigonometry" (unchecked), and "4022 Microeconomics" (unchecked). A "Save" button is located at the bottom left of the form.

## Customize the Create and Edit Pages for Courses

When a new course entity is created, it must have a relationship to an existing department. To facilitate this, the scaffolded code includes controller methods and Create and Edit views that include a drop-down list for selecting the department. The drop-down list sets the `Course.DepartmentID` foreign key property, and that's all the Entity Framework needs in order to load the `Department` navigation property with the appropriate Department entity. You'll use the scaffolded code, but change it slightly to add error handling and sort the drop-down list.

In `CoursesController.cs`, delete the four Create and Edit methods and replace them with the following code:

```
public IActionResult Create()
{
    PopulateDepartmentsDropDownList();
    return View();
}
```

```
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Create([Bind("CourseID,Credits,DepartmentID,Title")] Course course)
{
    if (ModelState.IsValid)
    {
        _context.Add(course);
        await _context.SaveChangesAsync();
        return RedirectToAction(nameof(Index));
    }
    PopulateDepartmentsDropDownList(course.DepartmentID);
    return View(course);
}
```

```
public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var course = await _context.Courses
        .AsNoTracking()
        .SingleOrDefaultAsync(m => m.CourseID == id);
    if (course == null)
    {
        return NotFound();
    }
    PopulateDepartmentsDropDownList(course.DepartmentID);
    return View(course);
}
```

```

[HttpPost, ActionName("Edit")]
[ValidateAntiForgeryToken]
public async Task<IActionResult> EditPost(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var courseToUpdate = await _context.Courses
        .SingleOrDefaultAsync(c => c.CourseID == id);

    if (await TryUpdateModelAsync<Course>(courseToUpdate,
        "",
        c => c.Credits, c => c.DepartmentID, c => c.Title))
    {
        try
        {
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateException /* ex */)
        {
            //Log the error (uncomment ex variable name and write a log.)
            ModelState.AddModelError("", "Unable to save changes. " +
                "Try again, and if the problem persists, " +
                "see your system administrator.");
        }
        return RedirectToAction(nameof(Index));
    }
    PopulateDepartmentsDropDownList(courseToUpdate.DepartmentID);
    return View(courseToUpdate);
}

```

After the `Edit` `HttpPost` method, create a new method that loads department info for the drop-down list.

```

private void PopulateDepartmentsDropDownList(object selectedDepartment = null)
{
    var departmentsQuery = from d in _context.Departments
                           orderby d.Name
                           select d;
    ViewBag.DepartmentID = new SelectList(departmentsQuery.AsNoTracking(), "DepartmentID", "Name",
    selectedDepartment);
}

```

The `PopulateDepartmentsDropDownList` method gets a list of all departments sorted by name, creates a `SelectList` collection for a drop-down list, and passes the collection to the view in `ViewBag`. The method accepts the optional `selectedDepartment` parameter that allows the calling code to specify the item that will be selected when the drop-down list is rendered. The view will pass the name "DepartmentID" to the `<select>` tag helper, and the helper then knows to look in the `ViewBag` object for a `SelectList` named "DepartmentID".

The `HttpGet Create` method calls the `PopulateDepartmentsDropDownList` method without setting the selected item, because for a new course the department isn't established yet:

```

public IActionResult Create()
{
    PopulateDepartmentsDropDownList();
    return View();
}

```

The `HttpGet Edit` method sets the selected item, based on the ID of the department that's already assigned to

the course being edited:

```
public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var course = await _context.Courses
        .AsNoTracking()
        .SingleOrDefaultAsync(m => m.CourseID == id);
    if (course == null)
    {
        return NotFound();
    }
    PopulateDepartmentsDropDownList(course.DepartmentID);
    return View(course);
}
```

The `HttpPost` methods for both `Create` and `Edit` also include code that sets the selected item when they redisplay the page after an error. This ensures that when the page is redisplayed to show the error message, whatever department was selected stays selected.

### Add `.AsNoTracking` to Details and Delete methods

To optimize performance of the Course Details and Delete pages, add `AsNoTracking` calls in the `Details` and `HttpGet Delete` methods.

```
public async Task<IActionResult> Details(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var course = await _context.Courses
        .Include(c => c.Department)
        .AsNoTracking()
        .SingleOrDefaultAsync(m => m.CourseID == id);
    if (course == null)
    {
        return NotFound();
    }

    return View(course);
}
```

```

public async Task<IActionResult> Delete(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var course = await _context.Courses
        .Include(c => c.Department)
        .AsNoTracking()
        .SingleOrDefaultAsync(m => m.CourseID == id);
    if (course == null)
    {
        return NotFound();
    }

    return View(course);
}

```

## Modify the Course views

In *Views/Courses/Create.cshtml*, add a "Select Department" option to the **Department** drop-down list, change the caption from **DepartmentID** to **Department**, and add a validation message.

```

<div class="form-group">
    <label asp-for="Department" class="control-label"></label>
    <select asp-for="DepartmentID" class="form-control" asp-items="ViewBag.DepartmentID">
        <option value="">-- Select Department --</option>
    </select>
    <span asp-validation-for="DepartmentID" class="text-danger" />

```

In *Views/Courses/Edit.cshtml*, make the same change for the Department field that you just did in *Create.cshtml*.

Also in *Views/Courses/Edit.cshtml*, add a course number field before the **Title** field. Because the course number is the primary key, it's displayed, but it can't be changed.

```

<div class="form-group">
    <label asp-for="CourseID" class="control-label"></label>
    <div>@Html.DisplayFor(model => model.CourseID)</div>
</div>

```

There's already a hidden field (`<input type="hidden">`) for the course number in the Edit view. Adding a `<label>` tag helper doesn't eliminate the need for the hidden field because it doesn't cause the course number to be included in the posted data when the user clicks **Save** on the **Edit** page.

In *Views/Courses/Delete.cshtml*, add a course number field at the top and change department ID to department name.

```

@model ContosoUniversity.Models.Course

 @{
     ViewData["Title"] = "Delete";
 }

<h2>Delete</h2>

<h3>Are you sure you want to delete this?</h3>
<div>
    <h4>Course</h4>
    <hr />
    <dl class="dl-horizontal">
        <dt>
            @Html.DisplayNameFor(model => model.CourseID)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.CourseID)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Title)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Title)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Credits)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Credits)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Department)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Department.Name)
        </dd>
    </dl>

    <form asp-action="Delete">
        <div class="form-actions no-color">
            <input type="submit" value="Delete" class="btn btn-default" /> |
            <a asp-action="Index">Back to List</a>
        </div>
    </form>
</div>

```

In *Views/Courses/Details.cshtml*, make the same change that you just did for *Delete.cshtml*.

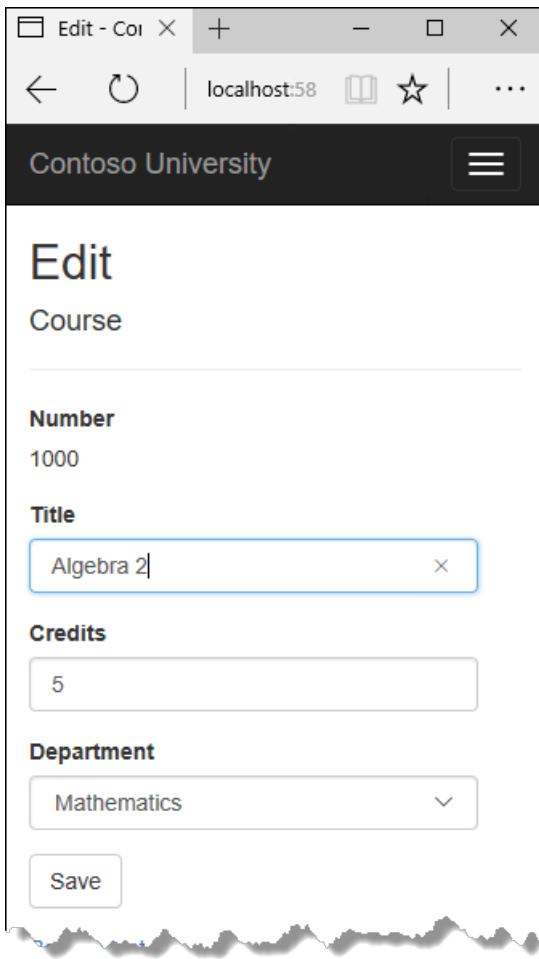
## Test the Course pages

Run the app, select the **Courses** tab, click **Create New**, and enter data for a new course:

The screenshot shows a web browser window with the address bar displaying "localhost:581". The title bar says "Create - C". The main content area is titled "Create" and has a sub-section "Course". It contains four input fields: "Number" with value "1000", "Title" with value "Algebra", "Credits" with value "5", and a dropdown "Department" set to "Mathematics". At the bottom is a "Create" button.

Click **Create**. The Courses Index page is displayed with the new course added to the list. The department name in the Index page list comes from the navigation property, showing that the relationship was established correctly.

Click **Edit** on a course in the Courses Index page.



Change data on the page and click **Save**. The Courses Index page is displayed with the updated course data.

## Add an Edit Page for Instructors

When you edit an instructor record, you want to be able to update the instructor's office assignment. The Instructor entity has a one-to-zero-or-one relationship with the OfficeAssignment entity, which means your code has to handle the following situations:

- If the user clears the office assignment and it originally had a value, delete the OfficeAssignment entity.
- If the user enters an office assignment value and it originally was empty, create a new OfficeAssignment entity.
- If the user changes the value of an office assignment, change the value in an existing OfficeAssignment entity.

### Update the Instructors controller

In *InstructorsController.cs*, change the code in the `HttpGet [Edit]` method so that it loads the Instructor entity's `OfficeAssignment` navigation property and calls `AsNoTracking`:

```

public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var instructor = await _context.Instructors
        .Include(i => i.OfficeAssignment)
        .AsNoTracking()
        .SingleOrDefaultAsync(m => m.ID == id);
    if (instructor == null)
    {
        return NotFound();
    }
    return View(instructor);
}

```

Replace the `HttpPost` `Edit` method with the following code to handle office assignment updates:

```

[HttpPost, ActionName("Edit")]
[ValidateAntiForgeryToken]
public async Task<IActionResult> EditPost(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var instructorToUpdate = await _context.Instructors
        .Include(i => i.OfficeAssignment)
        .SingleOrDefaultAsync(s => s.ID == id);

    if (await TryUpdateModelAsync<Instructor>(
        instructorToUpdate,
        "",
        i => i.FirstMidName, i => i.LastName, i => i.HireDate, i => i.OfficeAssignment))
    {
        if (String.IsNullOrWhiteSpace(instructorToUpdate.OfficeAssignment?.Location))
        {
            instructorToUpdate.OfficeAssignment = null;
        }
        try
        {
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateException /* ex */)
        {
            //Log the error (uncomment ex variable name and write a log.)
            ModelState.AddModelError("", "Unable to save changes. " +
                "Try again, and if the problem persists, " +
                "see your system administrator.");
        }
        return RedirectToAction(nameof(Index));
    }
    return View(instructorToUpdate);
}

```

The code does the following:

- Changes the method name to `EditPost` because the signature is now the same as the `HttpGet` `Edit` method (the `ActionName` attribute specifies that the `/Edit/` URL is still used).
- Gets the current `Instructor` entity from the database using eager loading for the `OfficeAssignment`

navigation property. This is the same as what you did in the `HttpGet` `Edit` method.

- Updates the retrieved Instructor entity with values from the model binder. The `TryUpdateModel` overload enables you to whitelist the properties you want to include. This prevents over-posting, as explained in the [second tutorial](#).

```
if (await TryUpdateModelAsync<Instructor>(
    instructorToUpdate,
    "",
    i => i.FirstMidName, i => i.LastName, i => i.HireDate, i => i.OfficeAssignment))
```

- If the office location is blank, sets the `Instructor.OfficeAssignment` property to null so that the related row in the `OfficeAssignment` table will be deleted.

```
if (String.IsNullOrWhiteSpace(instructorToUpdate.OfficeAssignment?.Location))
{
    instructorToUpdate.OfficeAssignment = null;
}
```

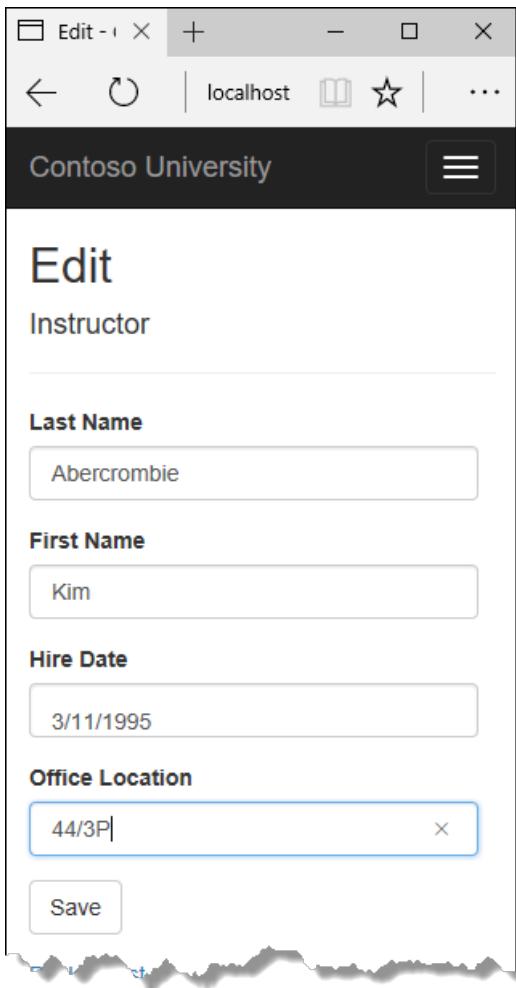
- Saves the changes to the database.

## Update the Instructor Edit view

In `Views/Instructors/Edit.cshtml`, add a new field for editing the office location, at the end before the **Save** button:

```
<div class="form-group">
    <label asp-for="OfficeAssignment.Location" class="control-label"></label>
    <input asp-for="OfficeAssignment.Location" class="form-control" />
    <span asp-validation-for="OfficeAssignment.Location" class="text-danger" />
</div>
```

Run the app, select the **Instructors** tab, and then click **Edit** on an instructor. Change the **Office Location** and click **Save**.



## Add Course assignments to the Instructor Edit page

Instructors may teach any number of courses. Now you'll enhance the Instructor Edit page by adding the ability to change course assignments using a group of check boxes, as shown in the following screen shot:

Last Name  
Abercrombie

First Name  
Kim

Hire Date  
3/11/1995

Office Location  
44/3P

1000 Algebra 2    1045 Calculus    1050 Chemistry  
 2021 Composition    2042 Literature    3141 Trigonometry  
 4022 Microeconomics    4041 Macroeconomics

Save

The relationship between the Course and Instructor entities is many-to-many. To add and remove relationships, you add and remove entities to and from the CourseAssignments join entity set.

The UI that enables you to change which courses an instructor is assigned to is a group of check boxes. A check box for every course in the database is displayed, and the ones that the instructor is currently assigned to are selected. The user can select or clear check boxes to change course assignments. If the number of courses were much greater, you would probably want to use a different method of presenting the data in the view, but you'd use the same method of manipulating a join entity to create or delete relationships.

#### Update the Instructors controller

To provide data to the view for the list of check boxes, you'll use a view model class.

Create *AssignedCourseData.cs* in the *SchoolViewModels* folder and replace the existing code with the following code:

```

using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;

namespace ContosoUniversity.Models.SchoolViewModels
{
    public class AssignedCourseData
    {
        public int CourseID { get; set; }
        public string Title { get; set; }
        public bool Assigned { get; set; }
    }
}

```

In *InstructorsController.cs*, replace the `HttpGet` `Edit` method with the following code. The changes are highlighted.

```

public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var instructor = await _context.Instructors
        .Include(i => i.OfficeAssignment)
        .Include(i => i.CourseAssignments).ThenInclude(i => i.Course)
        .AsNoTracking()
        .SingleOrDefaultAsync(m => m.ID == id);
    if (instructor == null)
    {
        return NotFound();
    }
    PopulateAssignedCourseData(instructor);
    return View(instructor);
}

private void PopulateAssignedCourseData(Instructor instructor)
{
    var allCourses = _context.Courses;
    var instructorCourses = new HashSet<int>(instructor.CourseAssignments.Select(c => c.CourseID));
    var viewModel = new List<AssignedCourseData>();
    foreach (var course in allCourses)
    {
        viewModel.Add(new AssignedCourseData
        {
            CourseID = course.CourseID,
            Title = course.Title,
            Assigned = instructorCourses.Contains(course.CourseID)
        });
    }
    ViewData["Courses"] = viewModel;
}

```

The code adds eager loading for the `Courses` navigation property and calls the new `PopulateAssignedCourseData` method to provide information for the check box array using the `AssignedCourseData` view model class.

The code in the `PopulateAssignedCourseData` method reads through all Course entities in order to load a list of courses using the view model class. For each course, the code checks whether the course exists in the instructor's `Courses` navigation property. To create efficient lookup when checking whether a course is assigned to the instructor, the courses assigned to the instructor are put into a `HashSet` collection. The `Assigned` property is set to

true for courses the instructor is assigned to. The view will use this property to determine which check boxes must be displayed as selected. Finally, the list is passed to the view in `ViewData`.

Next, add the code that's executed when the user clicks **Save**. Replace the `EditPost` method with the following code, and add a new method that updates the `Courses` navigation property of the `Instructor` entity.

```
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int? id, string[] selectedCourses)
{
    if (id == null)
    {
        return NotFound();
    }

    var instructorToUpdate = await _context.Instructors
        .Include(i => i.OfficeAssignment)
        .Include(i => i.CourseAssignments)
            .ThenInclude(i => i.Course)
        .SingleOrDefaultAsync(m => m.ID == id);

    if (await TryUpdateModelAsync<Instructor>(
        instructorToUpdate,
        "",
        i => i.FirstMidName, i => i.LastName, i => i.HireDate, i => i.OfficeAssignment))
    {
        if (String.IsNullOrWhiteSpace(instructorToUpdate.OfficeAssignment?.Location))
        {
            instructorToUpdate.OfficeAssignment = null;
        }
        UpdateInstructorCourses(selectedCourses, instructorToUpdate);
        try
        {
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateException /* ex */)
        {
            //Log the error (uncomment ex variable name and write a log.)
            ModelState.AddModelError("", "Unable to save changes. " +
                "Try again, and if the problem persists, " +
                "see your system administrator.");
        }
        return RedirectToAction(nameof(Index));
    }
    UpdateInstructorCourses(selectedCourses, instructorToUpdate);
    PopulateAssignedCourseData(instructorToUpdate);
    return View(instructorToUpdate);
}
```

```

private void UpdateInstructorCourses(string[] selectedCourses, Instructor instructorToUpdate)
{
    if (selectedCourses == null)
    {
        instructorToUpdate.CourseAssignments = new List<CourseAssignment>();
        return;
    }

    var selectedCoursesHS = new HashSet<string>(selectedCourses);
    var instructorCourses = new HashSet<int>
        (instructorToUpdate.CourseAssignments.Select(c => c.Course.CourseID));
    foreach (var course in _context.Courses)
    {
        if (selectedCoursesHS.Contains(course.CourseID.ToString()))
        {
            if (!instructorCourses.Contains(course.CourseID))
            {
                instructorToUpdate.CourseAssignments.Add(new CourseAssignment { InstructorID =
instructorToUpdate.ID, CourseID = course.CourseID });
            }
        }
        else
        {

            if (instructorCourses.Contains(course.CourseID))
            {
                CourseAssignment courseToRemove = instructorToUpdate.CourseAssignments.SingleOrDefault(i =>
i.CourseID == course.CourseID);
                _context.Remove(courseToRemove);
            }
        }
    }
}

```

The method signature is now different from the `HttpGet` `Edit` method, so the method name changes from `EditPost` back to `Edit`.

Since the view doesn't have a collection of `Course` entities, the model binder can't automatically update the `CourseAssignments` navigation property. Instead of using the model binder to update the `CourseAssignments` navigation property, you do that in the new `UpdateInstructorCourses` method. Therefore you need to exclude the `CourseAssignments` property from model binding. This doesn't require any change to the code that calls `TryUpdateModel` because you're using the whitelisting overload and `CourseAssignments` isn't in the include list.

If no check boxes were selected, the code in `UpdateInstructorCourses` initializes the `CourseAssignments` navigation property with an empty collection and returns:

```

private void UpdateInstructorCourses(string[] selectedCourses, Instructor instructorToUpdate)
{
    if (selectedCourses == null)
    {
        instructorToUpdate.CourseAssignments = new List<CourseAssignment>();
        return;
    }

    var selectedCoursesHS = new HashSet<string>(selectedCourses);
    var instructorCourses = new HashSet<int>
        (instructorToUpdate.CourseAssignments.Select(c => c.Course.CourseID));
    foreach (var course in _context.Courses)
    {
        if (selectedCoursesHS.Contains(course.CourseID.ToString()))
        {
            if (!instructorCourses.Contains(course.CourseID))
            {
                instructorToUpdate.CourseAssignments.Add(new CourseAssignment { InstructorID =
instructorToUpdate.ID, CourseID = course.CourseID });
            }
        }
        else
        {

            if (instructorCourses.Contains(course.CourseID))
            {
                CourseAssignment courseToRemove = instructorToUpdate.CourseAssignments.SingleOrDefault(i =>
i.CourseID == course.CourseID);
                _context.Remove(courseToRemove);
            }
        }
    }
}

```

The code then loops through all courses in the database and checks each course against the ones currently assigned to the instructor versus the ones that were selected in the view. To facilitate efficient lookups, the latter two collections are stored in `HashSet` objects.

If the check box for a course was selected but the course isn't in the `Instructor.CourseAssignments` navigation property, the course is added to the collection in the navigation property.

```

private void UpdateInstructorCourses(string[] selectedCourses, Instructor instructorToUpdate)
{
    if (selectedCourses == null)
    {
        instructorToUpdate.CourseAssignments = new List<CourseAssignment>();
        return;
    }

    var selectedCoursesHS = new HashSet<string>(selectedCourses);
    var instructorCourses = new HashSet<int>
        (instructorToUpdate.CourseAssignments.Select(c => c.Course.CourseID));
    foreach (var course in _context.Courses)
    {
        if (selectedCoursesHS.Contains(course.CourseID.ToString()))
        {
            if (!instructorCourses.Contains(course.CourseID))
            {
                instructorToUpdate.CourseAssignments.Add(new CourseAssignment { InstructorID =
instructorToUpdate.ID, CourseID = course.CourseID });
            }
        }
        else
        {

            if (instructorCourses.Contains(course.CourseID))
            {
                CourseAssignment courseToRemove = instructorToUpdate.CourseAssignments.SingleOrDefault(i =>
i.CourseID == course.CourseID);
                _context.Remove(courseToRemove);
            }
        }
    }
}

```

If the check box for a course wasn't selected, but the course is in the `Instructor.CourseAssignments` navigation property, the course is removed from the navigation property.

```

private void UpdateInstructorCourses(string[] selectedCourses, Instructor instructorToUpdate)
{
    if (selectedCourses == null)
    {
        instructorToUpdate.CourseAssignments = new List<CourseAssignment>();
        return;
    }

    var selectedCoursesHS = new HashSet<string>(selectedCourses);
    var instructorCourses = new HashSet<int>
        (instructorToUpdate.CourseAssignments.Select(c => c.Course.CourseID));
    foreach (var course in _context.Courses)
    {
        if (selectedCoursesHS.Contains(course.CourseID.ToString()))
        {
            if (!instructorCourses.Contains(course.CourseID))
            {
                instructorToUpdate.CourseAssignments.Add(new CourseAssignment { InstructorID =
instructorToUpdate.ID, CourseID = course.CourseID });
            }
        }
        else
        {

            if (instructorCourses.Contains(course.CourseID))
            {
                CourseAssignment courseToRemove = instructorToUpdate.CourseAssignments.SingleOrDefault(i =>
i.CourseID == course.CourseID);
                _context.Remove(courseToRemove);
            }
        }
    }
}

```

## Update the Instructor views

In *Views/Instructors/Edit.cshtml*, add a **Courses** field with an array of check boxes by adding the following code immediately after the `div` elements for the **Office** field and before the `div` element for the **Save** button.

### NOTE

When you paste the code in Visual Studio, line breaks will be changed in a way that breaks the code. Press Ctrl+Z one time to undo the automatic formatting. This will fix the line breaks so that they look like what you see here. The indentation doesn't have to be perfect, but the `@</tr><tr>`, `@:<td>`, `@:</td>`, and `@:</tr>` lines must each be on a single line as shown or you'll get a runtime error. With the block of new code selected, press Tab three times to line up the new code with the existing code. You can check the status of this problem [here](#).

```

<div class="form-group">
    <div class="col-md-offset-2 col-md-10">
        <table>
            <tr>
                @{
                    int cnt = 0;
                    List<ContosoUniversity.Models.SchoolViewModels.AssignedCourseData> courses =
                    ViewBag.Courses;

                    foreach (var course in courses)
                    {
                        if (cnt++ % 3 == 0)
                        {
                            @:</tr><tr>
                        }
                        @:<td>
                            <input type="checkbox"
                                name="selectedCourses"
                                value="@course.CourseID"
                                @(Html.Raw(course.Assigned ? "checked=\"checked\" : "")) />
                                @course.CourseID @: @course.Title
                        @:</td>
                    }
                    @:</tr>
                }
            </table>
        </div>
    </div>

```

This code creates an HTML table that has three columns. In each column is a check box followed by a caption that consists of the course number and title. The check boxes all have the same name ("selectedCourses"), which informs the model binder that they're to be treated as a group. The value attribute of each check box is set to the value of `CourseID`. When the page is posted, the model binder passes an array to the controller that consists of the `CourseID` values for only the check boxes which are selected.

When the check boxes are initially rendered, those that are for courses assigned to the instructor have checked attributes, which selects them (displays them checked).

Run the app, select the **Instructors** tab, and click **Edit** on an instructor to see the **Edit** page.

The screenshot shows a web browser window titled "Edit - Contoso University". The address bar displays "localhost:5813/Instruct". The main content area is titled "Edit Instructor". It contains the following form fields:

- Last Name:** Abercrombie
- First Name:** Kim
- Hire Date:** 3/11/1995
- Office Location:** 44/3P
- Courses:** A list of checkboxes for various courses:
  - 1000 Algebra 2
  - 1045 Calculus
  - 1050 Chemistry
  - 2021 Composition
  - 2042 Literature
  - 3141 Trigonometry
  - 4022 Microeconomics
  - 4041 Macroeconomics
- Save:** A button to save the changes.

Change some course assignments and click Save. The changes you make are reflected on the Index page.

**NOTE**

The approach taken here to edit instructor course data works well when there's a limited number of courses. For collections that are much larger, a different UI and a different updating method would be required.

## Update the Delete page

In *InstructorsController.cs*, delete the `DeleteConfirmed` method and insert the following code in its place.

```

[HttpPost, ActionName("Delete")]
[ValidateAntiForgeryToken]
public async Task<IActionResult> DeleteConfirmed(int id)
{
    Instructor instructor = await _context.Instructors
        .Include(i => i.CourseAssignments)
        .SingleAsync(i => i.ID == id);

    var departments = await _context.Departments
        .Where(d => d.InstructorID == id)
        .ToListAsync();
    departments.ForEach(d => d.InstructorID = null);

    _context.Instructors.Remove(instructor);

    await _context.SaveChangesAsync();
    return RedirectToAction(nameof(Index));
}

```

This code makes the following changes:

- Does eager loading for the `CourseAssignments` navigation property. You have to include this or EF won't know about related `CourseAssignment` entities and won't delete them. To avoid needing to read them here you could configure cascade delete in the database.
- If the instructor to be deleted is assigned as administrator of any departments, removes the instructor assignment from those departments.

## Add office location and courses to the Create page

In `InstructorsController.cs`, delete the `HttpGet` and `HttpPost` `Create` methods, and then add the following code in their place:

```

public IActionResult Create()
{
    var instructor = new Instructor();
    instructor.CourseAssignments = new List<CourseAssignment>();
    PopulateAssignedCourseData(instructor);
    return View();
}

// POST: Instructors/Create
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Create([Bind("FirstMidName,HireDate,LastName,OfficeAssignment")] Instructor
instructor, string[] selectedCourses)
{
    if (selectedCourses != null)
    {
        instructor.CourseAssignments = new List<CourseAssignment>();
        foreach (var course in selectedCourses)
        {
            var courseToAdd = new CourseAssignment { InstructorID = instructor.ID, CourseID =
int.Parse(course) };
            instructor.CourseAssignments.Add(courseToAdd);
        }
    }
    if (ModelState.IsValid)
    {
        _context.Add(instructor);
        await _context.SaveChangesAsync();
        return RedirectToAction(nameof(Index));
    }
    PopulateAssignedCourseData(instructor);
    return View(instructor);
}

```

This code is similar to what you saw for the `Edit` methods except that initially no courses are selected. The `HttpGet` `Create` method calls the `PopulateAssignedCourseData` method not because there might be courses selected but in order to provide an empty collection for the `foreach` loop in the view (otherwise the view code would throw a null reference exception).

The `HttpPost` `Create` method adds each selected course to the `CourseAssignments` navigation property before it checks for validation errors and adds the new instructor to the database. Courses are added even if there are model errors so that when there are model errors (for an example, the user keyed an invalid date), and the page is redisplayed with an error message, any course selections that were made are automatically restored.

Notice that in order to be able to add courses to the `CourseAssignments` navigation property you have to initialize the property as an empty collection:

```
instructor.CourseAssignments = new List<CourseAssignment>();
```

As an alternative to doing this in controller code, you could do it in the `Instructor` model by changing the property getter to automatically create the collection if it doesn't exist, as shown in the following example:

```

private ICollection<CourseAssignment> _courseAssignments;
public ICollection<CourseAssignment> CourseAssignments
{
get
{
return _courseAssignments ?? (_courseAssignments = new List<CourseAssignment>());
}
set
{
_courseAssignments = value;
}
}

```

If you modify the `CourseAssignments` property in this way, you can remove the explicit property initialization code in the controller.

In `Views/Instructor/Create.cshtml`, add an office location text box and check boxes for courses before the Submit button. As in the case of the Edit page, [fix the formatting if Visual Studio reformats the code when you paste it](#).

```

<div class="form-group">
    <label asp-for="OfficeAssignment.Location" class="control-label"></label>
    <input asp-for="OfficeAssignment.Location" class="form-control" />
    <span asp-validation-for="OfficeAssignment.Location" class="text-danger" />
</div>

<div class="form-group">
    <div class="col-md-offset-2 col-md-10">
        <table>
            <tr>
                @{
                    int cnt = 0;
                    List<ContosoUniversity.Models.SchoolViewModels.AssignedCourseData> courses =
                    ViewBag.Courses;
                    foreach (var course in courses)
                    {
                        if (cnt++ % 3 == 0)
                        {
                            @:</tr><tr>
                        }
                        @:<td>
                            <input type="checkbox"
                                name="selectedCourses"
                                value="@course.CourseID"
                                @(Html.Raw(course.Assigned ? "checked=\"checked\" : "")) />
                                @course.CourseID @: @course.Title
                        @:</td>
                    }
                    @:</tr>
                }
            </table>
        </div>
    </div>

```

Test by running the app and creating an instructor.

## Handling Transactions

As explained in the [CRUD tutorial](#), the Entity Framework implicitly implements transactions. For scenarios where you need more control -- for example, if you want to include operations done outside of Entity Framework in a transaction -- see [Transactions](#).

## Summary

You have now completed the introduction to working with related data. In the next tutorial you'll see how to handle concurrency conflicts.

[PREVIOUS](#)

[NEXT](#)

# ASP.NET Core MVC with EF Core - Concurrency - 8 of 10

6/28/2018 • 19 minutes to read • [Edit Online](#)

This tutorial has not been upgraded to ASP.NET Core 2.1. The ASP.NET Core 2.0 version of this tutorial is available by selecting **ASP.NET Core 2.0** above the table of contents or at the top of the page:

The ASP.NET Core 2.1 Razor Pages version of this tutorial has many improvements over the 2.0 version.

The 2.0 tutorial teaches ASP.NET Core MVC and Entity Framework Core with controllers and views. Razor Pages is a page-based programming model that makes building web UI easier and more productive. We recommend the [Razor Pages](#) tutorial over the MVC version. The Razor Pages tutorial:

- Is easier to follow. For example, the scaffolding code has been significantly simplified.
- Provides more EF Core best practices.
- Uses more efficient queries.
- Is more current with the latest API.
- Covers more features.
- Is the preferred approach for new application development.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub discussion](#).

By [Tom Dykstra](#) and [Rick Anderson](#)

The Contoso University sample web application demonstrates how to create ASP.NET Core MVC web applications using Entity Framework Core and Visual Studio. For information about the tutorial series, see [the first tutorial in the series](#).

In earlier tutorials, you learned how to update data. This tutorial shows how to handle conflicts when multiple users update the same entity at the same time.

You'll create web pages that work with the Department entity and handle concurrency errors. The following illustrations show the Edit and Delete pages, including some messages that are displayed if a concurrency conflict occurs.

Departmen X Edit - Cont X + - □ ×

localhost:5813/Departr | ⌂ ⌂ ⌂ ...

## Contoso University

# Edit

## Department

---

The record you attempted to edit was modified by another user after you got the original value. The edit operation was canceled and the current values in the database have been displayed. If you still want to edit this record, click the Save button again. Otherwise click the Back to List hyperlink.

**Name**

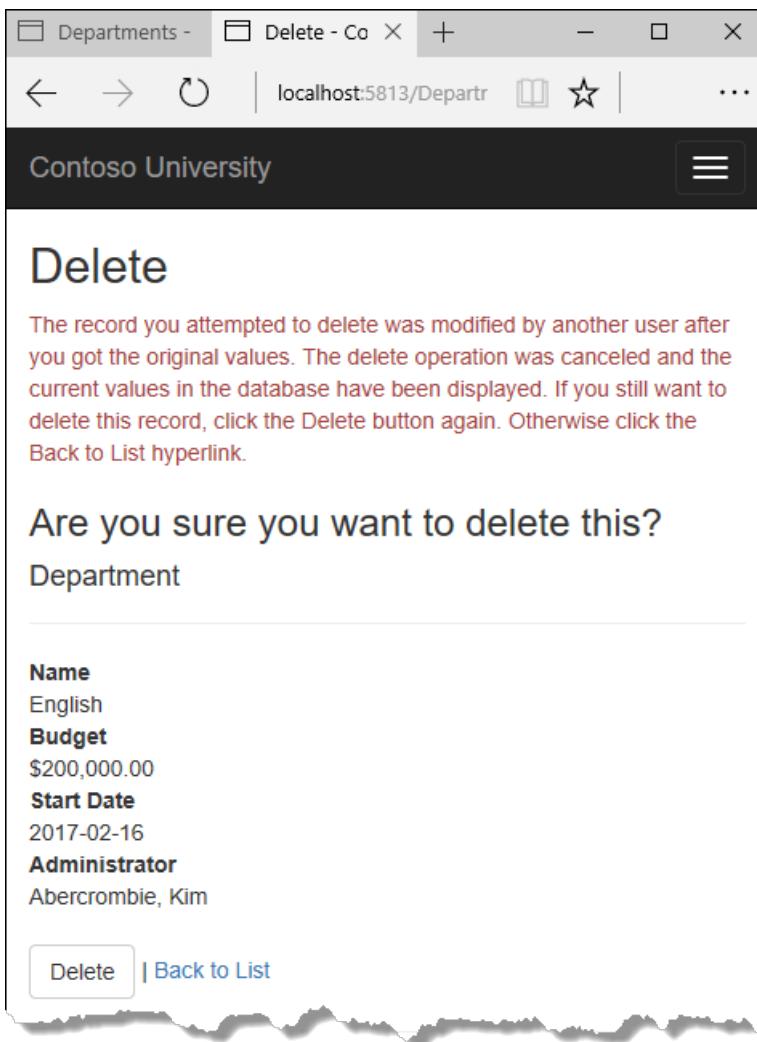
**Budget**

Current value: \$50,000.00

**Start Date**

**InstructorID**

Save



## Concurrency conflicts

A concurrency conflict occurs when one user displays an entity's data in order to edit it, and then another user updates the same entity's data before the first user's change is written to the database. If you don't enable the detection of such conflicts, whoever updates the database last overwrites the other user's changes. In many applications, this risk is acceptable: if there are few users, or few updates, or if isn't really critical if some changes are overwritten, the cost of programming for concurrency might outweigh the benefit. In that case, you don't have to configure the application to handle concurrency conflicts.

### Pessimistic concurrency (locking)

If your application does need to prevent accidental data loss in concurrency scenarios, one way to do that is to use database locks. This is called pessimistic concurrency. For example, before you read a row from a database, you request a lock for read-only or for update access. If you lock a row for update access, no other users are allowed to lock the row either for read-only or update access, because they would get a copy of data that's in the process of being changed. If you lock a row for read-only access, others can also lock it for read-only access but not for update.

Managing locks has disadvantages. It can be complex to program. It requires significant database management resources, and it can cause performance problems as the number of users of an application increases. For these reasons, not all database management systems support pessimistic concurrency. Entity Framework Core provides no built-in support for it, and this tutorial doesn't show you how to implement it.

### Optimistic Concurrency

The alternative to pessimistic concurrency is optimistic concurrency. Optimistic concurrency means allowing concurrency conflicts to happen, and then reacting appropriately if they do. For example, Jane visits the Department Edit page and changes the Budget amount for the English department from \$350,000.00 to \$0.00.

Edit

Department

Budget

Administrator

Name

Start Date

Save

Before Jane clicks **Save**, John visits the same page and changes the Start Date field from 9/1/2007 to 9/1/2013.

Edit

Department

Budget

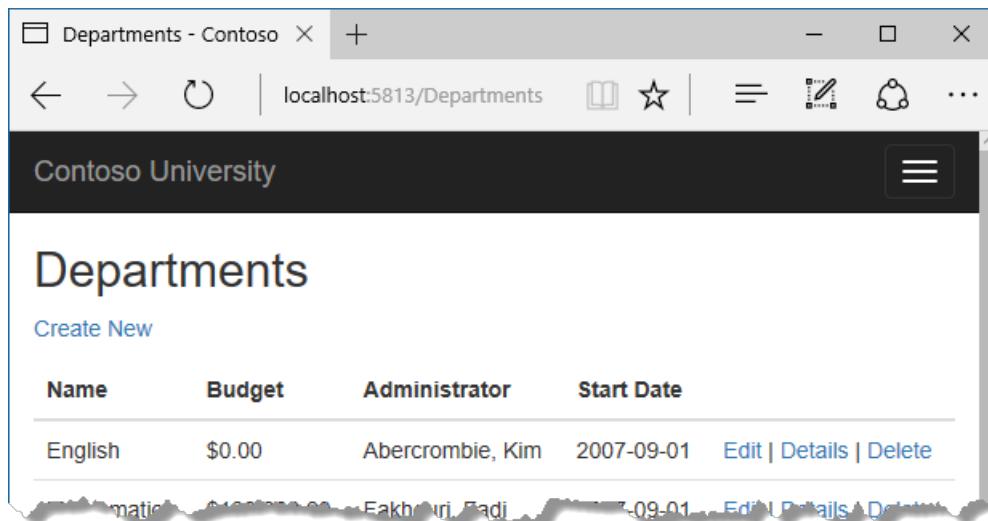
Administrator

Name

Start Date

Save

Jane clicks **Save** first and sees her change when the browser returns to the Index page.



Name	Budget	Administrator	Start Date
English	\$0.00	Abercrombie, Kim	2007-09-01
Information Systems	\$350,000.00	Fakhruji, Fadi	2013-09-01

Then John clicks **Save** on an Edit page that still shows a budget of \$350,000.00. What happens next is determined by how you handle concurrency conflicts.

Some of the options include the following:

- You can keep track of which property a user has modified and update only the corresponding columns in the database.

In the example scenario, no data would be lost, because different properties were updated by the two users. The next time someone browses the English department, they will see both Jane's and John's changes -- a start date of 9/1/2013 and a budget of zero dollars. This method of updating can reduce the number of conflicts that could result in data loss, but it can't avoid data loss if competing changes are made to the same property of an entity. Whether the Entity Framework works this way depends on how you implement your update code. It's often not practical in a web application, because it can require that you maintain large amounts of state in order to keep track of all original property values for an entity as well as new values. Maintaining large amounts of state can affect application performance because it either requires server resources or must be included in the web page itself (for example, in hidden fields) or in a cookie.

- You can let John's change overwrite Jane's change.

The next time someone browses the English department, they will see 9/1/2013 and the restored \$350,000.00 value. This is called a *Client Wins* or *Last in Wins* scenario. (All values from the client take precedence over what's in the data store.) As noted in the introduction to this section, if you don't do any coding for concurrency handling, this will happen automatically.

- You can prevent John's change from being updated in the database.

Typically, you would display an error message, show him the current state of the data, and allow him to reapply his changes if he still wants to make them. This is called a *Store Wins* scenario. (The data-store values take precedence over the values submitted by the client.) You'll implement the Store Wins scenario in this tutorial. This method ensures that no changes are overwritten without a user being alerted to what's happening.

### Detecting concurrency conflicts

You can resolve conflicts by handling `DbConcurrencyException` exceptions that the Entity Framework throws. In order to know when to throw these exceptions, the Entity Framework must be able to detect conflicts. Therefore, you must configure the database and the data model appropriately. Some options for enabling conflict detection include the following:

- In the database table, include a tracking column that can be used to determine when a row has been changed. You can then configure the Entity Framework to include that column in the Where clause of SQL Update or

Delete commands.

The data type of the tracking column is typically `rowversion`. The `rowversion` value is a sequential number that's incremented each time the row is updated. In an Update or Delete command, the Where clause includes the original value of the tracking column (the original row version). If the row being updated has been changed by another user, the value in the `rowversion` column is different than the original value, so the Update or Delete statement can't find the row to update because of the Where clause. When the Entity Framework finds that no rows have been updated by the Update or Delete command (that is, when the number of affected rows is zero), it interprets that as a concurrency conflict.

- Configure the Entity Framework to include the original values of every column in the table in the Where clause of Update and Delete commands.

As in the first option, if anything in the row has changed since the row was first read, the Where clause won't return a row to update, which the Entity Framework interprets as a concurrency conflict. For database tables that have many columns, this approach can result in very large Where clauses, and can require that you maintain large amounts of state. As noted earlier, maintaining large amounts of state can affect application performance. Therefore this approach is generally not recommended, and it isn't the method used in this tutorial.

If you do want to implement this approach to concurrency, you have to mark all non-primary-key properties in the entity you want to track concurrency for by adding the `ConcurrencyCheck` attribute to them. That change enables the Entity Framework to include all columns in the SQL Where clause of Update and Delete statements.

In the remainder of this tutorial you'll add a `rowversion` tracking property to the Department entity, create a controller and views, and test to verify that everything works correctly.

## Add a tracking property to the Department entity

In `Models/Department.cs`, add a tracking property named `RowVersion`:

```

using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Department
    {
        public int DepartmentID { get; set; }

        [StringLength(50, MinimumLength = 3)]
        public string Name { get; set; }

        [DataType(DataType.Currency)]
        [Column(TypeName = "money")]
        public decimal Budget { get; set; }

        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        [Display(Name = "Start Date")]
        public DateTime StartDate { get; set; }

        public int? InstructorID { get; set; }

        [Timestamp]
        public byte[] RowVersion { get; set; }

        public Instructor Administrator { get; set; }
        public ICollection<Course> Courses { get; set; }
    }
}

```

The `Timestamp` attribute specifies that this column will be included in the `Where` clause of `Update` and `Delete` commands sent to the database. The attribute is called `Timestamp` because previous versions of SQL Server used a SQL `timestamp` data type before the SQL `rowversion` replaced it. The .NET type for `rowversion` is a byte array.

If you prefer to use the fluent API, you can use the `IsConcurrencyToken` method (in `Data/SchoolContext.cs`) to specify the tracking property, as shown in the following example:

```

modelBuilder.Entity<Department>()
    .Property(p => p.RowVersion).IsConcurrencyToken();

```

By adding a property you changed the database model, so you need to do another migration.

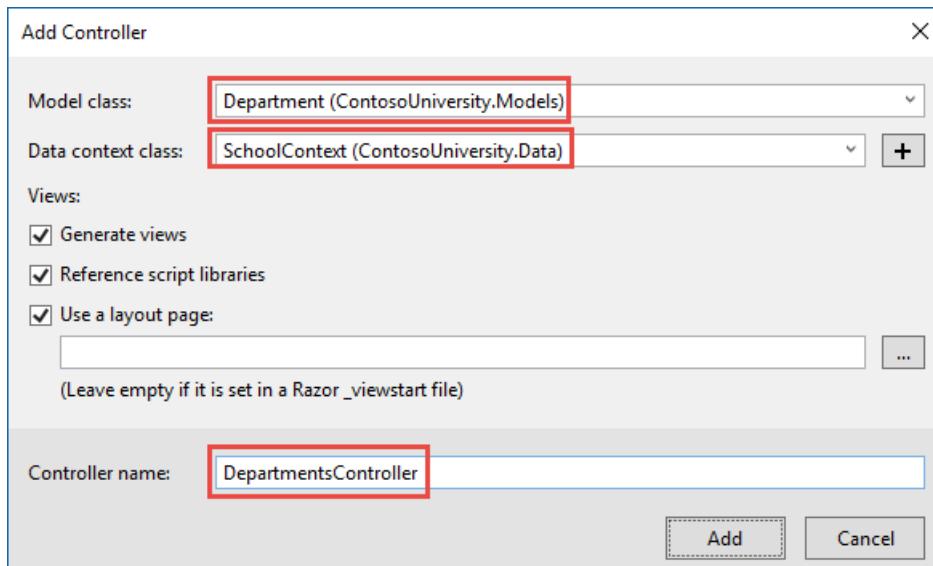
Save your changes and build the project, and then enter the following commands in the command window:

```
dotnet ef migrations add RowVersion
```

```
dotnet ef database update
```

## Create a Departments controller and views

Scaffold a Departments controller and views as you did earlier for Students, Courses, and Instructors.



In the *DepartmentsController.cs* file, change all four occurrences of "FirstMidName" to "FullName" so that the department administrator drop-down lists will contain the full name of the instructor rather than just the last name.

```
ViewData["InstructorID"] = new SelectList(_context.Instructors, "ID", "FullName", department.InstructorID);
```

## Update the Departments Index view

The scaffolding engine created a RowVersion column in the Index view, but that field shouldn't be displayed.

Replace the code in *Views/Departments/Index.cshtml* with the following code.

```

@model IEnumerable<ContosoUniversity.Models.Department>

 @{
     ViewData["Title"] = "Departments";
 }

<h2>Departments</h2>

<p>
    <a asp-action="Create">Create New</a>
</p>
<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.Name)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Budget)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.StartDate)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Administrator)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model)
        {
            <tr>
                <td>
                    @Html.DisplayFor(modelItem => item.Name)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Budget)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.StartDate)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Administrator.FullName)
                </td>
                <td>
                    <a asp-action="Edit" asp-route-id="@item.DepartmentID">Edit</a> |
                    <a asp-action="Details" asp-route-id="@item.DepartmentID">Details</a> |
                    <a asp-action="Delete" asp-route-id="@item.DepartmentID">Delete</a>
                </td>
            </tr>
        }
    </tbody>
</table>

```

This changes the heading to "Departments", deletes the RowVersion column, and shows full name instead of first name for the administrator.

## Update the Edit methods in the Departments controller

In both the `HttpGet` `Edit` method and the `Details` method, add `AsNoTracking`. In the `HttpGet` `Edit` method, add eager loading for the Administrator.

```

var department = await _context.Departments
    .Include(i => i.Administrator)
    .AsNoTracking()
    .SingleOrDefaultAsync(m => m.DepartmentID == id);

```

Replace the existing code for the `HttpPost` `Edit` method with the following code:

```

[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int? id, byte[] rowVersion)
{
    if (id == null)
    {
        return NotFound();
    }

    var departmentToUpdate = await _context.Departments.Include(i => i.Administrator).SingleOrDefaultAsync(m => m.DepartmentID == id);

    if (departmentToUpdate == null)
    {
        Department deletedDepartment = new Department();
        await TryUpdateModelAsync(deletedDepartment);
        ModelState.AddModelError(string.Empty,
            "Unable to save changes. The department was deleted by another user.");
        ViewData["InstructorID"] = new SelectList(_context.Instructors, "ID", "FullName",
deletedDepartment.InstructorID);
        return View(deletedDepartment);
    }

    _context.Entry(departmentToUpdate).Property("RowVersion").OriginalValue = rowVersion;

    if (await TryUpdateModelAsync<Department>(
        departmentToUpdate,
        "",
        s => s.Name, s => s.StartDate, s => s.Budget, s => s.InstructorID))
    {
        try
        {
            await _context.SaveChangesAsync();
            return RedirectToAction(nameof(Index));
        }
        catch (DbUpdateConcurrencyException ex)
        {
            var exceptionEntry = ex.Entries.Single();
            var clientValues = (Department)exceptionEntry.Entity;
            var databaseEntry = exceptionEntry.GetDatabaseValues();
            if (databaseEntry == null)
            {
                ModelState.AddModelError(string.Empty,
                    "Unable to save changes. The department was deleted by another user.");
            }
            else
            {
                var databaseValues = (Department)databaseEntry.ToObject();

                if (databaseValues.Name != clientValues.Name)
                {
                    ModelState.AddModelError("Name", $"Current value: {databaseValues.Name}");
                }
                if (databaseValues.Budget != clientValues.Budget)
                {
                    ModelState.AddModelError("Budget", $"Current value: {databaseValues.Budget:c}");
                }
                if (databaseValues.StartDate != clientValues.StartDate)
                {

```

```

        ModelState.AddModelError("StartDate", $"Current value: {databaseValues.StartDate:d}");
    }
    if (databaseValues.InstructorID != clientValues.InstructorID)
    {
        Instructor databaseInstructor = await _context.Instructors.SingleOrDefaultAsync(i => i.ID
== databaseValues.InstructorID);
        ModelState.AddModelError("InstructorID", $"Current value:
{databaseInstructor?.FullName}");
    }

    ModelState.AddModelError(string.Empty, "The record you attempted to edit "
        + "was modified by another user after you got the original value. The "
        + "edit operation was canceled and the current values in the database "
        + "have been displayed. If you still want to edit this record, click "
        + "the Save button again. Otherwise click the Back to List hyperlink.");
departmentToUpdate.RowVersion = (byte[])databaseValues.RowVersion;
ModelState.Remove("RowVersion");
}
}
}
ViewData["InstructorID"] = new SelectList(_context.Instructors, "ID", "FullName",
departmentToUpdate.InstructorID);
return View(departmentToUpdate);
}

```

The code begins by trying to read the department to be updated. If the `SingleOrDefaultAsync` method returns null, the department was deleted by another user. In that case the code uses the posted form values to create a department entity so that the Edit page can be redisplayed with an error message. As an alternative, you wouldn't have to re-create the department entity if you display only an error message without redisplaying the department fields.

The view stores the original `RowVersion` value in a hidden field, and this method receives that value in the `rowVersion` parameter. Before you call `SaveChanges`, you have to put that original `RowVersion` property value in the `OriginalValues` collection for the entity.

```
_context.Entry(departmentToUpdate).Property("RowVersion").OriginalValue = rowVersion;
```

Then when the Entity Framework creates a SQL UPDATE command, that command will include a WHERE clause that looks for a row that has the original `RowVersion` value. If no rows are affected by the UPDATE command (no rows have the original `RowVersion` value), the Entity Framework throws a `DbUpdateConcurrencyException` exception.

The code in the catch block for that exception gets the affected Department entity that has the updated values from the `Entries` property on the exception object.

```
var exceptionEntry = ex.Entries.Single();
```

The `Entries` collection will have just one `EntityEntry` object. You can use that object to get the new values entered by the user and the current database values.

```
var clientValues = (Department)exceptionEntry.Entity;
var databaseEntry = exceptionEntry.GetDatabaseValues();
```

The code adds a custom error message for each column that has database values different from what the user entered on the Edit page (only one field is shown here for brevity).

```
var databaseValues = (Department)databaseEntry.ToObject();

if (databaseValues.Name != clientValues.Name)
{
    ModelState.AddModelError("Name", $"Current value: {databaseValues.Name}");
}
```

Finally, the code sets the `RowVersion` value of the `departmentToUpdate` to the new value retrieved from the database. This new `RowVersion` value will be stored in the hidden field when the Edit page is redisplayed, and the next time the user clicks **Save**, only concurrency errors that happen since the redisplay of the Edit page will be caught.

```
departmentToUpdate.RowVersion = (byte[])databaseValues.RowVersion;
ModelState.Remove("RowVersion");
```

The `ModelState.Remove` statement is required because `ModelState` has the old `RowVersion` value. In the view, the `ModelState` value for a field takes precedence over the model property values when both are present.

## Update the Department Edit view

In `Views/Departments/Edit.cshtml`, make the following changes:

- Add a hidden field to save the `RowVersion` property value, immediately following the hidden field for the `DepartmentID` property.
- Add a "Select Administrator" option to the drop-down list.

```

@model ContosoUniversity.Models.Department

 @{
     ViewData["Title"] = "Edit";
 }

<h2>Edit</h2>

<h4>Department</h4>
<hr />
<div class="row">
    <div class="col-md-4">
        <form asp-action="Edit">
            <div asp-validation-summary="ModelOnly" class="text-danger"></div>
            <input type="hidden" asp-for="DepartmentID" />
            <input type="hidden" asp-for="RowVersion" />
            <div class="form-group">
                <label asp-for="Name" class="control-label"></label>
                <input asp-for="Name" class="form-control" />
                <span asp-validation-for="Name" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Budget" class="control-label"></label>
                <input asp-for="Budget" class="form-control" />
                <span asp-validation-for="Budget" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="StartDate" class="control-label"></label>
                <input asp-for="StartDate" class="form-control" />
                <span asp-validation-for="StartDate" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="InstructorID" class="control-label"></label>
                <select asp-for="InstructorID" class="form-control" asp-items="ViewBag.InstructorID">
                    <option value="">-- Select Administrator --</option>
                </select>
                <span asp-validation-for="InstructorID" class="text-danger"></span>
            </div>
            <div class="form-group">
                <input type="submit" value="Save" class="btn btn-default" />
            </div>
        </form>
    </div>
</div>

<div>
    <a asp-action="Index">Back to List</a>
</div>

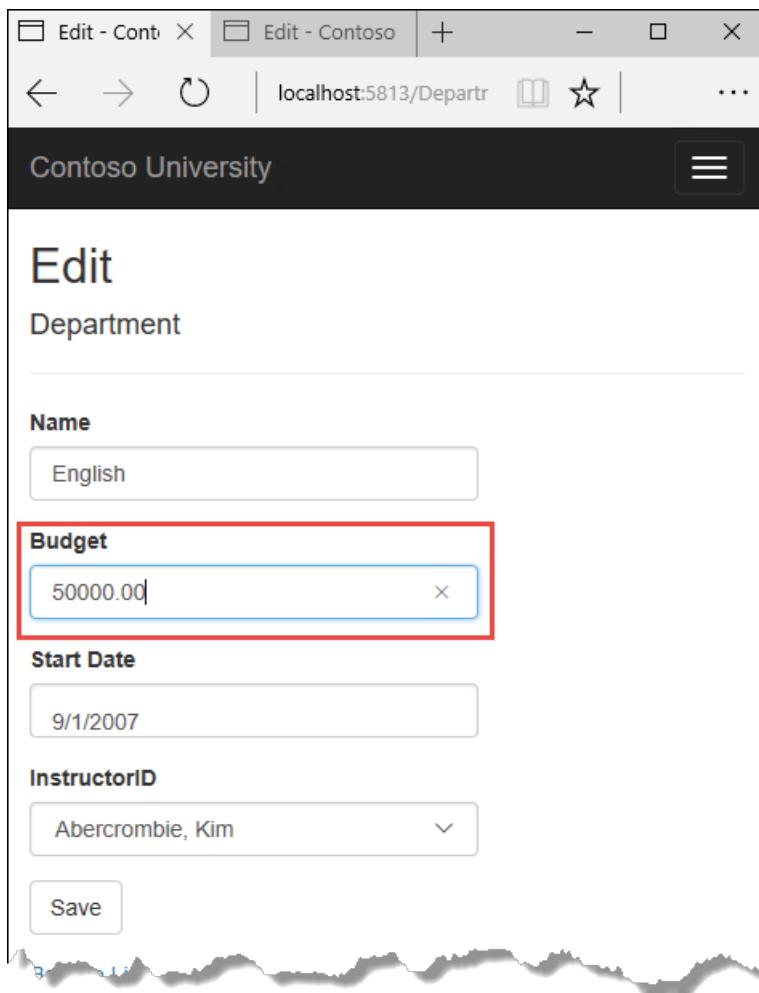
@section Scripts {
    @{await Html.RenderPartialAsync("_ValidationScriptsPartial");}
}

```

## Test concurrency conflicts in the Edit page

Run the app and go to the Departments Index page. Right-click the **Edit** hyperlink for the English department and select **Open in new tab**, then click the **Edit** hyperlink for the English department. The two browser tabs now display the same information.

Change a field in the first browser tab and click **Save**.



The screenshot shows a web browser window with two tabs: "Edit - Contoso" and "Edit - Contoso". The active tab displays the URL "localhost:5813/Departments/1/edit". The page title is "Contoso University". The main content is an "Edit" form for a "Department". The form fields include:

- Name**: English
- Budget**: 50000.00 (This field is highlighted with a red border)
- Start Date**: 9/1/2007
- InstructorID**: Abercrombie, Kim

A "Save" button is located at the bottom left of the form.

The browser shows the Index page with the changed value.

Change a field in the second browser tab.

Departments - Edit - Cont... + - ×

localhost:5813/Departr

Contoso University

Edit

Department

Name

English

Budget

200000.00

Start Date

9/1/2007

InstructorID

Abercrombie, Kim

Save

Click **Save**. You see an error message:

The screenshot shows a browser window with the address bar displaying "localhost:5813/Departm". The main content area is titled "Edit" and "Department". A red warning message is present: "The record you attempted to edit was modified by another user after you got the original value. The edit operation was canceled and the current values in the database have been displayed. If you still want to edit this record, click the Save button again. Otherwise click the Back to List hyperlink." Below the message are four form fields: "Name" with value "English", "Budget" with value "200000.00" and note "Current value: \$50,000.00", "Start Date" with value "9/1/2007", and "InstructorID" with value "Abercrombie, Kim". A "Save" button is at the bottom.

Click **Save** again. The value you entered in the second browser tab is saved. You see the saved values when the Index page appears.

## Update the Delete page

For the Delete page, the Entity Framework detects concurrency conflicts caused by someone else editing the department in a similar manner. When the `HttpGet` `Delete` method displays the confirmation view, the view includes the original `RowVersion` value in a hidden field. That value is then available to the `HttpPost` `Delete` method that's called when the user confirms the deletion. When the Entity Framework creates the SQL DELETE command, it includes a WHERE clause with the original `RowVersion` value. If the command results in zero rows affected (meaning the row was changed after the Delete confirmation page was displayed), a concurrency exception is thrown, and the `HttpGet` `Delete` method is called with an error flag set to true in order to redisplay the confirmation page with an error message. It's also possible that zero rows were affected because the row was deleted by another user, so in that case no error message is displayed.

### Update the Delete methods in the Departments controller

In `DepartmentsController.cs`, replace the `HttpGet` `Delete` method with the following code:

```

public async Task<IActionResult> Delete(int? id, bool? concurrencyError)
{
    if (id == null)
    {
        return NotFound();
    }

    var department = await _context.Departments
        .Include(d => d.Administrator)
        .AsNoTracking()
        .SingleOrDefaultAsync(m => m.DepartmentID == id);
    if (department == null)
    {
        if (concurrencyError.GetValueOrDefault())
        {
            return RedirectToAction(nameof(Index));
        }
        return NotFound();
    }

    if (concurrencyError.GetValueOrDefault())
    {
        ViewData["ConcurrencyErrorMessage"] = "The record you attempted to delete "
            + "was modified by another user after you got the original values. "
            + "The delete operation was canceled and the current values in the "
            + "database have been displayed. If you still want to delete this "
            + "record, click the Delete button again. Otherwise "
            + "click the Back to List hyperlink.";
    }

    return View(department);
}

```

The method accepts an optional parameter that indicates whether the page is being redisplayed after a concurrency error. If this flag is true and the department specified no longer exists, it was deleted by another user. In that case, the code redirects to the Index page. If this flag is true and the Department does exist, it was changed by another user. In that case, the code sends an error message to the view using `ViewData`.

Replace the code in the `HttpPost` `Delete` method (named `DeleteConfirmed`) with the following code:

```

[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Delete(Department department)
{
    try
    {
        if (await _context.Departments.AnyAsync(m => m.DepartmentID == department.DepartmentID))
        {
            _context.Departments.Remove(department);
            await _context.SaveChangesAsync();
        }
        return RedirectToAction(nameof(Index));
    }
    catch (DbUpdateConcurrencyException /* ex */)
    {
        //Log the error (uncomment ex variable name and write a log.)
        return RedirectToAction(nameof(Delete), new { concurrencyError = true, id = department.DepartmentID });
    }
}

```

In the scaffolded code that you just replaced, this method accepted only a record ID:

```
public async Task<IActionResult> DeleteConfirmed(int id)
```

You've changed this parameter to a Department entity instance created by the model binder. This gives EF access to the RowVersion property value in addition to the record key.

```
public async Task<IActionResult> Delete(Department department)
```

You have also changed the action method name from `DeleteConfirmed` to `Delete`. The scaffolded code used the name `DeleteConfirmed` to give the `HttpPost` method a unique signature. (The CLR requires overloaded methods to have different method parameters.) Now that the signatures are unique, you can stick with the MVC convention and use the same name for the `HttpPost` and `HttpGet` delete methods.

If the department is already deleted, the `AnyAsync` method returns false and the application just goes back to the `Index` method.

If a concurrency error is caught, the code redisplays the `Delete` confirmation page and provides a flag that indicates it should display a concurrency error message.

### Update the `Delete` view

In `Views/Departments/Delete.cshtml`, replace the scaffolded code with the following code that adds an error message field and hidden fields for the `DepartmentID` and `RowVersion` properties. The changes are highlighted.

```

@model ContosoUniversity.Models.Department

 @{
     ViewData["Title"] = "Delete";
 }

<h2>Delete</h2>

<p class="text-danger">@ViewData["ConcurrencyErrorMessage"]</p>

<h3>Are you sure you want to delete this?</h3>
<div>
    <h4>Department</h4>
    <hr />
    <dl class="dl-horizontal">
        <dt>
            @Html.DisplayNameFor(model => model.Name)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Name)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Budget)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Budget)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.StartDate)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.StartDate)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Administrator)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Administrator.FullName)
        </dd>
    </dl>

    <form asp-action="Delete">
        <input type="hidden" asp-for="DepartmentID" />
        <input type="hidden" asp-for="RowVersion" />
        <div class="form-actions no-color">
            <input type="submit" value="Delete" class="btn btn-default" /> |
            <a asp-action="Index">Back to List</a>
        </div>
    </form>
</div>

```

This makes the following changes:

- Adds an error message between the `h2` and `h3` headings.
- Replaces `FirstMidName` with `FullName` in the **Administrator** field.
- Removes the `RowVersion` field.
- Adds a hidden field for the `RowVersion` property.

Run the app and go to the Departments Index page. Right-click the **Delete** hyperlink for the English department and select **Open in new tab**, then in the first tab click the **Edit** hyperlink for the English department.

In the first window, change one of the values, and click **Save**:

Edit

Department

Name

English

Budget

200000.00

Start Date

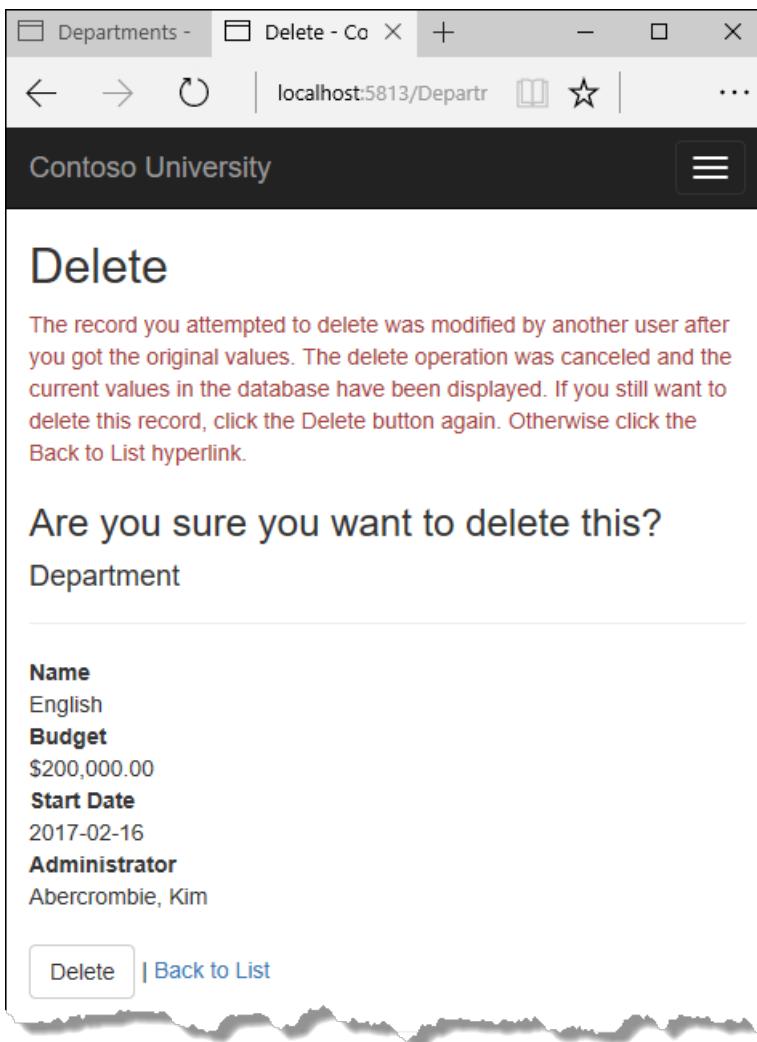
2/16/2017

InstructorID

Abercrombie, Kim

Save

In the second tab, click **Delete**. You see the concurrency error message, and the Department values are refreshed with what's currently in the database.



If you click **Delete** again, you're redirected to the Index page, which shows that the department has been deleted.

## Update Details and Create views

You can optionally clean up scaffolded code in the Details and Create views.

Replace the code in *Views/Departments/Details.cshtml* to delete the RowVersion column and show the full name of the Administrator.

```

@model ContosoUniversity.Models.Department

 @{
     ViewData["Title"] = "Details";
 }

<h2>Details</h2>

<div>
    <h4>Department</h4>
    <hr />
    <dl class="dl-horizontal">
        <dt>
            @Html.DisplayNameFor(model => model.Name)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Name)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Budget)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Budget)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.StartDate)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.StartDate)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Administrator)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Administrator.FullName)
        </dd>
    </dl>
</div>
<div>
    <a href="#">Edit</a> |
    <a href="#">Back to List</a>
</div>

```

Replace the code in *Views/Departments/Create.cshtml* to add a Select option to the drop-down list.

```

@model ContosoUniversity.Models.Department

 @{
     ViewData["Title"] = "Create";
 }

<h2>Create</h2>

<h4>Department</h4>
<hr />
<div class="row">
    <div class="col-md-4">
        <form asp-action="Create">
            <div asp-validation-summary="ModelOnly" class="text-danger"></div>
            <div class="form-group">
                <label asp-for="Name" class="control-label"></label>
                <input asp-for="Name" class="form-control" />
                <span asp-validation-for="Name" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Budget" class="control-label"></label>
                <input asp-for="Budget" class="form-control" />
                <span asp-validation-for="Budget" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="StartDate" class="control-label"></label>
                <input asp-for="StartDate" class="form-control" />
                <span asp-validation-for="StartDate" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="InstructorID" class="control-label"></label>
                <select asp-for="InstructorID" class="form-control" asp-items="ViewBag.InstructorID">
                    <option value="">-- Select Administrator --</option>
                </select>
            </div>
            <div class="form-group">
                <input type="submit" value="Create" class="btn btn-default" />
            </div>
        </form>
    </div>
</div>

<div>
    <a asp-action="Index">Back to List</a>
</div>

@section Scripts {
    @await Html.RenderPartialAsync("_ValidationScriptsPartial");
}

```

## Summary

This completes the introduction to handling concurrency conflicts. For more information about how to handle concurrency in EF Core, see [Concurrency conflicts](#). The next tutorial shows how to implement table-per-hierarchy inheritance for the Instructor and Student entities.

[PREVIOUS](#)

[NEXT](#)

# ASP.NET Core MVC with EF Core - Inheritance - 9 of 10

6/28/2018 • 8 minutes to read • [Edit Online](#)

This tutorial has not been upgraded to ASP.NET Core 2.1. The ASP.NET Core 2.0 version of this tutorial is available by selecting **ASP.NET Core 2.0** above the table of contents or at the top of the page:

The ASP.NET Core 2.1 Razor Pages version of this tutorial has many improvements over the 2.0 version.

The 2.0 tutorial teaches ASP.NET Core MVC and Entity Framework Core with controllers and views. Razor Pages is a page-based programming model that makes building web UI easier and more productive. We recommend the [Razor Pages](#) tutorial over the MVC version. The Razor Pages tutorial:

- Is easier to follow. For example, the scaffolding code has been significantly simplified.
- Provides more EF Core best practices.
- Uses more efficient queries.
- Is more current with the latest API.
- Covers more features.
- Is the preferred approach for new application development.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub discussion](#).

By [Tom Dykstra](#) and [Rick Anderson](#)

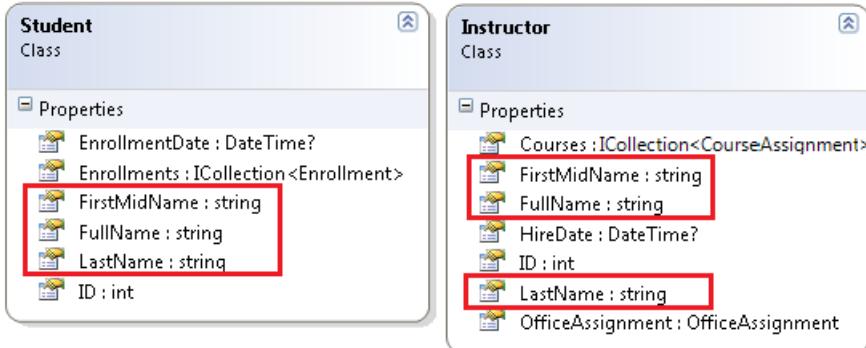
The Contoso University sample web application demonstrates how to create ASP.NET Core MVC web applications using Entity Framework Core and Visual Studio. For information about the tutorial series, see [the first tutorial in the series](#).

In the previous tutorial, you handled concurrency exceptions. This tutorial will show you how to implement inheritance in the data model.

In object-oriented programming, you can use inheritance to facilitate code reuse. In this tutorial, you'll change the `Instructor` and `Student` classes so that they derive from a `Person` base class which contains properties such as `LastName` that are common to both instructors and students. You won't add or change any web pages, but you'll change some of the code and those changes will be automatically reflected in the database.

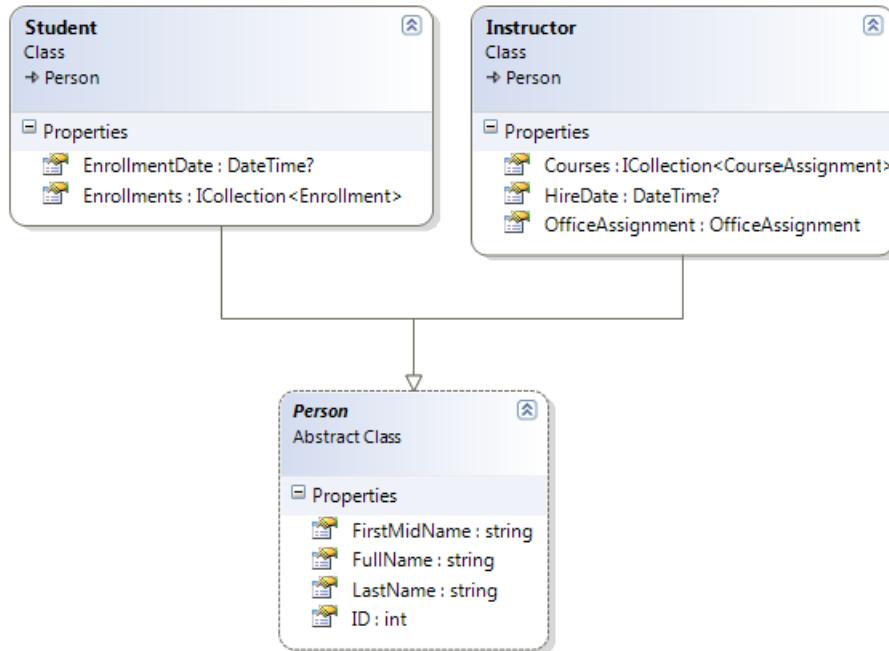
## Options for mapping inheritance to database tables

The `Instructor` and `Student` classes in the School data model have several properties that are identical:

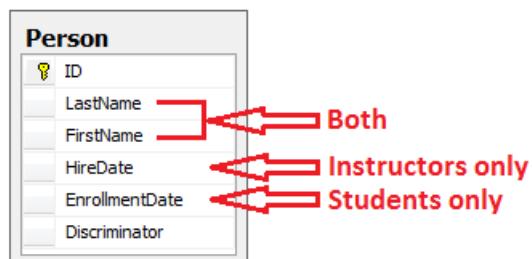


Suppose you want to eliminate the redundant code for the properties that are shared by the `Instructor` and

`Student` entities. Or you want to write a service that can format names without caring whether the name came from an instructor or a student. You could create a `Person` base class that contains only those shared properties, then make the `Instructor` and `Student` classes inherit from that base class, as shown in the following illustration:

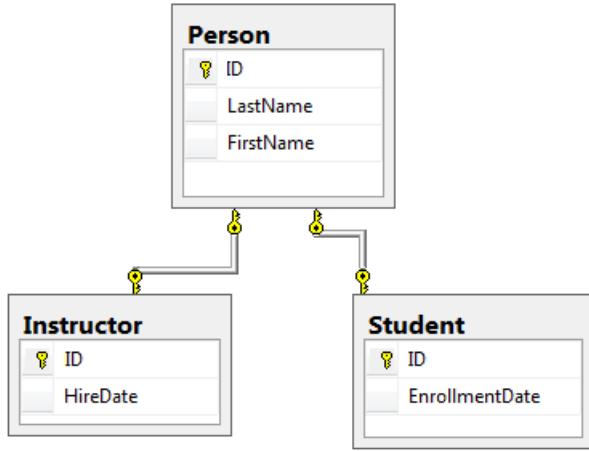


There are several ways this inheritance structure could be represented in the database. You could have a `Person` table that includes information about both students and instructors in a single table. Some of the columns could apply only to instructors (`HireDate`), some only to students (`EnrollmentDate`), some to both (`LastName`, `FirstName`). Typically, you'd have a discriminator column to indicate which type each row represents. For example, the discriminator column might have "Instructor" for instructors and "Student" for students.



This pattern of generating an entity inheritance structure from a single database table is called table-per-hierarchy (TPH) inheritance.

An alternative is to make the database look more like the inheritance structure. For example, you could have only the name fields in the `Person` table and have separate `Instructor` and `Student` tables with the date fields.



This pattern of making a database table for each entity class is called table per type (TPT) inheritance.

Yet another option is to map all non-abstract types to individual tables. All properties of a class, including inherited properties, map to columns of the corresponding table. This pattern is called Table-per-Concrete Class (TPC) inheritance. If you implemented TPC inheritance for the Person, Student, and Instructor classes as shown earlier, the Student and Instructor tables would look no different after implementing inheritance than they did before.

TPC and TPH inheritance patterns generally deliver better performance than TPT inheritance patterns, because TPT patterns can result in complex join queries.

This tutorial demonstrates how to implement TPH inheritance. TPH is the only inheritance pattern that the Entity Framework Core supports. What you'll do is create a `Person` class, change the `Instructor` and `Student` classes to derive from `Person`, add the new class to the `DbContext`, and create a migration.

#### TIP

Consider saving a copy of the project before making the following changes. Then if you run into problems and need to start over, it will be easier to start from the saved project instead of reversing steps done for this tutorial or going back to the beginning of the whole series.

## Create the Person class

In the Models folder, create `Person.cs` and replace the template code with the following code:

```

using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public abstract class Person
    {
        public int ID { get; set; }

        [Required]
        [StringLength(50)]
        [Display(Name = "Last Name")]
        public string LastName { get; set; }

        [Required]
        [StringLength(50, ErrorMessage = "First name cannot be longer than 50 characters.")]
        [Column("FirstName")]
        [Display(Name = "First Name")]
        public string FirstMidName { get; set; }

        [Display(Name = "Full Name")]
        public string FullName
        {
            get
            {
                return LastName + ", " + FirstMidName;
            }
        }
    }
}

```

## Make Student and Instructor classes inherit from Person

In *Instructor.cs*, derive the Instructor class from the Person class and remove the key and name fields. The code will look like the following example:

```

using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Instructor : Person
    {
        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        [Display(Name = "Hire Date")]
        public DateTime HireDate { get; set; }

        public ICollection<CourseAssignment> CourseAssignments { get; set; }
        public OfficeAssignment OfficeAssignment { get; set; }
    }
}

```

Make the same changes in *Student.cs*.

```

using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Student : Person
    {
        [DataType(DataType.Date)]
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        [Display(Name = "Enrollment Date")]
        public DateTime EnrollmentDate { get; set; }

        public ICollection<Enrollment> Enrollments { get; set; }
    }
}

```

## Add the Person entity type to the data model

Add the Person entity type to *SchoolContext.cs*. The new lines are highlighted.

```

using ContosoUniversity.Models;
using Microsoft.EntityFrameworkCore;

namespace ContosoUniversity.Data
{
    public class SchoolContext : DbContext
    {
        public SchoolContext(DbContextOptions<SchoolContext> options) : base(options)
        {
        }

        public DbSet<Course> Courses { get; set; }
        public DbSet<Enrollment> Enrollments { get; set; }
        public DbSet<Student> Students { get; set; }
        public DbSet<Department> Departments { get; set; }
        public DbSet<Instructor> Instructors { get; set; }
        public DbSet<OfficeAssignment> OfficeAssignments { get; set; }
        public DbSet<CourseAssignment> CourseAssignments { get; set; }
        public DbSet<Person> People { get; set; }

        protected override void OnModelCreating(ModelBuilder modelBuilder)
        {
            modelBuilder.Entity<Course>().ToTable("Course");
            modelBuilder.Entity<Enrollment>().ToTable("Enrollment");
            modelBuilder.Entity<Student>().ToTable("Student");
            modelBuilder.Entity<Department>().ToTable("Department");
            modelBuilder.Entity<Instructor>().ToTable("Instructor");
            modelBuilder.Entity<OfficeAssignment>().ToTable("OfficeAssignment");
            modelBuilder.Entity<CourseAssignment>().ToTable("CourseAssignment");
            modelBuilder.Entity<Person>().ToTable("Person");

            modelBuilder.Entity<CourseAssignment>()
                .HasKey(c => new { c.CourseID, c.InstructorID });
        }
    }
}

```

This is all that the Entity Framework needs in order to configure table-per-hierarchy inheritance. As you'll see, when the database is updated, it will have a Person table in place of the Student and Instructor tables.

## Create and customize migration code

Save your changes and build the project. Then open the command window in the project folder and enter the following command:

```
dotnet ef migrations add Inheritance
```

Don't run the `database update` command yet. That command will result in lost data because it will drop the Instructor table and rename the Student table to Person. You need to provide custom code to preserve existing data.

Open *Migrations/<timestamp>\_Inheritance.cs* and replace the `Up` method with the following code:

```
protected override void Up(MigrationBuilder migrationBuilder)
{
    migrationBuilder.DropForeignKey(
        name: "FK_Enrollment_Student_StudentID",
        table: "Enrollment");

    migrationBuilder DropIndex(name: "IX_Enrollment_StudentID", table: "Enrollment");

    migrationBuilder.RenameTable(name: "Instructor", newName: "Person");
    migrationBuilder.AddColumn<DateTime>(name: "EnrollmentDate", table: "Person", nullable: true);
    migrationBuilder.AddColumn<string>(name: "Discriminator", table: "Person", nullable: false, maxLength: 128, defaultValue: "Instructor");
    migrationBuilder.AlterColumn<DateTime>(name: "HireDate", table: "Person", nullable: true);
    migrationBuilder.AddColumn<int>(name: "OldId", table: "Person", nullable: true);

    // Copy existing Student data into new Person table.
    migrationBuilder.Sql("INSERT INTO dbo.Person (LastName, FirstName, HireDate, EnrollmentDate, Discriminator, OldId) SELECT LastName, FirstName, null AS HireDate, EnrollmentDate, 'Student' AS Discriminator, ID AS OldId FROM dbo.Student");
    // Fix up existing relationships to match new PK's.
    migrationBuilder.Sql("UPDATE dbo.Enrollment SET StudentId = (SELECT ID FROM dbo.Person WHERE OldId = Enrollment.StudentId AND Discriminator = 'Student')");

    // Remove temporary key
    migrationBuilder.DropColumn(name: "OldID", table: "Person");

    migrationBuilder.DropTable(
        name: "Student");

    migrationBuilder.CreateIndex(
        name: "IX_Enrollment_StudentID",
        table: "Enrollment",
        column: "StudentID");

    migrationBuilder.AddForeignKey(
        name: "FK_Enrollment_Person_StudentID",
        table: "Enrollment",
        column: "StudentID",
        principalTable: "Person",
        principalColumn: "ID",
        onDelete: ReferentialAction.Cascade);
}
```

This code takes care of the following database update tasks:

- Removes foreign key constraints and indexes that point to the Student table.
- Renames the Instructor table as Person and makes changes needed for it to store Student data.
- Adds nullable EnrollmentDate for students.

- Adds Discriminator column to indicate whether a row is for a student or an instructor.
- Makes HireDate nullable since student rows won't have hire dates.
- Adds a temporary field that will be used to update foreign keys that point to students. When you copy students into the Person table they will get new primary key values.
- Copies data from the Student table into the Person table. This causes students to get assigned new primary key values.
- Fixes foreign key values that point to students.
- Re-creates foreign key constraints and indexes, now pointing them to the Person table.

(If you had used GUID instead of integer as the primary key type, the student primary key values wouldn't have to change, and several of these steps could have been omitted.)

Run the `database update` command:

```
dotnet ef database update
```

(In a production system you would make corresponding changes to the `Down` method in case you ever had to use that to go back to the previous database version. For this tutorial you won't be using the `Down` method.)

#### **NOTE**

It's possible to get other errors when making schema changes in a database that has existing data. If you get migration errors that you can't resolve, you can either change the database name in the connection string or delete the database. With a new database, there's no data to migrate, and the `update-database` command is more likely to complete without errors. To delete the database, use SSOX or run the `database drop` CLI command.

## Test with inheritance implemented

Run the app and try various pages. Everything works the same as it did before.

In **SQL Server Object Explorer**, expand **Data Connections/SchoolContext** and then **Tables**, and you see that the Student and Instructor tables have been replaced by a Person table. Open the Person table designer and you see that it has all of the columns that used to be in the Student and Instructor tables.

	Name	Data Type	Allow Nulls	Default
1	ID	int	<input type="checkbox"/>	
2	FirstName	nvarchar(50)	<input type="checkbox"/>	
3	HireDate	datetime2(7)	<input checked="" type="checkbox"/>	
4	LastName	nvarchar(50)	<input type="checkbox"/>	
5	EnrollmentDate	datetime2(7)	<input checked="" type="checkbox"/>	
6	Discriminator	nvarchar(128)	<input type="checkbox"/>	(N'Instructor')

Keys (1)  
PK\_Instructor (Primary Key)

Check Constraints (0)

Indexes (0)

Foreign Keys (0)

Triggers (0)

```
1 CREATE TABLE [dbo].[Person] (
2     [ID] INT IDENTITY (1, 1) NOT NULL,
3     [FirstName] NVARCHAR (50) NOT NULL,
4     [HireDate] DATETIME2 (7) NULL,
5     [LastName] NVARCHAR (50) NOT NULL,
6     [EnrollmentDate] DATETIME2 (7) NULL,
7     [Discriminator] NVARCHAR (128) DEFAULT (N'Instructor') NOT NULL,
8     CONSTRAINT [PK_Instructor] PRIMARY KEY CLUSTERED ([ID] ASC)
9 );
10 
```

100 %

Connection Ready | (localdb)\MSSQLLocalDB | REDMOND\tdykstra | aspnet-ContosoUniversi...

Right-click the Person table, and then click **Show Table Data** to see the discriminator column.

ID	FirstName	HireDate	LastName	Enrollme...	Discriminator
1	Kim	3/11/1995...	Abercrombie	NULL	Instructor
2	Fadi	7/6/2002 ...	Fakhouri	NULL	Instructor
3	Roger	7/1/1998 ...	Harui	NULL	Instructor
4	Candace	1/15/2001...	Kapoor	NULL	Instructor
5	Roger	2/12/2004...	Zheng	NULL	Instructor
7	Nancy	8/17/2016...	Davolio	NULL	Instructor
8	Carson	NULL	Alexander	9/1/2010 ...	Student
9	Meredith	NULL	Alonso	9/1/2012 ...	Student
10	Arturo	NULL	Anand	9/1/2013 ...	Student
11	Gytis	NULL	Barzdukas	9/1/2012 ...	Student
12	Yan	NULL	Li	9/1/2012	Student

## Summary

You've implemented table-per-hierarchy inheritance for the `Person`, `Student`, and `Instructor` classes. For more information about inheritance in Entity Framework Core, see [Inheritance](#). In the next tutorial you'll see how to handle a variety of relatively advanced Entity Framework scenarios.

[PREVIOUS](#)

[NEXT](#)

# ASP.NET Core MVC with EF Core - Advanced - 10 of 10

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- Provides more EF Core best practices.
- Uses more efficient queries.
- Is more current with the latest API.
- Covers more features.
- Is the preferred approach for new application development.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub discussion](#).

By [Tom Dykstra](#) and [Rick Anderson](#)

The Contoso University sample web application demonstrates how to create ASP.NET Core MVC web applications using Entity Framework Core and Visual Studio. For information about the tutorial series, see [the first tutorial in the series](#).

In the previous tutorial, you implemented table-per-hierarchy inheritance. This tutorial introduces several topics that are useful to be aware of when you go beyond the basics of developing ASP.NET Core web applications that use Entity Framework Core.

## Raw SQL Queries

One of the advantages of using the Entity Framework is that it avoids tying your code too closely to a particular method of storing data. It does this by generating SQL queries and commands for you, which also frees you from having to write them yourself. But there are exceptional scenarios when you need to run specific SQL queries that you have manually created. For these scenarios, the Entity Framework Code First API includes methods that enable you to pass SQL commands directly to the database. You have the following options in EF Core 1.0:

- Use the `DbSet.FromSql` method for queries that return entity types. The returned objects must be of the type expected by the `DbSet` object, and they're automatically tracked by the database context unless you [turn tracking off](#).
- Use the `Database.ExecuteSqlCommand` for non-query commands.

If you need to run a query that returns types that aren't entities, you can use ADO.NET with the database connection provided by EF. The returned data isn't tracked by the database context, even if you use this method to retrieve entity types.

As is always true when you execute SQL commands in a web application, you must take precautions to protect your site against SQL injection attacks. One way to do that is to use parameterized queries to make sure that

strings submitted by a web page can't be interpreted as SQL commands. In this tutorial you'll use parameterized queries when integrating user input into a query.

## Call a query that returns entities

The `DbSet< TEntity >` class provides a method that you can use to execute a query that returns an entity of type `TEntity`. To see how this works you'll change the code in the `Details` method of the Department controller.

In `DepartmentsController.cs`, in the `Details` method, replace the code that retrieves a department with a `FromSql` method call, as shown in the following highlighted code:

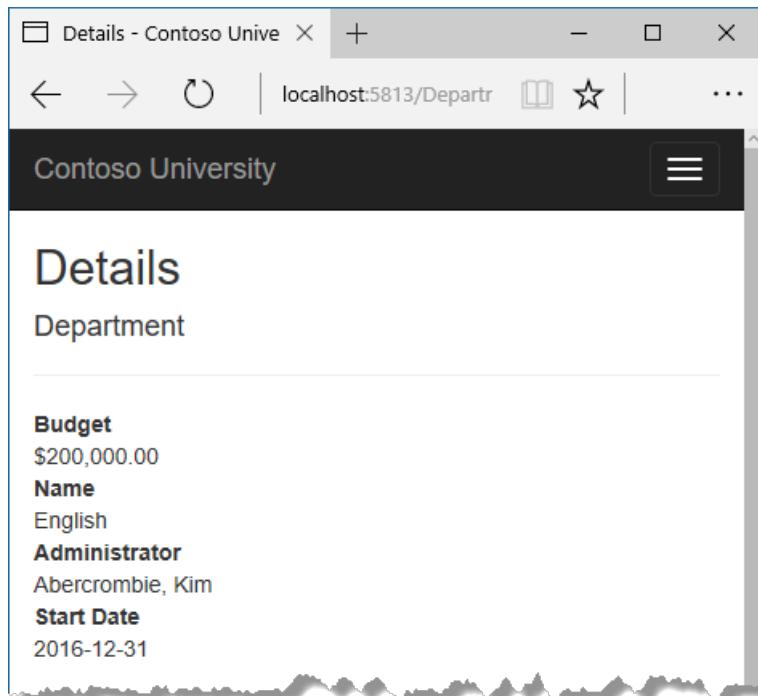
```
public async Task<IActionResult> Details(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    string query = "SELECT * FROM Department WHERE DepartmentID = {0}";
    var department = await _context.Departments
        .FromSql(query, id)
        .Include(d => d.Administrator)
        .AsNoTracking()
        .SingleOrDefaultAsync();

    if (department == null)
    {
        return NotFound();
    }

    return View(department);
}
```

To verify that the new code works correctly, select the **Departments** tab and then **Details** for one of the departments.



## Call a query that returns other types

Earlier you created a student statistics grid for the About page that showed the number of students for each

enrollment date. You got the data from the Students entity set (`_context.Students`) and used LINQ to project the results into a list of `EnrollmentDateGroup` view model objects. Suppose you want to write the SQL itself rather than using LINQ. To do that you need to run a SQL query that returns something other than entity objects. In EF Core 1.0, one way to do that is write ADO.NET code and get the database connection from EF.

In `HomeController.cs`, replace the `About` method with the following code:

```
public async Task<ActionResult> About()
{
    List<EnrollmentDateGroup> groups = new List<EnrollmentDateGroup>();
    var conn = _context.Database.GetDbConnection();
    try
    {
        await conn.OpenAsync();
        using (var command = conn.CreateCommand())
        {
            string query = "SELECT EnrollmentDate, COUNT(*) AS StudentCount "
                + "FROM Person "
                + "WHERE Discriminator = 'Student' "
                + "GROUP BY EnrollmentDate";
            command.CommandText = query;
            DbDataReader reader = await command.ExecuteReaderAsync();

            if (reader.HasRows)
            {
                while (await reader.ReadAsync())
                {
                    var row = new EnrollmentDateGroup { EnrollmentDate = reader.GetDateTime(0), StudentCount =
                        reader.GetInt32(1) };
                    groups.Add(row);
                }
            }
            reader.Dispose();
        }
    }
    finally
    {
        conn.Close();
    }
    return View(groups);
}
```

Add a using statement:

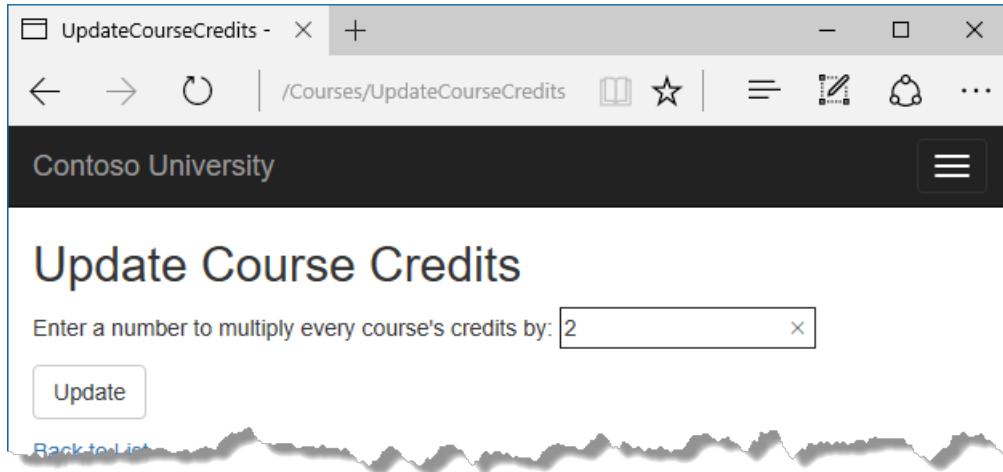
```
using System.Data.Common;
```

Run the app and go to the About page. It displays the same data it did before.

Enrollment Date	Students
9/1/2005	1
9/1/2010	1
9/1/2011	1
9/1/2012	3

## Call an update query

Suppose Contoso University administrators want to perform global changes in the database, such as changing the number of credits for every course. If the university has a large number of courses, it would be inefficient to retrieve them all as entities and change them individually. In this section you'll implement a web page that enables the user to specify a factor by which to change the number of credits for all courses, and you'll make the change by executing a SQL UPDATE statement. The web page will look like the following illustration:



In `CoursesController.cs`, add `UpdateCourseCredits` methods for `HttpGet` and `HttpPost`:

```
public IActionResult UpdateCourseCredits()
{
    return View();
}

[HttpPost]
public async Task<IActionResult> UpdateCourseCredits(int? multiplier)
{
    if (multiplier != null)
    {
        ViewData["RowsAffected"] =
            await _context.Database.ExecuteSqlCommandAsync(
                "UPDATE Course SET Credits = Credits * {0}",
                parameters: multiplier);
    }
    return View();
}
```

When the controller processes an `HttpGet` request, nothing is returned in `ViewData["RowsAffected"]`, and the view displays an empty text box and a submit button, as shown in the preceding illustration.

When the **Update** button is clicked, the `HttpPost` method is called, and `multiplier` has the value entered in the text box. The code then executes the SQL that updates courses and returns the number of affected rows to the view in `ViewData`. When the view gets a `RowsAffected` value, it displays the number of rows updated.

In **Solution Explorer**, right-click the `Views/Courses` folder, and then click **Add > New Item**.

In the **Add New Item** dialog, click **ASP.NET** under **Installed** in the left pane, click **MVC View Page**, and name the new view `UpdateCourseCredits.cshtml`.

In `Views/Courses/UpdateCourseCredits.cshtml`, replace the template code with the following code:

```

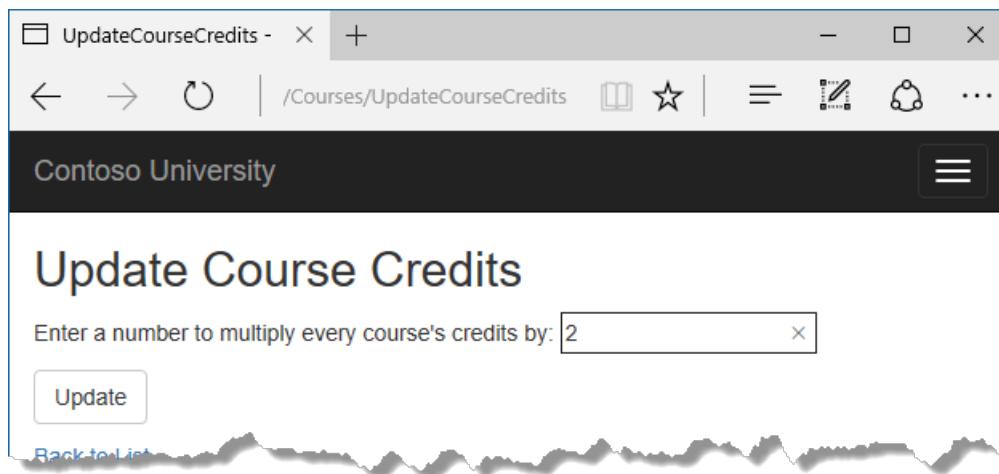
@{
    ViewBag.Title = "UpdateCourseCredits";
}

<h2>Update Course Credits</h2>

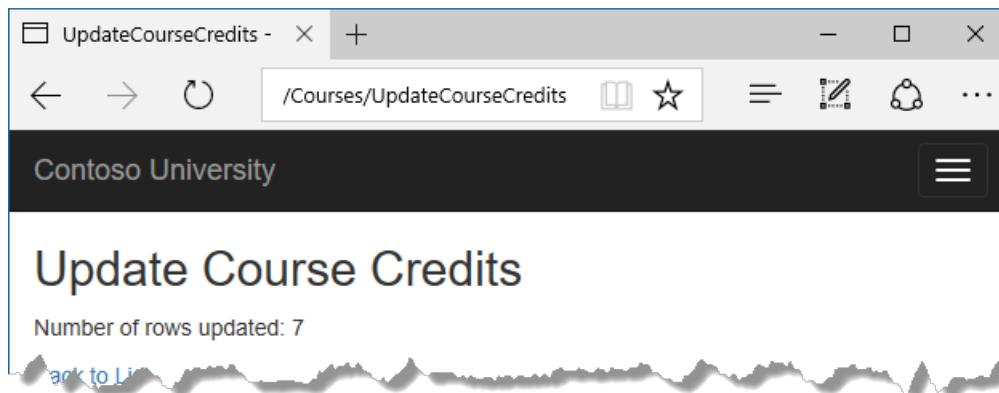
@if (ViewData["RowsAffected"] == null)
{
    <form asp-action="UpdateCourseCredits">
        <div class="form-actions no-color">
            <p>
                Enter a number to multiply every course's credits by: @Html.TextBox("multiplier")
            </p>
            <p>
                <input type="submit" value="Update" class="btn btn-default" />
            </p>
        </div>
    </form>
}
@if (ViewData["RowsAffected"] != null)
{
    <p>
        Number of rows updated: @ViewData["RowsAffected"]
    </p>
}
<div>
    @Html.ActionLink("Back to List", "Index")
</div>

```

Run the `UpdateCourseCredits` method by selecting the **Courses** tab, then adding "/UpdateCourseCredits" to the end of the URL in the browser's address bar (for example: <http://localhost:5813/Courses/UpdateCourseCredits>). Enter a number in the text box:



Click **Update**. You see the number of rows affected:



Click **Back to List** to see the list of courses with the revised number of credits.

Note that production code would ensure that updates always result in valid data. The simplified code shown here could multiply the number of credits enough to result in numbers greater than 5. (The `Credits` property has a `[Range(0, 5)]` attribute.) The update query would work but the invalid data could cause unexpected results in other parts of the system that assume the number of credits is 5 or less.

For more information about raw SQL queries, see [Raw SQL Queries](#).

## Examine SQL sent to the database

Sometimes it's helpful to be able to see the actual SQL queries that are sent to the database. Built-in logging functionality for ASP.NET Core is automatically used by EF Core to write logs that contain the SQL for queries and updates. In this section you'll see some examples of SQL logging.

Open `StudentsController.cs` and in the `Details` method set a breakpoint on the `if (student == null)` statement.

Run the app in debug mode, and go to the Details page for a student.

Go to the **Output** window showing debug output, and you see the query:

```
Microsoft.EntityFrameworkCore.Database.Command:Information: Executed DbCommand (56ms) [Parameters=@__id_0='?'], CommandType='Text', CommandTimeout='30'
SELECT TOP(2) [s].[ID], [s].[Discriminator], [s].[FirstName], [s].[LastName], [s].[EnrollmentDate]
FROM [Person] AS [s]
WHERE ([s].[Discriminator] = N'Student') AND ([s].[ID] = @__id_0)
ORDER BY [s].[ID]
Microsoft.EntityFrameworkCore.Database.Command:Information: Executed DbCommand (122ms) [Parameters=@__id_0='?'], CommandType='Text', CommandTimeout='30'
SELECT [s.Enrollments].[EnrollmentID], [s.Enrollments].[CourseID], [s.Enrollments].[Grade], [s.Enrollments].[StudentID], [e.Course].[CourseID], [e.Course].[Credits], [e.Course].[DepartmentID], [e.Course].[Title]
FROM [Enrollment] AS [s.Enrollments]
INNER JOIN [Course] AS [e.Course] ON [s.Enrollments].[CourseID] = [e.Course].[CourseID]
INNER JOIN (
    SELECT TOP(1) [s0].[ID]
    FROM [Person] AS [s0]
    WHERE ([s0].[Discriminator] = N'Student') AND ([s0].[ID] = @__id_0)
    ORDER BY [s0].[ID]
) AS [t] ON [s.Enrollments].[StudentID] = [t].[ID]
ORDER BY [t].[ID]
```

You'll notice something here that might surprise you: the SQL selects up to 2 rows (`TOP(2)`) from the Person table. The `SingleOrDefaultAsync` method doesn't resolve to 1 row on the server. Here's why:

- If the query would return multiple rows, the method returns null.
- To determine whether the query would return multiple rows, EF has to check if it returns at least 2.

Note that you don't have to use debug mode and stop at a breakpoint to get logging output in the **Output** window. It's just a convenient way to stop the logging at the point you want to look at the output. If you don't do that, logging continues and you have to scroll back to find the parts you're interested in.

## Repository and unit of work patterns

Many developers write code to implement the repository and unit of work patterns as a wrapper around code that works with the Entity Framework. These patterns are intended to create an abstraction layer between the data access layer and the business logic layer of an application. Implementing these patterns can help insulate your application from changes in the data store and can facilitate automated unit testing or test-driven development (TDD). However, writing additional code to implement these patterns isn't always the best choice for applications that use EF, for several reasons:

- The EF context class itself insulates your code from data-store-specific code.
- The EF context class can act as a unit-of-work class for database updates that you do using EF.
- EF includes features for implementing TDD without writing repository code.

For information about how to implement the repository and unit of work patterns, see [the Entity Framework 5 version of this tutorial series](#).

Entity Framework Core implements an in-memory database provider that can be used for testing. For more information, see [Test with InMemory](#).

## Automatic change detection

The Entity Framework determines how an entity has changed (and therefore which updates need to be sent to the database) by comparing the current values of an entity with the original values. The original values are stored when the entity is queried or attached. Some of the methods that cause automatic change detection are the following:

- `DbContext.SaveChanges`
- `DbContext.Entry`
- `ChangeTracker.Entries`

If you're tracking a large number of entities and you call one of these methods many times in a loop, you might get significant performance improvements by temporarily turning off automatic change detection using the `ChangeTracker.AutoDetectChangesEnabled` property. For example:

```
_context.ChangeTracker.AutoDetectChangesEnabled = false;
```

## Entity Framework Core source code and development plans

The Entity Framework Core source is at <https://github.com/aspnet/EntityFrameworkCore>. The EF Core repository contains nightly builds, issue tracking, feature specs, design meeting notes, and [the roadmap for future development](#). You can file or find bugs, and contribute.

Although the source code is open, Entity Framework Core is fully supported as a Microsoft product. The Microsoft Entity Framework team keeps control over which contributions are accepted and tests all code changes to ensure the quality of each release.

## Reverse engineer from existing database

To reverse engineer a data model including entity classes from an existing database, use the `scaffold-dbcontext` command. See the [getting-started tutorial](#).

## Use dynamic LINQ to simplify sort selection code

The [third tutorial in this series](#) shows how to write LINQ code by hard-coding column names in a `switch` statement. With two columns to choose from, this works fine, but if you have many columns the code could get verbose. To solve that problem, you can use the `EF.Property` method to specify the name of the property as a string. To try out this approach, replace the `Index` method in the `StudentsController` with the following code.

```

public async Task<IActionResult> Index(
    string sortOrder,
    string currentFilter,
    string searchString,
    int? page)
{
    ViewData["CurrentSort"] = sortOrder;
    ViewData["NameSortParm"] =
        String.IsNullOrEmpty(sortOrder) ? "LastName_desc" : "";
    ViewData["DateSortParm"] =
        sortOrder == "EnrollmentDate" ? "EnrollmentDate_desc" : "EnrollmentDate";

    if (searchString != null)
    {
        page = 1;
    }
    else
    {
        searchString = currentFilter;
    }

    ViewData["CurrentFilter"] = searchString;

    var students = from s in _context.Students
                  select s;

    if (!String.IsNullOrEmpty(searchString))
    {
        students = students.Where(s => s.LastName.Contains(searchString)
                           || s.FirstMidName.Contains(searchString));
    }

    if (string.IsNullOrEmpty(sortOrder))
    {
        sortOrder = "LastName";
    }

    bool descending = false;
    if (sortOrder.EndsWith("_desc"))
    {
        sortOrder = sortOrder.Substring(0, sortOrder.Length - 5);
        descending = true;
    }

    if (descending)
    {
        students = students.OrderByDescending(e => EF.Property<object>(e, sortOrder));
    }
    else
    {
        students = students.OrderBy(e => EF.Property<object>(e, sortOrder));
    }

    int pageSize = 3;
    return View(await PaginatedList<Student>.CreateAsync(students.AsNoTracking(),
        page ?? 1, pageSize));
}

```

## Next steps

This completes this series of tutorials on using the Entity Framework Core in an ASP.NET MVC application.

For more information about EF Core, see the [Entity Framework Core documentation](#). A book is also available: [Entity Framework Core in Action](#).

For information on how to deploy a web app, see [Host and deploy](#).

For information about other topics related to ASP.NET Core MVC, such as authentication and authorization, see the [ASP.NET Core documentation](#).

## Acknowledgments

Tom Dykstra and Rick Anderson (twitter @RickAndMSFT) wrote this tutorial. Rowan Miller, Diego Vega, and other members of the Entity Framework team assisted with code reviews and helped debug issues that arose while we were writing code for the tutorials.

## Common errors

### ContosoUniversity.dll used by another process

Error message:

```
Cannot open '...bin\Debug\netcoreapp1.0\ContosoUniversity.dll' for writing -- 'The process cannot access the file '...bin\Debug\netcoreapp1.0\ContosoUniversity.dll' because it is being used by another process.'
```

Solution:

Stop the site in IIS Express. Go to the Windows System Tray, find IIS Express and right-click its icon, select the Contoso University site, and then click **Stop Site**.

### Migration scaffolded with no code in Up and Down methods

Possible cause:

The EF CLI commands don't automatically close and save code files. If you have unsaved changes when you run the `migrations add` command, EF won't find your changes.

Solution:

Run the `migrations remove` command, save your code changes and rerun the `migrations add` command.

### Errors while running database update

It's possible to get other errors when making schema changes in a database that has existing data. If you get migration errors you can't resolve, you can either change the database name in the connection string or delete the database. With a new database, there's no data to migrate, and the update-database command is much more likely to complete without errors.

The simplest approach is to rename the database in `appsettings.json`. The next time you run `database update`, a new database will be created.

To delete a database in SSOX, right-click the database, click **Delete**, and then in the **Delete Database** dialog box select **Close existing connections** and click **OK**.

To delete a database by using the CLI, run the `database drop` CLI command:

```
dotnet ef database drop
```

### Error locating SQL Server instance

Error Message:

```
A network-related or instance-specific error occurred while establishing a connection to SQL Server. The server was not found or was not accessible. Verify that the instance name is correct and that SQL Server is
```

configured to allow remote connections. (provider: SQL Network Interfaces, error: 26 - Error Locating Server/Instance Specified)

Solution:

Check the connection string. If you have manually deleted the database file, change the name of the database in the construction string to start over with a new database.

[PREVIOUS](#)

# ASP.NET Core tutorials

6/21/2018 • 2 minutes to read • [Edit Online](#)

The following step-by-step guides for developing ASP.NET Core applications are available:

## Build web apps

Razor Pages is the recommended approach to create a new Web UI app with ASP.NET Core 2.0 and later.

- [Introduction to Razor Pages in ASP.NET Core](#)
- Create a Razor Pages web app with ASP.NET Core
  - [Razor Pages on macOS](#)
  - [Razor Pages with VS Code](#)
- Create an ASP.NET Core MVC web app
  - [Web app with Visual Studio for Mac](#)
  - [Web app with Visual Studio Code on macOS or Linux](#)

## Build Web APIs

- Create a Web API with ASP.NET Core
  - [Web API with Visual Studio for Mac](#)
  - [Web API with Visual Studio Code](#)

# Create a Razor Pages web app with ASP.NET Core on macOS with Visual Studio for Mac

6/21/2018 • 2 minutes to read • [Edit Online](#)

This is a work in progress.

This series explains the basics of building a Razor Pages web app with ASP.NET Core on macOS.

1. [Get started with Razor Pages on macOS](#)
2. [Add a model to a Razor Pages app](#)
3. [Scaffolded Razor Pages](#)
4. [Work with SQLite](#)
5. [Update the pages](#)
6. [Add search](#)

Until the next section is complete, follow the Visual Studio for Windows version.

1. [Add a new field](#)
2. [Add validation](#)

# Get started with Razor Pages in ASP.NET Core on macOS with Visual Studio for Mac

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

This tutorial teaches the basics of building an ASP.NET Core Razor Pages web app. We recommend you review [Introduction to Razor Pages](#) before starting this tutorial. Razor Pages is the recommended way to build UI for web applications in ASP.NET Core.

## Prerequisites

[Visual Studio for Mac](#)

## Create a Razor web app

From a terminal, run the following commands:

```
dotnet new webapp -o RazorPagesMovie  
cd RazorPagesMovie  
dotnet run
```

### NOTE

In ASP.NET Core 2.1 or later, `webapp` is an alias of the `razor` argument. If the `dotnet new webapp <OPTIONS>` command loads the `dotnet new` command help instead of creating a new Razor Pages app, install the [.NET Core 2.1 SDK](#).

```
dotnet new razor -o RazorPagesMovie  
cd RazorPagesMovie  
dotnet run
```

The preceding commands use the [.NET Core CLI](#) to create and run a Razor Pages project. Open a browser to <http://localhost:5000> to view the application.

The screenshot shows a web browser window with the title "Home page - RazorPagesMovie". The address bar displays "localhost:5000". The page content includes a navigation bar with links for "RazorPagesMovie", "Home", "About", and "Contact". Below the navigation bar is a large blue banner with the text "ASP.NET Core" and "Windows", "Linux", "OSX". A central message reads "Learn how to build ASP.NET apps that can run anywhere." with a "Learn More" button. At the bottom of the banner is a navigation bar with three dots.

## Application uses

- Sample pages using ASP.NET Core Razor Pages
- Bower for managing client-side libraries
- Theming using Bootstrap

## How to

- Working with Razor Pages

The default template creates **RazorPagesMovie**, **Home**, **About** and **Contact** links and pages. Depending on the size of your browser window, you might need to click the navigation icon to show the links.

The screenshot shows a web browser window with the title "Home page - RazorPagesMovie". The address bar displays "localhost:5000". The page content includes a navigation bar with links for "RazorPagesMovie", "Home", "About", and "Contact". A yellow box highlights the three-line navigation icon in the top right corner of the header. Below the navigation bar is a large blue banner with the text "ASP.NET Core" and "Windows", "Linux", "OSX". A central message reads "Learn how to build ASP.NET apps that can run anywhere." with a "Learn More" button. At the bottom of the banner is a navigation bar with three dots.

## Application uses

- Sample pages using ASP.NET Core Razor Pages
- Bower for managing client-side libraries
- Theming using Bootstrap

## How to

- Working with Razor Pages.
- Manage User Secrets using Secret Manager.
- Use logging to log a message.
- Add packages using NuGet.

Test the links. The **RazorPagesMovie** and **Home** links go to the Index page. The **About** and **Contact** links go to

the [About](#) and [Contact](#) pages, respectively.

## Project files and folders

The following table lists the files and folders in the project. For this tutorial, the *Startup.cs* file is the most important to understand. You don't need to review each link provided below. The links are provided as a reference when you need more information on a file or folder in the project.

FILE OR FOLDER	PURPOSE
wwwroot	Contains static files. See <a href="#">Static files</a> .
Pages	Folder for <a href="#">Razor Pages</a> .
<i>appsettings.json</i>	<a href="#">Configuration</a>
<i>Program.cs</i>	<a href="#">Hosts</a> the ASP.NET Core app.
<i>Startup.cs</i>	Configures services and the request pipeline. See <a href="#">Startup</a> .

### The Pages folder

The *\_Layout.cshtml* file contains common HTML elements (scripts and stylesheets) and sets the layout for the application. For example, when you click on **RazorPagesMovie**, **Home**, **About** or **Contact**, you see the same elements. The common elements include the navigation menu on the top and the header on the bottom of the window. See [Layout](#) for more information.

The *\_ViewStart.cshtml* sets the Razor Pages [Layout](#) property to use the *\_Layout.cshtml* file. See [Layout](#) for more information.

The *\_ViewImports.cshtml* file contains Razor directives that are imported into each Razor Page. See [Importing Shared Directives](#) for more information.

The *\_ValidationScriptsPartial.cshtml* file provides a reference to [jQuery](#) validation scripts. When we add [Create](#) and [Edit](#) pages later in the tutorial, the *\_ValidationScriptsPartial.cshtml* file will be used.

The [About](#), [Contact](#) and [Index](#) pages are basic pages you can use to start an app. The [Error](#) page is used to display error information.

## Open the project

Press **Ctrl+C** to shut down the application.

From Visual Studio, select **File > Open**, and then select the *RazorPagesMovie.csproj* file.

### Launch the app

In Visual Studio, select **Run > Start Without Debugging** to launch the app. Visual Studio starts [Kestrel](#), launches a browser, and navigates to <http://localhost:5000>.

In the next tutorial, we add a model to the project.

NEXT: ADDING A  
MODEL

# Add a model to an ASP.NET Core Razor Pages app with Visual Studio for Mac

6/21/2018 • 4 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section, you add classes for managing movies in a database. You use these classes with [Entity Framework Core](#) (EF Core) to work with a database. EF Core is an object-relational mapping (ORM) framework that simplifies the data access code that you have to write.

The model classes you create are known as POCO classes (from "plain-old CLR objects") because they don't have any dependency on EF Core. They define the properties of the data that are stored in the database.

In this tutorial, you write the model classes first, and EF Core creates the database. An alternate approach not covered here is to [generate model classes from an existing database](#).

[View or download](#) sample.

## Add a data model

- In Solution Explorer, right-click the **RazorPagesMovie** project, and then select **Add > New Folder**. Name the folder *Models*.
- Right-click the *Models* folder, and then select **Add > New File**.
- In the **New File** dialog:
  - Select **General** in the left pane.
  - Select **Empty Class** in the center pain.
  - Name the class **Movie** and select **New**.

Add the following properties to the `Movie` class:

```
using System;

namespace RazorPagesMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}
```

The `ID` field is required by the database for the primary key.

### Add a database context class

Add the following `MovieContext.cs` class to the *Models* folder:

```

using Microsoft.EntityFrameworkCore;

namespace RazorPagesMovie.Models
{
    public class MovieContext : DbContext
    {
        public MovieContext(DbContextOptions<MovieContext> options)
            : base(options)
        {

        }

        public DbSet<Movie> Movie { get; set; }
    }
}

```

The preceding code creates a `DbSet` property for the entity set. In Entity Framework terminology, an entity set typically corresponds to a database table, and an entity corresponds to a row in the table.

## Add a database connection string

Add a connection string to the `appsettings.json` file.

```

{
    "Logging": {
        "IncludeScopes": false,
        "LogLevel": {
            "Default": "Warning"
        }
    },
    "ConnectionStrings": {
        "MovieContext": "Data Source=MvcMovie.db"
    }
}

```

## Register the database context

Register the database context with the [dependency injection](#) container in the `Startup.cs` file.

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<MovieContext>(options =>
        options.UseSqlite(Configuration.GetConnectionString("MovieContext")));
    services.AddMvc();
}

```

Right click on a red squiggly line, for example `MovieContext` in the line

`services.AddDbContext<MovieContext>(options => ).` Select **Quick Fix > using RazorPagesMovie.Models;**. Visual studio adds the using statement.

Build the project to verify you don't have any errors.

```

public IConfiguration Configuration { get; }

// This method gets called by the runtime. Use this method to add services to the container.
public void ConfigureServices(IServiceCollection services)
{
    // requires using RazorPagesMovie.Models;
    // and using Microsoft.Extensions.DependencyInjection;
    // and using Microsoft.EntityFrameworkCore;

    services.AddDbContext<MovieContext>()
        .options.UseSqlite(Configuration);
    services.AddMvc();
}

// This method gets called by the runtime. Use this method to configure the HTTP request pipeline.
public void Configure(IApplicationBuilder app, IWebHostEnvironment env)
{
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
    }
    else
    {
        app.UseExceptionHandler("/Error");
        app.UseHsts();
    }
    app.UseStaticFiles();
    app.UseMvc(routes =>
    {
        routes.MapRoute(
            name: "default",
            template: "{controller=Home}/{action=Index}/{id?}");
    });
}

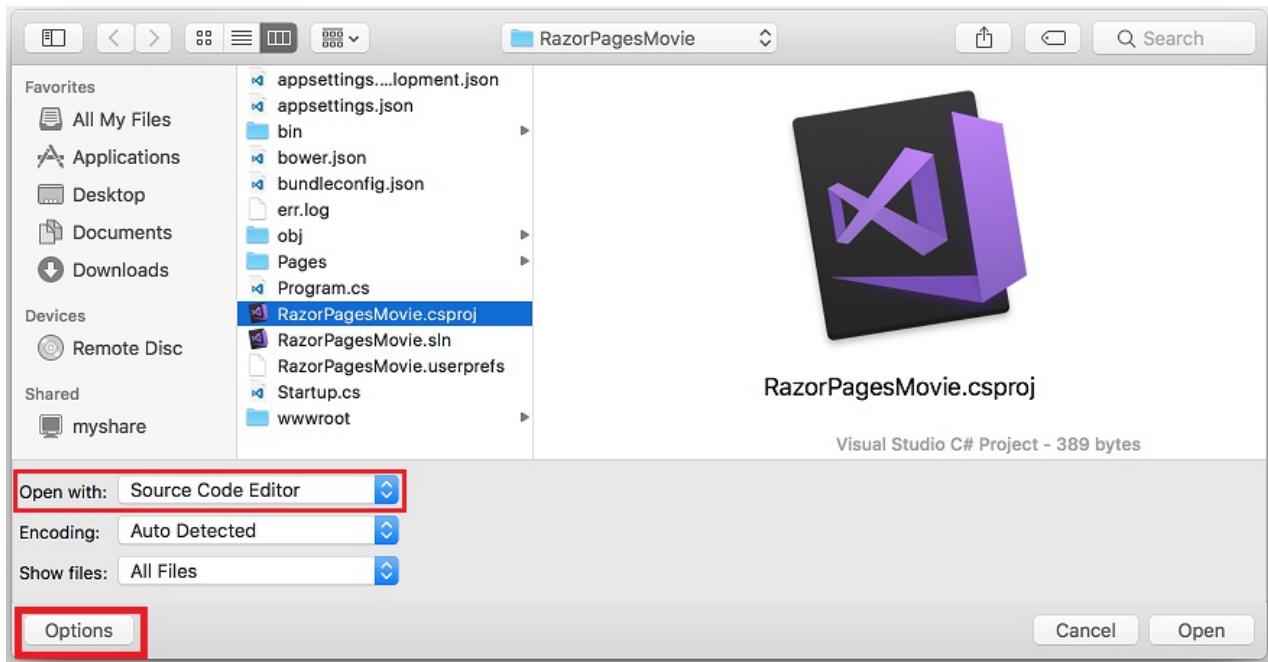
```

## Entity Framework Core NuGet packages for migrations

The EF tools for the command-line interface (CLI) are provided in [Microsoft.EntityFrameworkCore.Tools.DotNet](#). Click on the [Microsoft.EntityFrameworkCore.Tools.DotNet](#) link to get the version number to use. To install this package, add it to the `DotNetCliToolReference` collection in the `.csproj` file. **Note:** You have to install this package by editing the `.csproj` file; you can't use the `install-package` command or the package manager GUI.

To edit a `.csproj` file:

- Select **File > Open**, and then select the `.csproj` file.
- Select **Options**.
- Change **Open with** to **Source Code Editor**.



Add the `Microsoft.EntityFrameworkCore.Tools.DotNet` tool reference to the second `<ItemGroup>`:

```
<Project Sdk="Microsoft.NET.Sdk.Web">
  <PropertyGroup>
    <TargetFramework>netcoreapp2.0</TargetFramework>
  </PropertyGroup>
  <ItemGroup>
    <PackageReference Include="Microsoft.AspNetCore.All" Version="2.0.3" />
  </ItemGroup>
  <ItemGroup>
    <DotNetCliToolReference Include="Microsoft.VisualStudio.Web.CodeGeneration.Tools" Version="2.0.2" />
    <DotNetCliToolReference Include="Microsoft.EntityFrameworkCore.Tools.DotNet" Version="2.0.1" />
  </ItemGroup>
</Project>
```

The version numbers shown in the following code were correct at the time of writing.

## Add scaffold tooling and perform initial migration

From the command line, run the following .NET Core CLI commands:

```
dotnet add package Microsoft.VisualStudio.Web.CodeGeneration.Design
dotnet restore
dotnet ef migrations add InitialCreate
dotnet ef database update
```

The `add package` command installs the tooling required to run the scaffolding engine.

The `ef migrations add InitialCreate` command generates code to create the initial database schema. The schema is based on the model specified in the `DbContext` (In the *Models/MovieContext.cs* file). The `InitialCreate` argument is used to name the migrations. You can use any name, but by convention you choose a name that describes the migration. See [Introduction to migrations](#) for more information.

The `ef database update` command runs the `Up` method in the *Migrations/<time-stamp>\_InitialCreate.cs* file, which creates the database.

### Scaffold the Movie model

- Run the following from the command line (in the project directory that contains the *Program.cs*, *Startup.cs*, and *.csproj* files):

```
dotnet aspnet-codegenerator razorpage -m Movie -dc MovieContext -udl -outDir Pages/Movies --
referenceScriptLibraries
```

If you get the error:

```
No executable found matching command "dotnet-aspnet-codegenerator"
```

Open a command shell to the project directory (The directory that contains the *Program.cs*, *Startup.cs*, and *.csproj* files).

If you get the error:

```
The process cannot access the file
'RazorPagesMovie/bin/Debug/netcoreapp2.0/RazorPagesMovie.dll'
because it is being used by another process.
```

Exit Visual Studio and run the command again.

The following table details the ASP.NET Core code generators' parameters:

PARAMETER	DESCRIPTION
-m	The name of the model.
-dc	The data context.
-udl	Use the default layout.
-outDir	The relative output folder path to create the views.
--referenceScriptLibraries	Adds <code>_ValidationScriptsPartial</code> to Edit and Create pages

Use the `h` switch to get help on the `aspnet-codegenerator razorpage` command:

```
dotnet aspnet-codegenerator razorpage -h
```

## Test the app

- Run the app and append `/Movies` to the URL in the browser (`http://localhost:port/movies`).
- Test the **Create** link.

The screenshot shows a browser window titled "Create - Movie". The address bar indicates a secure connection to `https://localhost:44348/Movies/Create`. The page itself is titled "Create" and has a sub-header "Movie". It contains four input fields: "Title" (value: "The Good, the bad, and the ugly"), "Release Date" (value: "05/30/2018", with a date picker UI), "Genre" (value: "Western"), and "Price" (value: "1.19"). Below these fields is a "Create" button. At the bottom of the page is a link "Back to List" and a copyright notice "© 2018 - RazorPagesMovie".

- Test the **Edit**, **Details**, and **Delete** links.

If you get the error similar to the following, verify you have run migrations and updated the database:

```
An unhandled exception occurred while processing the request.  
'no such table: Movie'.
```

### Add the Pages/Movies files to the project

- In Visual Studio, Right-click the *Pages* folder and select **Add > Add existing Folder**.
- Select the *Movies* folder.
- In the *Choose files to include in the project* dialog, select **Include All**.

The next tutorial explains the files created by scaffolding.

PREVIOUS: GET  
STARTED

NEXT: SCAFFOLDED RAZOR  
PAGES

# Scaffolded Razor Pages in ASP.NET Core

6/21/2018 • 8 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

This tutorial examines the Razor Pages created by scaffolding in the previous tutorial.

[View or download sample](#).

## The Create, Delete, Details, and Edit pages.

Examine the *Pages/Movies/Index.cshtml.cs* Page Model:

```
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using System.Collections.Generic;
using System.Threading.Tasks;
using RazorPagesMovie.Models;

namespace RazorPagesMovie.Pages.Movies
{
    public class IndexModel : PageModel
    {
        private readonly RazorPagesMovie.Models.MovieContext _context;

        public IndexModel(RazorPagesMovie.Models.MovieContext context)
        {
            _context = context;
        }

        public IList<Movie> Movie { get; set; }

        public async Task OnGetAsync()
        {
            Movie = await _context.Movie.ToListAsync();
        }
    }
}
```

```

using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using RazorPagesMovie.Models;
using System.Collections.Generic;
using System.Threading.Tasks;

namespace RazorPagesMovie.Pages.Movies
{
    public class IndexModel : PageModel
    {
        private readonly RazorPagesMovie.Models.RazorPagesMovieContext _context;

        public IndexModel(RazorPagesMovie.Models.RazorPagesMovieContext context)
        {
            _context = context;
        }

        public IList<Movie> Movie { get; set; }

        public async Task OnGetAsync()
        {
            Movie = await _context.Movie.ToListAsync();
        }
    }
}

```

Razor Pages are derived from `PageModel`. By convention, the `PageModel`-derived class is called `<PageName>Model`. The constructor uses [dependency injection](#) to add the `MovieContext` to the page. All the scaffolded pages follow this pattern. See [Asynchronous code](#) for more information on asynchronous programming with Entity Framework.

When a request is made for the page, the `OnGetAsync` method returns a list of movies to the Razor Page.

`OnGetAsync` or `OnGet` is called on a Razor Page to initialize the state for the page. In this case, `OnGetAsync` gets a list of movies and displays them.

When `OnGet` returns `void` or `OnGetAsync` returns `Task`, no return method is used. When the return type is `IActionResult` or `Task<IActionResult>`, a return statement must be provided. For example, the `Pages/Movies/Create.cshtml.cs` `OnPostAsync` method:

```

public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    _context.Movie.Add(Movie);
    await _context.SaveChangesAsync();

    return RedirectToPage("./Index");
}

```

Examine the `Pages/Movies/Index.cshtml` Razor Page:

```

@page
@model RazorPagesMovie.Pages.Movies.IndexModel

 @{
    ViewData["Title"] = "Index";
}

<h2>Index</h2>

<p>
    <a asp-page="Create">Create New</a>
</p>
<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].ReleaseDate)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].Genre)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].Price)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
@foreach (var item in Model.Movie) {
        <tr>
            <td>
                @Html.DisplayFor(modelItem => item.Title)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.ReleaseDate)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.Genre)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.Price)
            </td>
            <td>
                <a asp-page="./Edit" asp-route-id="@item.ID">Edit</a> |
                <a asp-page="./Details" asp-route-id="@item.ID">Details</a> |
                <a asp-page="./Delete" asp-route-id="@item.ID">Delete</a>
            </td>
        </tr>
}
    </tbody>
</table>

```

Razor can transition from HTML into C# or into Razor-specific markup. When an `@` symbol is followed by a [Razor reserved keyword](#), it transitions into Razor-specific markup, otherwise it transitions into C#.

The `@page` Razor directive makes the file into an MVC action — which means that it can handle requests. `@page` must be the first Razor directive on a page. `@page` is an example of transitioning into Razor-specific markup. See [Razor syntax](#) for more information.

Examine the lambda expression used in the following HTML Helper:

```
@Html.DisplayNameFor(model => model.Movie[0].Title))
```

The `DisplayNameFor` HTML Helper inspects the `Title` property referenced in the lambda expression to determine the display name. The lambda expression is inspected rather than evaluated. That means there is no access violation when `model`, `model.Movie`, or `model.Movie[0]` are `null` or empty. When the lambda expression is evaluated (for example, with `@Html.DisplayFor(modelItem => item.Title)`), the model's property values are evaluated.

## The `@model` directive

```
@page  
@model RazorPagesMovie.Pages.Movies.IndexModel
```

The `@model` directive specifies the type of the model passed to the Razor Page. In the preceding example, the `@model` line makes the `PageModel`-derived class available to the Razor Page. The model is used in the `@Html.DisplayNameFor` and `@Html.DisplayName` [HTML Helpers](#) on the page.

## ViewData and layout

Consider the following code:

```
@page  
@model RazorPagesMovie.Pages.Movies.IndexModel  
  
{@  
    ViewData["Title"] = "Index";  
}
```

The preceding highlighted code is an example of Razor transitioning into C#. The `{` and `}` characters enclose a block of C# code.

The `PageModel` base class has a `ViewData` dictionary property that can be used to add data that you want to pass to a View. You add objects into the `ViewData` dictionary using a key/value pattern. In the preceding sample, the "Title" property is added to the `ViewData` dictionary.

The "Title" property is used in the `Pages/_Layout.cshtml` file. The following markup shows the first few lines of the `Pages/_Layout.cshtml` file.

The "Title" property is used in the `Pages/Shared/_Layout.cshtml` file. The following markup shows the first few lines of the `_Layout.cshtml` file.

```
<!DOCTYPE html>  
<html>  
<head>  
    <meta charset="utf-8" />  
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />  
    <title>@ViewData["Title"] - RazorPagesMovie</title>  
  
    /*Markup removed for brevity.*@
```

The line `/*Markup removed for brevity.*@` is a Razor comment. Unlike HTML comments (`<!-- -->`), Razor comments are not sent to the client.

Run the app and test the links in the project (**Home**, **About**, **Contact**, **Create**, **Edit**, and **Delete**). Each page sets the title, which you can see in the browser tab. When you bookmark a page, the title is used for the bookmark. `Pages/Index.cshtml` and `Pages/Movies/Index.cshtml` currently have the same title, but you can modify them to have

different values.

#### NOTE

You may not be able to enter decimal commas in the `Price` field. To support [jQuery validation](#) for non-US-English locales that use a comma (",") for a decimal point, and non US-English date formats, you must take steps to globalize your app. This [GitHub issue 4076](#) for instructions on adding decimal comma.

The `Layout` property is set in the *Pages/\_ViewStart.cshtml* file:

```
@{  
    Layout = "_Layout";  
}
```

The preceding markup sets the layout file to *Pages/\_Layout.cshtml* for all Razor files under the *Pages* folder. See [Layout](#) for more information.

#### Update the layout

Change the `<title>` element in the *Pages/\_Layout.cshtml* file to use a shorter string.

```
<!DOCTYPE html>  
<html>  
<head>  
    <meta charset="utf-8" />  
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />  
    <title>@ ViewData["Title"] - Movie</title>
```

Find the following anchor element in the *Pages/\_Layout.cshtml* file.

```
<a asp-page="/Index" class="navbar-brand">RazorPagesMovie</a>
```

Replace the preceding element with the following markup.

```
<a asp-page="/Movies/Index" class="navbar-brand">RpMovie</a>
```

The preceding anchor element is a [Tag Helper](#). In this case, it's the [Anchor Tag Helper](#). The `asp-page="/Movies/Index"` Tag Helper attribute and value creates a link to the `/Movies/Index` Razor Page.

Save your changes, and test the app by clicking on the **RpMovie** link. See the *\_Layout.cshtml* file in GitHub.

#### The Create page model

Examine the *Pages/Movies/Create.cshtml.cs* page model:

```
// Unused usings removed.
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using RazorPagesMovie.Models;
using System.Threading.Tasks;

namespace RazorPagesMovie.Pages.Movies
{
    public class CreateModel : PageModel
    {
        private readonly RazorPagesMovie.Models.MovieContext _context;

        public CreateModel(RazorPagesMovie.Models.MovieContext context)
        {
            _context = context;
        }

        public IActionResult OnGet()
        {
            return Page();
        }

        [BindProperty]
        public Movie Movie { get; set; }

        public async Task<IActionResult> OnPostAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            _context.Movie.Add(Movie);
            await _context.SaveChangesAsync();

            return RedirectToPage("./Index");
        }
    }
}
```

```

// Unused usings removed.
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using RazorPagesMovie.Models;
using System.Threading.Tasks;

namespace RazorPagesMovie.Pages.Movies
{
    public class CreateModel : PageModel
    {
        private readonly RazorPagesMovie.Models.RazorPagesMovieContext _context;

        public CreateModel(RazorPagesMovie.Models.RazorPagesMovieContext context)
        {
            _context = context;
        }

        public IActionResult OnGet()
        {
            return Page();
        }

        [BindProperty]
        public Movie Movie { get; set; }

        public async Task<IActionResult> OnPostAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            _context.Movie.Add(Movie);
            await _context.SaveChangesAsync();

            return RedirectToPage("./Index");
        }
    }
}

```

The `OnGet` method initializes any state needed for the page. The Create page doesn't have any state to initialize, so `Page` is returned. Later in the tutorial you see `OnGet` method initialize state. The `Page` method creates a `PageResult` object that renders the *Create.cshtml* page.

The `Movie` property uses the `[BindProperty]` attribute to opt-in to [model binding](#). When the Create form posts the form values, the ASP.NET Core runtime binds the posted values to the `Movie` model.

The `OnPostAsync` method is run when the page posts form data:

```

public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    _context.Movie.Add(Movie);
    await _context.SaveChangesAsync();

    return RedirectToPage("./Index");
}

```

If there are any model errors, the form is redisplayed, along with any form data posted. Most model errors can be

caught on the client-side before the form is posted. An example of a model error is posting a value for the date field that cannot be converted to a date. We'll talk more about client-side validation and model validation later in the tutorial.

If there are no model errors, the data is saved, and the browser is redirected to the Index page.

## The Create Razor Page

Examine the *Pages/Movies/Create.cshtml* Razor Page file:

```
@page
@model RazorPagesMovie.Pages.Movies.CreateModel

@{
    ViewData["Title"] = "Create";
}

<h2>Create</h2>

<h4>Movie</h4>
<hr />
<div class="row">
    <div class="col-md-4">
        <form method="post">
            <div asp-validation-summary="ModelOnly" class="text-danger"></div>
            <div class="form-group">
                <label asp-for="Movie.Title" class="control-label"></label>
                <input asp-for="Movie.Title" class="form-control" />
                <span asp-validation-for="Movie.Title" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Movie.ReleaseDate" class="control-label"></label>
                <input asp-for="Movie.ReleaseDate" class="form-control" />
                <span asp-validation-for="Movie.ReleaseDate" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Movie.Genre" class="control-label"></label>
                <input asp-for="Movie.Genre" class="form-control" />
                <span asp-validation-for="Movie.Genre" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Movie.Price" class="control-label"></label>
                <input asp-for="Movie.Price" class="form-control" />
                <span asp-validation-for="Movie.Price" class="text-danger"></span>
            </div>
            <div class="form-group">
                <input type="submit" value="Create" class="btn btn-default" />
            </div>
        </form>
    </div>
</div>

<a asp-page="Index">Back to List</a>
</div>

@section Scripts {
    @await Html.RenderPartialAsync("_ValidationScriptsPartial");
}
```

The `<form method="post">` element is a [Form Tag Helper](#). The Form Tag Helper automatically includes an [antiforgery token](#).

The scaffolding engine creates Razor markup for each field in the model (except the ID) similar to the following:

```
<div asp-validation-summary="ModelOnly" class="text-danger"></div>
<div class="form-group">
    <label asp-for="Movie.Title" class="control-label"></label>
    <input asp-for="Movie.Title" class="form-control" />
    <span asp-validation-for="Movie.Title" class="text-danger"></span>
</div>
```

The [Validation Tag Helpers](#) (`<div asp-validation-summary` and `<span asp-validation-for`) display validation errors. Validation is covered in more detail later in this series.

The [Label Tag Helper](#) (`<label asp-for="Movie.Title" class="control-label"></label>`) generates the label caption and `for` attribute for the `Title` property.

The [Input Tag Helper](#) (`<input asp-for="Movie.Title" class="form-control" />`) uses the [DataAnnotations](#) attributes and produces HTML attributes needed for jQuery Validation on the client-side.

The next tutorial explains SQLite and seeding the database.

[PREVIOUS: ADDING A](#)

[MODEL](#)

[NEXT:](#)

[SQLITE](#)

# Work with SQLite in an ASP.NET Core Razor Pages app

6/26/2018 • 2 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

The `MovieContext` object handles the task of connecting to the database and mapping `Movie` objects to database records. The database context is registered with the [Dependency Injection](#) container in the `ConfigureServices` method in the *Startup.cs* file:

```
public void ConfigureServices(IServiceCollection services)
{
    // requires
    // using RazorPagesMovie.Models;
    // using Microsoft.EntityFrameworkCore;

    services.AddDbContext<MovieContext>(options =>
        options.UseSqlite(Configuration.GetConnectionString("MovieContext")));
    services.AddMvc();
}
```

## SQLite

The [SQLite](#) website states:

SQLite is a self-contained, high-reliability, embedded, full-featured, public-domain, SQL database engine.  
SQLite is the most used database engine in the world.

There are many third party tools you can download to manage and view a SQLite database. The image below is from [DB Browser for SQLite](#). If you have a favorite SQLite tool, leave a comment on what you like about it.

The screenshot shows the DB Browser for SQLite interface with the following details:

- Toolbar:** New Database, Open Database, Write Changes, Revert Changes.
- Tab Bar:** Database Structure (selected), Browse Data, Edit Pragmas, Execute SQL.
- Sub-Toolbar:** Create Table, Create Index, Modify Table, Delete Table.
- Table List:**
  - Tables (3):**
    - Movie:** Contains columns ID (INTEGER), Genre (TEXT), Price (TEXT), ReleaseDate (TEXT), and Title (TEXT).
    - \_\_EFMigrationsHistory:** Contains column MigrationId (TEXT).
    - sqlite\_sequence:** Contains columns name (TEXT) and seq (INTEGER).
  - Indices (1):** sqlite\_autoindex\_\_EFMigrationsHis...
  - Views (0):** None.
  - Triggers (0):** None.
- Bottom Right:** UTF-8 encoding indicator.

## Seed the database

Create a new class named `SeedData` in the *Models* folder. Replace the generated code with the following:

```

using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using System;
using System.Linq;

namespace RazorPagesMovie.Models
{
    public static class SeedData
    {
        public static void Initialize(IServiceProvider serviceProvider)
        {
            using (var context = new MovieContext(
                serviceProvider.GetRequiredService<DbContextOptions<MovieContext>>()))
            {
                // Look for any movies.
                if (context.Movie.Any())
                {
                    return; // DB has been seeded
                }

                context.Movie.AddRange(
                    new Movie
                    {
                        Title = "When Harry Met Sally",
                        ReleaseDate = DateTime.Parse("1989-2-12"),
                        Genre = "Romantic Comedy",
                        Price = 7.99M
                    },
                    new Movie
                    {
                        Title = "Ghostbusters",
                        ReleaseDate = DateTime.Parse("1984-3-13"),
                        Genre = "Comedy",
                        Price = 8.99M
                    },
                    new Movie
                    {
                        Title = "Ghostbusters 2",
                        ReleaseDate = DateTime.Parse("1986-2-23"),
                        Genre = "Comedy",
                        Price = 9.99M
                    },
                    new Movie
                    {
                        Title = "Rio Bravo",
                        ReleaseDate = DateTime.Parse("1959-4-15"),
                        Genre = "Western",
                        Price = 3.99M
                    }
                );
                context.SaveChanges();
            }
        }
    }
}

```

If there are any movies in the DB, the seed initializer returns.

```
if (context.Movie.Any())
{
    return; // DB has been seeded.
}
```

## Add the seed initializer

Add the seed initializer to the `Main` method in the `Program.cs` file:

```
// Unused usings removed.
using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;
using RazorPagesMovie.Models;
using System;
using Microsoft.EntityFrameworkCore;

namespace RazorPagesMovie
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = BuildWebHost(args);

            using (var scope = host.Services.CreateScope())
            {
                var services = scope.ServiceProvider;

                try
                {
                    var context = services.GetRequiredService<MovieContext>();
                    // requires using Microsoft.EntityFrameworkCore;
                    context.Database.Migrate();
                    // Requires using RazorPagesMovie.Models;
                    SeedData.Initialize(services);
                }
                catch (Exception ex)
                {
                    var logger = services.GetRequiredService<ILogger<Program>>();
                    logger.LogError(ex, "An error occurred seeding the DB.");
                }
            }

            host.Run();
        }

        public static IWebHost BuildWebHost(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>()
                .Build();
    }
}
```

## Test the app

Delete all the records in the DB (So the seed method will run). Stop and start the app to seed the database.

The app shows the seeded data.

[PREVIOUS: ADDING A  
MODEL](#)

[NEXT: UPDATE THE  
PAGES](#)

# Update the generated pages

6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

We have a good start to the movie app, but the presentation isn't ideal. We don't want to see the time (12:00:00 AM in the image below) and **ReleaseDate** should be **Release Date** (two words).

Title	ReleaseDate	Genre	Price
When Harry Met Sally	2/12/1989 12:00:00 AM	Romantic Comedy	7.99
Ghostbusters	3/13/1984 12:00:00 AM	Comedy	8.99
Ghostbusters 2	2/23/1986 12:00:00 AM	Comedy	9.99
Rio Bravo	4/15/1959 12:00:00 AM	Western	3.99

## Update the generated code

Open the *Models/Movie.cs* file and add the highlighted lines shown in the following code:

```
using System;
using System.ComponentModel.DataAnnotations;

namespace RazorPagesMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }

        [Display(Name = "Release Date")]
        [DataType(DataType.Date)]
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}
```

Right click on a red squiggly line > **Quick Actions and Refactorings** on the [Column] attribute and select

```
using System.ComponentModel.DataAnnotations.Schema;
```

The [Column(TypeName = "decimal(18, 2)")] data annotation is required so Entity Framework Core can correctly map Price to currency in the database. For more information, see [Data Types](#).

The completed model:

```
using System;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

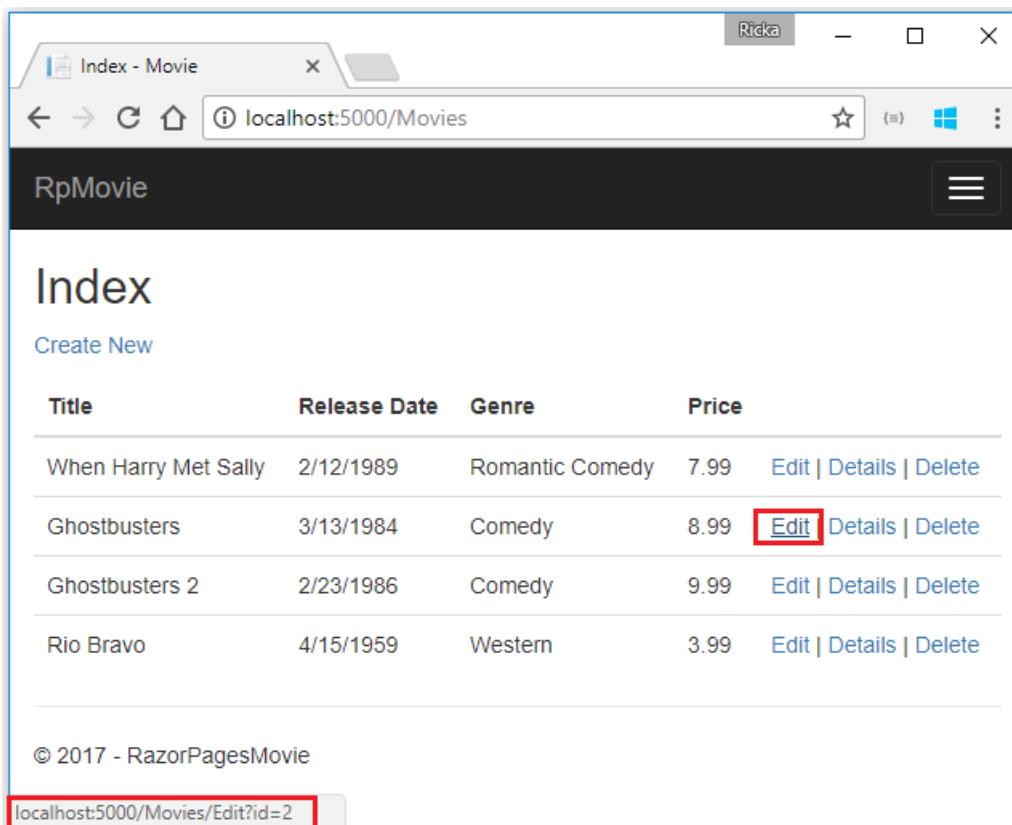
namespace RazorPagesMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }

        [Display(Name = "Release Date")]
        [DataType(DataType.Date)]
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }

        [Column(TypeName = "decimal(18, 2)")]
        public decimal Price { get; set; }
    }
}
```

We'll cover [DataAnnotations](#) in the next tutorial. The [Display](#) attribute specifies what to display for the name of a field (in this case "Release Date" instead of "ReleaseDate"). The [DataType](#) attribute specifies the type of the data (Date), so the time information stored in the field isn't displayed.

Browse to Pages/Movies and hover over an **Edit** link to see the target URL.



The **Edit**, **Details**, and **Delete** links are generated by the [Anchor Tag Helper](#) in the *Pages/Movies/Index.cshtml* file.

```

@foreach (var item in Model.Movie) {
    <tr>
        <td>
            @Html.DisplayFor(modelItem => item.Title)
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.ReleaseDate)
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.Genre)
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.Price)
        </td>
        <td>
            <a asp-page="./Edit" asp-route-id="@item.ID">Edit</a> | 
            <a asp-page="./Details" asp-route-id="@item.ID">Details</a> | 
            <a asp-page="./Delete" asp-route-id="@item.ID">Delete</a>
        </td>
    </tr>
}
</tbody>
</table>

```

Tag Helpers enable server-side code to participate in creating and rendering HTML elements in Razor files. In the preceding code, the `AnchorTagHelper` dynamically generates the HTML `href` attribute value from the Razor Page (the route is relative), the `asp-page`, and the route id (`asp-route-id`). See [URL generation for Pages](#) for more information.

Use **View Source** from your favorite browser to examine the generated markup. A portion of the generated HTML is shown below:

```

<td>
    <a href="/Movies/Edit?id=1">Edit</a> | 
    <a href="/Movies/Details?id=1">Details</a> | 
    <a href="/Movies/Delete?id=1">Delete</a>
</td>

```

The dynamically-generated links pass the movie ID with a query string (for example,

`http://localhost:5000/Movies/Details?id=2`).

Update the Edit, Details, and Delete Razor Pages to use the "`{id:int}`" route template. Change the page directive for each of these pages from `@page` to `@page "{id:int}"`. Run the app and then view source. The generated HTML adds the ID to the path portion of the URL:

```

<td>
    <a href="/Movies/Edit/1">Edit</a> | 
    <a href="/Movies/Details/1">Details</a> | 
    <a href="/Movies/Delete/1">Delete</a>
</td>

```

A request to the page with the "`{id:int}`" route template that does **not** include the integer will return an HTTP 404 (not found) error. For example, `http://localhost:5000/Movies/Details` will return a 404 error. To make the ID optional, append `?` to the route constraint:

```

@page "{id:int?}"

```

## Update concurrency exception handling

Update the `OnPostAsync` method in the `Pages/Movies/Edit.cshtml.cs` file. The following highlighted code shows the changes:

```
public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    _context.Attach(Movie).State = EntityState.Modified;

    try
    {
        await _context.SaveChangesAsync();
    }
    catch (DbUpdateConcurrencyException)
    {
        if (!_context.Movie.Any(e => e.ID == Movie.ID))
        {
            return NotFound();
        }
        else
        {
            throw;
        }
    }

    return RedirectToPage("./Index");
}
```

The previous code only detects concurrency exceptions when the first concurrent client deletes the movie, and the second concurrent client posts changes to the movie.

To test the `catch` block:

- Set a breakpoint on `catch (DbUpdateConcurrencyException)`
- Edit a movie.
- In another browser window, select the **Delete** link for the same movie, and then delete the movie.
- In the previous browser window, post changes to the movie.

Production code would generally detect concurrency conflicts when two or more clients concurrently updated a record. See [Handle concurrency conflicts](#) for more information.

### Posting and binding review

Examine the `Pages/Movies/Edit.cshtml.cs` file:

```
public class EditModel : PageModel
{
    private readonly RazorPagesMovie.Models.MovieContext _context;

    public EditModel(RazorPagesMovie.Models.MovieContext context)
    {
        _context = context;
    }

    [BindProperty]
    public Movie Movie { get; set; }

    public async Task<IActionResult> OnGetAsync(int? id)
    {
        if (id == null)
        {
            return NotFound();
        }

        Movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);

        if (Movie == null)
        {
            return NotFound();
        }
        return Page();
    }

    public async Task<IActionResult> OnPostAsync()
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        _context.Attach(Movie).State = EntityState.Modified;

        try
        {
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!_context.Movie.Any(e => e.ID == Movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }

        return RedirectToPage("./Index");
    }
}
```

```

public class EditModel : PageModel
{
    private readonly RazorPagesMovie.Models.RazorPagesMovieContext _context;

    public EditModel(RazorPagesMovie.Models.RazorPagesMovieContext context)
    {
        _context = context;
    }

    [BindProperty]
    public Movie Movie { get; set; }

    public async Task<IActionResult> OnGetAsync(int? id)
    {
        if (id == null)
        {
            return NotFound();
        }

        Movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);

        if (Movie == null)
        {
            return NotFound();
        }
        return Page();
    }

    public async Task<IActionResult> OnPostAsync()
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        _context.Attach(Movie).State = EntityState.Modified;

        try
        {
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!_context.Movie.Any(e => e.ID == Movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }

        return RedirectToPage("./Index");
    }
}

```

When an HTTP GET request is made to the Movies/Edit page (for example, `http://localhost:5000/Movies/Edit/2`):

- The `OnGetAsync` method fetches the movie from the database and returns the `Page` method.
- The `Page` method renders the `Pages/Movies/Edit.cshtml` Razor Page. The `Pages/Movies/Edit.cshtml` file contains the model directive (`@model RazorPagesMovie.Pages.Movies.EditModel`), which makes the movie model available on the page.
- The Edit form is displayed with the values from the movie.

When the Movies/Edit page is posted:

- The form values on the page are bound to the `Movie` property. The `[BindProperty]` attribute enables [Model binding](#).

```
[BindProperty]  
public Movie Movie { get; set; }
```

- If there are errors in the model state (for example, `ReleaseDate` cannot be converted to a date), the form is posted again with the submitted values.
- If there are no model errors, the movie is saved.

The HTTP GET methods in the Index, Create, and Delete Razor pages follow a similar pattern. The HTTP POST `OnPostAsync` method in the Create Razor Page follows a similar pattern to the `OnPostAsync` method in the Edit Razor Page.

Search is added in the next tutorial.

[PREVIOUS: WORK WITH  
SQLLITE](#)

[ADD  
SEARCH](#)

# Add search to an ASP.NET Core Razor Pages app

6/26/2018 • 3 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this document, search capability is added to the Index page that enables searching movies by *genre* or *name*.

Update the Index page's `OnGetAsync` method with the following code:

```
@{  
    Layout = "_Layout";  
}
```

```
public async Task OnGetAsync(string searchString)  
{  
    var movies = from m in _context.Movie  
                select m;  
  
    if (!String.IsNullOrEmpty(searchString))  
    {  
        movies = movies.Where(s => s.Title.Contains(searchString));  
    }  
  
    Movie = await movies.ToListAsync();  
}
```

The first line of the `OnGetAsync` method creates a [LINQ](#) query to select the movies:

```
var movies = from m in _context.Movie  
            select m;
```

The query is *only* defined at this point, it has **not** been run against the database.

If the `searchString` parameter contains a string, the movies query is modified to filter on the search string:

```
if (!String.IsNullOrEmpty(searchString))  
{  
    movies = movies.Where(s => s.Title.Contains(searchString));  
}
```

The `s => s.Title.Contains()` code is a [Lambda Expression](#). Lambdas are used in method-based [LINQ](#) queries as arguments to standard query operator methods such as the [Where](#) method or `Contains` (used in the preceding code). LINQ queries are not executed when they're defined or when they're modified by calling a method (such as `Where`, `Contains` or `OrderBy`). Rather, query execution is deferred. That means the evaluation of an expression is delayed until its realized value is iterated over or the `ToListAsync` method is called. See [Query Execution](#) for more information.

**Note:** The `Contains` method is run on the database, not in the C# code. The case sensitivity on the query depends on the database and the collation. On SQL Server, `Contains` maps to [SQL LIKE](#), which is case insensitive. In SQLite, with the default collation, it's case sensitive.

Navigate to the Movies page and append a query string such as `?searchString=Ghost` to the URL (for example,

`http://localhost:5000/Movies?searchString=Ghost`). The filtered movies are displayed.

Title	Release Date	Genre	Price	
Ghostbusters	3/13/1984	Comedy	8.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Ghostbusters 2	2/23/1986	Comedy	9.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

If the following route template is added to the Index page, the search string can be passed as a URL segment (for example, `http://localhost:5000/Movies/ghost`).

```
@page "{searchString?}"
```

The preceding route constraint allows searching the title as route data (a URL segment) instead of as a query string value. The `?` in `"{searchString?}"` means this is an optional route parameter.

Title	Release Date	Genre	Price	
Ghostbusters	3/13/1984	Comedy	8.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Ghostbusters 2	2/23/1986	Comedy	9.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

However, you can't expect users to modify the URL to search for a movie. In this step, UI is added to filter movies. If you added the route constraint `"{searchString?}"`, remove it.

Open the `Pages/Movies/Index.cshtml` file, and add the `<form>` markup highlighted in the following code:

```

@page
@model RazorPagesMovie.Pages.Movies.IndexModel

 @{
     ViewData["Title"] = "Index";
 }

<h2>Index</h2>

<p>
    <a href="#" asp-page="Create">Create New</a>
</p>

<form>
    <p>
        Title: <input type="text" name="SearchString">
        <input type="submit" value="Filter" />
    </p>
</form>

<table class="table">
    @*Markup removed for brevity.*@

```

The HTML `<form>` tag uses the [Form Tag Helper](#). When the form is submitted, the filter string is sent to the `Pages/Movies/Index` page. Save the changes and test the filter.

Title	Release Date	Genre	Price	
Ghostbusters	3/13/1984	Comedy	8.99	Edit   Details   Delete
Ghostbusters 2	2/23/1986	Comedy	9.99	Edit   Details   Delete

## Search by genre

Add the following highlighted properties to `Pages/Movies/Index.cshtml.cs`:

```

public class IndexModel : PageModel
{
    private readonly RazorPagesMovie.Models.MovieContext _context;

    public IndexModel(RazorPagesMovie.Models.MovieContext context)
    {
        _context = context;
    }

    public IList<Movie> Movie { get; set; }
    public SelectList Genres { get; set; }
    public string MovieGenre { get; set; }

```

The `SelectList Genres` contains the list of genres. This allows the user to select a genre from the list.

The `MovieGenre` property contains the specific genre the user selects (for example, "Western").

Update the `OnGetAsync` method with the following code:

```

// Requires using Microsoft.AspNetCore.Mvc.Rendering;
public async Task OnGetAsync(string movieGenre, string searchString)
{
    // Use LINQ to get list of genres.
    IQueryable<string> genreQuery = from m in _context.Movie
                                         orderby m.Genre
                                         select m.Genre;

    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    if (!String.IsNullOrEmpty(movieGenre))
    {
        movies = movies.Where(x => x.Genre == movieGenre);
    }
    Genres = new SelectList(await genreQuery.Distinct().ToListAsync());
    Movie = await movies.ToListAsync();
}

```

The following code is a LINQ query that retrieves all the genres from the database.

```

// Use LINQ to get list of genres.
IQueryable<string> genreQuery = from m in _context.Movie
                                         orderby m.Genre
                                         select m.Genre;

```

The `SelectList` of genres is created by projecting the distinct genres.

```
Genres = new SelectList(await genreQuery.Distinct().ToListAsync());
```

## Adding search by genre

Update `Index.cshtml` as follows:

```
@page
@model RazorPagesMovie.Pages.Movies.IndexModel

@{
    ViewData["Title"] = "Index";
}

<h2>Index</h2>

<p>
    <a asp-page="Create">Create New</a>
</p>

<form>
    <p>
        <select asp-for="MovieGenre" asp-items="Model.Genres">
            <option value="">All</option>
        </select>

        Title: <input type="text" name="SearchString">
        <input type="submit" value="Filter" />
    </p>
</form>

<table class="table">
    <thead>
```

Test the app by searching by genre, by movie title, and by both.

PREVIOUS: UPDATING THE  
PAGES

NEXT: ADDING A NEW  
FIELD

# Create a Razor Pages web app with ASP.NET Core and Visual Studio Code

6/21/2018 • 2 minutes to read • [Edit Online](#)

This is a work in progress.

This series explains the basics of building a Razor Pages web app with ASP.NET Core using Visual Studio Code.

1. [Get started with Razor Pages with VS Code](#)
2. [Add a model to a Razor Pages app](#)
3. [Scaffolded Razor Pages](#)
4. [Work with SQLite](#)
5. [Update the pages](#)
6. [Add search](#)

Until the next section is complete, follow the Visual Studio for Windows version.

1. [Add a new field](#)
2. [Add validation](#)

# Get started with ASP.NET Core Razor Pages in Visual Studio Code

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

This tutorial teaches the basics of building an ASP.NET Core Razor Pages web app. We recommend you complete [Introduction to Razor Pages](#) before starting this tutorial. Razor Pages is the recommended way to build UI for web applications in ASP.NET Core.

## Prerequisites

Install the following:

- [.NET Core SDK 2.0 or later](#)
- [Visual Studio Code](#)
- [C# for Visual Studio Code](#)
- [.NET Core 2.1 SDK or later](#)
- [Visual Studio Code](#)
- [C# for Visual Studio Code](#)

## Create a Razor web app

From a terminal, run the following commands:

```
dotnet new webapp -o RazorPagesMovie  
cd RazorPagesMovie  
dotnet run
```

### NOTE

In ASP.NET Core 2.1 or later, `webapp` is an alias of the `razor` argument. If the `dotnet new webapp <OPTIONS>` command loads the `dotnet new` command help instead of creating a new Razor Pages app, install the [.NET Core 2.1 SDK](#).

```
dotnet new razor -o RazorPagesMovie  
cd RazorPagesMovie  
dotnet run
```

The preceding commands use the [.NET Core CLI](#) to create and run a Razor Pages project. Open a browser to <http://localhost:5000> to view the application.

The screenshot shows a web browser window with the title "Home page - RazorPagesMovie". The address bar displays "localhost:5000". The page content includes a navigation bar with links for "RazorPagesMovie", "Home", "About", and "Contact". Below the navigation bar is a large blue banner with the text "ASP.NET Core" and "Windows", "Linux", "OSX". A central message reads "Learn how to build ASP.NET apps that can run anywhere." with a "Learn More" button. At the bottom of the banner is a navigation bar with three dots.

## Application uses

- Sample pages using ASP.NET Core Razor Pages
- Bower for managing client-side libraries
- Theming using Bootstrap

## How to

- Working with Razor Pages

The default template creates **RazorPagesMovie**, **Home**, **About** and **Contact** links and pages. Depending on the size of your browser window, you might need to click the navigation icon to show the links.

The screenshot shows a web browser window with the title "Home page - RazorPagesMovie". The address bar displays "localhost:5000". The page content includes a navigation bar with links for "RazorPagesMovie", "Home", "About", and "Contact". A yellow box highlights the navigation icon (three horizontal lines) in the top right corner of the header. Below the navigation bar is a large blue banner with the text "ASP.NET Core" and "Windows", "Linux", "OSX". At the bottom of the banner is a navigation bar with three dots.

## Application uses

- Sample pages using ASP.NET Core Razor Pages
- Bower for managing client-side libraries
- Theming using Bootstrap

## How to

- Working with Razor Pages.
- Manage User Secrets using Secret Manager.
- Use logging to log a message.
- Add packages using NuGet.

Test the links. The **RazorPagesMovie** and **Home** links go to the Index page. The **About** and **Contact** links go to

the [About](#) and [Contact](#) pages, respectively.

## Project files and folders

The following table lists the files and folders in the project. For this tutorial, the *Startup.cs* file is the most important to understand. You don't need to review each link provided below. The links are provided as a reference when you need more information on a file or folder in the project.

FILE OR FOLDER	PURPOSE
wwwroot	Contains static files. See <a href="#">Static files</a> .
Pages	Folder for <a href="#">Razor Pages</a> .
<i>appsettings.json</i>	<a href="#">Configuration</a>
<i>Program.cs</i>	<a href="#">Hosts</a> the ASP.NET Core app.
<i>Startup.cs</i>	Configures services and the request pipeline. See <a href="#">Startup</a> .

### The Pages folder

The *\_Layout.cshtml* file contains common HTML elements (scripts and stylesheets) and sets the layout for the application. For example, when you click on **RazorPagesMovie**, **Home**, **About** or **Contact**, you see the same elements. The common elements include the navigation menu on the top and the header on the bottom of the window. See [Layout](#) for more information.

The *\_ViewStart.cshtml* sets the Razor Pages [Layout](#) property to use the *\_Layout.cshtml* file. See [Layout](#) for more information.

The *\_ViewImports.cshtml* file contains Razor directives that are imported into each Razor Page. See [Importing Shared Directives](#) for more information.

The *\_ValidationScriptsPartial.cshtml* file provides a reference to [jQuery](#) validation scripts. When we add [Create](#) and [Edit](#) pages later in the tutorial, the *\_ValidationScriptsPartial.cshtml* file will be used.

The [About](#), [Contact](#) and [Index](#) pages are basic pages you can use to start an app. The [Error](#) page is used to display error information.

## Open the project

Press Ctrl+C to shut down the application.

From Visual Studio Code (VS Code), select **File > Open Folder**, and then select the *RazorPagesMovie* folder.

- Select **Yes** to the **Warn** message "Required assets to build and debug are missing from 'RazorPagesMovie'. Add them?"
- Select **Restore** to the **Info** message "There are unresolved dependencies".

### Launch the app

Press Ctrl+F5 to start the app without debugging. Alternatively, from the **Debug** menu, select **Start Without Debugging**.

In the next tutorial, we add a model to the project.

NEXT: ADDING A

MODEL

# Add a model to an ASP.NET Core Razor Pages app with Visual Studio Code

7/6/2018 • 4 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section, you add classes for managing movies in a database. You use these classes with [Entity Framework Core](#) (EF Core) to work with a database. EF Core is an object-relational mapping (ORM) framework that simplifies the data access code that you have to write.

The model classes you create are known as POCO classes (from "plain-old CLR objects") because they don't have any dependency on EF Core. They define the properties of the data that are stored in the database.

In this tutorial, you write the model classes first, and EF Core creates the database. An alternate approach not covered here is to [generate model classes from an existing database](#).

[View or download](#) sample.

## Add a data model

- Add a folder named *Models*.
- Add a class to the *Models* folder named *Movie.cs*.
- Add the following code to the *Models/Movie.cs* file:

Add the following properties to the `Movie` class:

```
using System;

namespace RazorPagesMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}
```

The `ID` field is required by the database for the primary key.

### Add a database context class

Add the following *MovieContext.cs* class to the *Models* folder:

```

using Microsoft.EntityFrameworkCore;

namespace RazorPagesMovie.Models
{
    public class MovieContext : DbContext
    {
        public MovieContext(DbContextOptions<MovieContext> options)
            : base(options)
        {

        }

        public DbSet<Movie> Movie { get; set; }
    }
}

```

The preceding code creates a `DbSet` property for the entity set. In Entity Framework terminology, an entity set typically corresponds to a database table, and an entity corresponds to a row in the table.

## Add a database connection string

Add a connection string to the `appsettings.json` file.

```

{
  "Logging": {
    "IncludeScopes": false,
    "LogLevel": {
      "Default": "Warning"
    }
  },
  "ConnectionStrings": {
    "MovieContext": "Data Source=MvcMovie.db"
  }
}

```

## Register the database context

Register the database context with the [dependency injection](#) container in the `Startup.cs` file.

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<MovieContext>(options =>
        options.UseSqlite(Configuration.GetConnectionString("MovieContext")));
    services.AddMvc();
}

```

Add the following `using` statements at the top of `Startup.cs`:

```

using RazorPagesMovie.Models;
using Microsoft.EntityFrameworkCore;

```

Build the project to verify you don't have any errors.

## Entity Framework Core NuGet packages for migrations

The EF tools for the command-line interface (CLI) are provided in [Microsoft.EntityFrameworkCore.Tools.DotNet](#).

To install this package, add it to the `DotNetCliToolReference` collection in the `.csproj` file. **Note:** You have to install this package by editing the `.csproj` file; you can't use the `install-package` command or the package manager GUI.

Edit the `RazorPagesMovie.csproj` file:

- Select **File > Open File**, and then select the `RazorPagesMovie.csproj` file.

- Add tool reference for `Microsoft.EntityFrameworkCore.Tools.DotNet` to the second `<ItemGroup>`:

```

<Project Sdk="Microsoft.NET.Sdk.Web">
  <PropertyGroup>
    <TargetFramework>netcoreapp2.0</TargetFramework>
  </PropertyGroup>
  <ItemGroup>
    <PackageReference Include="Microsoft.AspNetCore.All" Version="2.0.3" />
  </ItemGroup>
  <ItemGroup>
    <DotNetCliToolReference Include="Microsoft.VisualStudio.Web.CodeGeneration.Tools" Version="2.0.2" />
    <DotNetCliToolReference Include="Microsoft.EntityFrameworkCore.Tools.DotNet" Version="2.0.1" />
  </ItemGroup>
</Project>

```

## Add scaffold tooling and perform initial migration

From the command line, run the following .NET Core CLI commands:

```

dotnet add package Microsoft.VisualStudio.Web.CodeGeneration.Design
dotnet restore
dotnet ef migrations add InitialCreate
dotnet ef database update

```

The `add package` command installs the tooling required to run the scaffolding engine.

The `ef migrations add InitialCreate` command generates code to create the initial database schema. The schema is based on the model specified in the `DbContext` (In the `Models/MovieContext.cs` file). The `InitialCreate` argument is used to name the migrations. You can use any name, but by convention you choose a name that describes the migration. See [Introduction to migrations](#) for more information.

The `ef database update` command runs the `Up` method in the `Migrations/<time-stamp>_InitialCreate.cs` file, which creates the database.

### Scaffold the Movie model

- Open a command window in the project directory (The directory that contains the `Program.cs`, `Startup.cs`, and `.csproj` files).
- Run the following command:

**Note: Run the following command on Windows. For MacOS and Linux, see the next command**

```

dotnet aspnet-codegenerator razorpage -m Movie -dc MovieContext -udl -outDir Pages\Movies --
referenceScriptLibraries

```

- On MacOS and Linux, run the following command:

```

dotnet aspnet-codegenerator razorpage -m Movie -dc MovieContext -udl -outDir Pages/Movies --
referenceScriptLibraries

```

If you get the error:

```

The process cannot access the file
'RazorPagesMovie/bin/Debug/netcoreapp2.0/RazorPagesMovie.dll'
because it is being used by another process.

```

Exit Visual Studio and run the command again.

The following table details the ASP.NET Core code generators' parameters:

PARAMETER	DESCRIPTION
-m	The name of the model.
-dc	The data context.
-udl	Use the default layout.
-outDir	The relative output folder path to create the views.
--referenceScriptLibraries	Adds <code>_ValidationScriptsPartial</code> to Edit and Create pages

Use the `-h` switch to get help on the `aspnet-codegenerator razorpage` command:

```
dotnet aspnet-codegenerator razorpage -h
```

### Test the app

- Run the app and append `/Movies` to the URL in the browser (`http://localhost:port/movies`).
- Test the **Create** link.

The screenshot shows a browser window titled "Create - Movie". The address bar indicates a secure connection to "https://localhost:44348/Movies/Create". The page header "RpMovie" has a three-line menu icon. The main content area is titled "Create" and "Movie". It contains four input fields: "Title" (value: "The Good, the bad, and the ugly"), "Release Date" (value: "05/30/2018", with a "Window Snip" placeholder and a date picker icon), "Genre" (value: "Western"), and "Price" (value: "1.19"). Below these fields is a "Create" button. At the bottom left is a link "Back to List", and at the bottom right is copyright information "© 2018 - RazorPagesMovie".

- Test the **Edit**, **Details**, and **Delete** links.

If you get the error similar to the following, verify you have run migrations and updated the database:

```
An unhandled exception occurred while processing the request.  
'no such table: Movie'.
```

The next tutorial explains the files created by scaffolding.

PREVIOUS: GET

STARTED

NEXT: SCAFFOLDED RAZOR

PAGES

# Scaffolded Razor Pages in ASP.NET Core

6/21/2018 • 8 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

This tutorial examines the Razor Pages created by scaffolding in the previous tutorial.

[View or download sample](#).

## The Create, Delete, Details, and Edit pages.

Examine the *Pages/Movies/Index.cshtml.cs* Page Model:

```
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using System.Collections.Generic;
using System.Threading.Tasks;
using RazorPagesMovie.Models;

namespace RazorPagesMovie.Pages.Movies
{
    public class IndexModel : PageModel
    {
        private readonly RazorPagesMovie.Models.MovieContext _context;

        public IndexModel(RazorPagesMovie.Models.MovieContext context)
        {
            _context = context;
        }

        public IList<Movie> Movie { get; set; }

        public async Task OnGetAsync()
        {
            Movie = await _context.Movie.ToListAsync();
        }
    }
}
```

```

using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using RazorPagesMovie.Models;
using System.Collections.Generic;
using System.Threading.Tasks;

namespace RazorPagesMovie.Pages.Movies
{
    public class IndexModel : PageModel
    {
        private readonly RazorPagesMovie.Models.RazorPagesMovieContext _context;

        public IndexModel(RazorPagesMovie.Models.RazorPagesMovieContext context)
        {
            _context = context;
        }

        public IList<Movie> Movie { get; set; }

        public async Task OnGetAsync()
        {
            Movie = await _context.Movie.ToListAsync();
        }
    }
}

```

Razor Pages are derived from `PageModel`. By convention, the `PageModel`-derived class is called `<PageName>Model`. The constructor uses [dependency injection](#) to add the `MovieContext` to the page. All the scaffolded pages follow this pattern. See [Asynchronous code](#) for more information on asynchronous programming with Entity Framework.

When a request is made for the page, the `OnGetAsync` method returns a list of movies to the Razor Page. `OnGetAsync` or `OnGet` is called on a Razor Page to initialize the state for the page. In this case, `OnGetAsync` gets a list of movies and displays them.

When `OnGet` returns `void` or `OnGetAsync` returns `Task`, no return method is used. When the return type is `IActionResult` or `Task<IActionResult>`, a return statement must be provided. For example, the `Pages/Movies/Create.cshtml.cs` `OnPostAsync` method:

```

public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    _context.Movie.Add(Movie);
    await _context.SaveChangesAsync();

    return RedirectToPage("./Index");
}

```

Examine the `Pages/Movies/Index.cshtml` Razor Page:

```

@page
@model RazorPagesMovie.Pages.Movies.IndexModel

 @{
    ViewData["Title"] = "Index";
}

<h2>Index</h2>

<p>
    <a asp-page="Create">Create New</a>
</p>
<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].ReleaseDate)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].Genre)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Movie[0].Price)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
@foreach (var item in Model.Movie) {
        <tr>
            <td>
                @Html.DisplayFor(modelItem => item.Title)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.ReleaseDate)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.Genre)
            </td>
            <td>
                @Html.DisplayFor(modelItem => item.Price)
            </td>
            <td>
                <a asp-page="./Edit" asp-route-id="@item.ID">Edit</a> |
                <a asp-page="./Details" asp-route-id="@item.ID">Details</a> |
                <a asp-page="./Delete" asp-route-id="@item.ID">Delete</a>
            </td>
        </tr>
}
    </tbody>
</table>

```

Razor can transition from HTML into C# or into Razor-specific markup. When an `@` symbol is followed by a [Razor reserved keyword](#), it transitions into Razor-specific markup, otherwise it transitions into C#.

The `@page` Razor directive makes the file into an MVC action — which means that it can handle requests. `@page` must be the first Razor directive on a page. `@page` is an example of transitioning into Razor-specific markup. See [Razor syntax](#) for more information.

Examine the lambda expression used in the following HTML Helper:

```
@Html.DisplayNameFor(model => model.Movie[0].Title))
```

The `DisplayNameFor` HTML Helper inspects the `Title` property referenced in the lambda expression to determine the display name. The lambda expression is inspected rather than evaluated. That means there is no access violation when `model`, `model.Movie`, or `model.Movie[0]` are `null` or empty. When the lambda expression is evaluated (for example, with `@Html.DisplayFor(modelItem => item.Title)`), the model's property values are evaluated.

### The `@model` directive

```
@page  
@model RazorPagesMovie.Pages.Movies.IndexModel
```

The `@model` directive specifies the type of the model passed to the Razor Page. In the preceding example, the `@model` line makes the `PageModel`-derived class available to the Razor Page. The model is used in the `@Html.DisplayNameFor` and `@Html.DisplayName` [HTML Helpers](#) on the page.

### ViewData and layout

Consider the following code:

```
@page  
@model RazorPagesMovie.Pages.Movies.IndexModel  
  
{@  
    ViewData["Title"] = "Index";  
}
```

The preceding highlighted code is an example of Razor transitioning into C#. The `{` and `}` characters enclose a block of C# code.

The `PageModel` base class has a `ViewData` dictionary property that can be used to add data that you want to pass to a View. You add objects into the `ViewData` dictionary using a key/value pattern. In the preceding sample, the "Title" property is added to the `ViewData` dictionary.

The "Title" property is used in the `Pages/_Layout.cshtml` file. The following markup shows the first few lines of the `Pages/_Layout.cshtml` file.

The "Title" property is used in the `Pages/Shared/_Layout.cshtml` file. The following markup shows the first few lines of the `_Layout.cshtml` file.

```
<!DOCTYPE html>  
<html>  
<head>  
    <meta charset="utf-8" />  
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />  
    <title>@ViewData["Title"] - RazorPagesMovie</title>  
  
    /*Markup removed for brevity.*@
```

The line `/*Markup removed for brevity.*@` is a Razor comment. Unlike HTML comments (`<!-- -->`), Razor comments are not sent to the client.

Run the app and test the links in the project (**Home**, **About**, **Contact**, **Create**, **Edit**, and **Delete**). Each page sets the title, which you can see in the browser tab. When you bookmark a page, the title is used for the bookmark. `Pages/Index.cshtml` and `Pages/Movies/Index.cshtml` currently have the same title, but you can modify them to have

different values.

#### NOTE

You may not be able to enter decimal commas in the `Price` field. To support [jQuery validation](#) for non-US-English locales that use a comma (",") for a decimal point, and non US-English date formats, you must take steps to globalize your app. This [GitHub issue 4076](#) for instructions on adding decimal comma.

The `Layout` property is set in the *Pages/\_ViewStart.cshtml* file:

```
@{  
    Layout = "_Layout";  
}
```

The preceding markup sets the layout file to *Pages/\_Layout.cshtml* for all Razor files under the *Pages* folder. See [Layout](#) for more information.

#### Update the layout

Change the `<title>` element in the *Pages/\_Layout.cshtml* file to use a shorter string.

```
<!DOCTYPE html>  
<html>  
<head>  
    <meta charset="utf-8" />  
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />  
    <title>@ ViewData["Title"] - Movie</title>
```

Find the following anchor element in the *Pages/\_Layout.cshtml* file.

```
<a asp-page="/Index" class="navbar-brand">RazorPagesMovie</a>
```

Replace the preceding element with the following markup.

```
<a asp-page="/Movies/Index" class="navbar-brand">RpMovie</a>
```

The preceding anchor element is a [Tag Helper](#). In this case, it's the [Anchor Tag Helper](#). The `asp-page="/Movies/Index"` Tag Helper attribute and value creates a link to the `/Movies/Index` Razor Page.

Save your changes, and test the app by clicking on the **RpMovie** link. See the *\_Layout.cshtml* file in GitHub.

#### The Create page model

Examine the *Pages/Movies/Create.cshtml.cs* page model:

```
// Unused usings removed.
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using RazorPagesMovie.Models;
using System.Threading.Tasks;

namespace RazorPagesMovie.Pages.Movies
{
    public class CreateModel : PageModel
    {
        private readonly RazorPagesMovie.Models.MovieContext _context;

        public CreateModel(RazorPagesMovie.Models.MovieContext context)
        {
            _context = context;
        }

        public IActionResult OnGet()
        {
            return Page();
        }

        [BindProperty]
        public Movie Movie { get; set; }

        public async Task<IActionResult> OnPostAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            _context.Movie.Add(Movie);
            await _context.SaveChangesAsync();

            return RedirectToPage("./Index");
        }
    }
}
```

```

// Unused usings removed.
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using RazorPagesMovie.Models;
using System.Threading.Tasks;

namespace RazorPagesMovie.Pages.Movies
{
    public class CreateModel : PageModel
    {
        private readonly RazorPagesMovie.Models.RazorPagesMovieContext _context;

        public CreateModel(RazorPagesMovie.Models.RazorPagesMovieContext context)
        {
            _context = context;
        }

        public IActionResult OnGet()
        {
            return Page();
        }

        [BindProperty]
        public Movie Movie { get; set; }

        public async Task<IActionResult> OnPostAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            _context.Movie.Add(Movie);
            await _context.SaveChangesAsync();

            return RedirectToPage("./Index");
        }
    }
}

```

The `OnGet` method initializes any state needed for the page. The Create page doesn't have any state to initialize, so `Page` is returned. Later in the tutorial you see `OnGet` method initialize state. The `Page` method creates a `PageResult` object that renders the *Create.cshtml* page.

The `Movie` property uses the `[BindProperty]` attribute to opt-in to [model binding](#). When the Create form posts the form values, the ASP.NET Core runtime binds the posted values to the `Movie` model.

The `OnPostAsync` method is run when the page posts form data:

```

public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    _context.Movie.Add(Movie);
    await _context.SaveChangesAsync();

    return RedirectToPage("./Index");
}

```

If there are any model errors, the form is redisplayed, along with any form data posted. Most model errors can be

caught on the client-side before the form is posted. An example of a model error is posting a value for the date field that cannot be converted to a date. We'll talk more about client-side validation and model validation later in the tutorial.

If there are no model errors, the data is saved, and the browser is redirected to the Index page.

## The Create Razor Page

Examine the *Pages/Movies/Create.cshtml* Razor Page file:

```
@page
@model RazorPagesMovie.Pages.Movies.CreateModel

@{
    ViewData["Title"] = "Create";
}

<h2>Create</h2>

<h4>Movie</h4>
<hr />
<div class="row">
    <div class="col-md-4">
        <form method="post">
            <div asp-validation-summary="ModelOnly" class="text-danger"></div>
            <div class="form-group">
                <label asp-for="Movie.Title" class="control-label"></label>
                <input asp-for="Movie.Title" class="form-control" />
                <span asp-validation-for="Movie.Title" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Movie.ReleaseDate" class="control-label"></label>
                <input asp-for="Movie.ReleaseDate" class="form-control" />
                <span asp-validation-for="Movie.ReleaseDate" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Movie.Genre" class="control-label"></label>
                <input asp-for="Movie.Genre" class="form-control" />
                <span asp-validation-for="Movie.Genre" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Movie.Price" class="control-label"></label>
                <input asp-for="Movie.Price" class="form-control" />
                <span asp-validation-for="Movie.Price" class="text-danger"></span>
            </div>
            <div class="form-group">
                <input type="submit" value="Create" class="btn btn-default" />
            </div>
        </form>
    </div>
</div>

<a asp-page="Index">Back to List</a>
</div>

@section Scripts {
    @await Html.RenderPartialAsync("_ValidationScriptsPartial");
}
```

The `<form method="post">` element is a [Form Tag Helper](#). The Form Tag Helper automatically includes an [antiforgery token](#).

The scaffolding engine creates Razor markup for each field in the model (except the ID) similar to the following:

```
<div asp-validation-summary="ModelOnly" class="text-danger"></div>
<div class="form-group">
    <label asp-for="Movie.Title" class="control-label"></label>
    <input asp-for="Movie.Title" class="form-control" />
    <span asp-validation-for="Movie.Title" class="text-danger"></span>
</div>
```

The [Validation Tag Helpers](#) (`<div asp-validation-summary` and `<span asp-validation-for`) display validation errors. Validation is covered in more detail later in this series.

The [Label Tag Helper](#) (`<label asp-for="Movie.Title" class="control-label"></label>`) generates the label caption and `for` attribute for the `Title` property.

The [Input Tag Helper](#) (`<input asp-for="Movie.Title" class="form-control" />`) uses the [DataAnnotations](#) attributes and produces HTML attributes needed for jQuery Validation on the client-side.

The next tutorial explains SQLite and seeding the database.

[PREVIOUS: ADDING A](#)

[MODEL](#)

[NEXT:](#)

[SQLITE](#)

# Work with SQLite in an ASP.NET Core Razor Pages app

6/26/2018 • 2 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

The `MovieContext` object handles the task of connecting to the database and mapping `Movie` objects to database records. The database context is registered with the [Dependency Injection](#) container in the `ConfigureServices` method in the *Startup.cs* file:

```
public void ConfigureServices(IServiceCollection services)
{
    // requires
    // using RazorPagesMovie.Models;
    // using Microsoft.EntityFrameworkCore;

    services.AddDbContext<MovieContext>(options =>
        options.UseSqlite(Configuration.GetConnectionString("MovieContext")));
    services.AddMvc();
}
```

## SQLite

The [SQLite](#) website states:

SQLite is a self-contained, high-reliability, embedded, full-featured, public-domain, SQL database engine.  
SQLite is the most used database engine in the world.

There are many third party tools you can download to manage and view a SQLite database. The image below is from [DB Browser for SQLite](#). If you have a favorite SQLite tool, leave a comment on what you like about it.

The screenshot shows the DB Browser for SQLite interface. The title bar reads "DB Browser for SQLite - /Users/ricka/t/MvcMovie/bin/Debug/netcoreapp1.1/MvcMovie.db". The main window has tabs at the top: "Database Structure" (selected), "Browse Data", "Edit Pragmas", and "Execute SQL". Below the tabs are buttons for "Create Table", "Create Index", "Modify Table", and "Delete Table". The main content area displays the database schema:

Name	Type	Schema
Tables (3)		
Movie		CREATE TABLE "Movie" ( "ID" INTEGER NOT NULL CONSTRAINT `ID` PRIMARY KEY AUTOINCREMENT, `Genre` TEXT, `Price` TEXT NOT NULL, `ReleaseDate` TEXT NOT NULL, `Title` TEXT )
ID	INTEGER	'ID` INTEGER NOT NULL PRIMARY KEY AUTOINCREMENT
Genre	TEXT	'Genre` TEXT
Price	TEXT	'Price` TEXT NOT NULL
ReleaseDate	TEXT	'ReleaseDate` TEXT NOT NULL
Title	TEXT	'Title` TEXT
__EFMigrationsHistory		CREATE TABLE "__EFMigrationsHistory" ( "MigrationId" TEXT, "ProductVersion" TEXT )
sqlite_sequence		CREATE TABLE sqlite_sequence(name,seq)
Indices (1)		sqlite_autoindex__EFMigrationsHis...
Views (0)		
Triggers (0)		

## Seed the database

Create a new class named `SeedData` in the *Models* folder. Replace the generated code with the following:

```

using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using System;
using System.Linq;

namespace RazorPagesMovie.Models
{
    public static class SeedData
    {
        public static void Initialize(IServiceProvider serviceProvider)
        {
            using (var context = new MovieContext(
                serviceProvider.GetRequiredService<DbContextOptions<MovieContext>>()))
            {
                // Look for any movies.
                if (context.Movie.Any())
                {
                    return; // DB has been seeded
                }

                context.Movie.AddRange(
                    new Movie
                    {
                        Title = "When Harry Met Sally",
                        ReleaseDate = DateTime.Parse("1989-2-12"),
                        Genre = "Romantic Comedy",
                        Price = 7.99M
                    },
                    new Movie
                    {
                        Title = "Ghostbusters",
                        ReleaseDate = DateTime.Parse("1984-3-13"),
                        Genre = "Comedy",
                        Price = 8.99M
                    },
                    new Movie
                    {
                        Title = "Ghostbusters 2",
                        ReleaseDate = DateTime.Parse("1986-2-23"),
                        Genre = "Comedy",
                        Price = 9.99M
                    },
                    new Movie
                    {
                        Title = "Rio Bravo",
                        ReleaseDate = DateTime.Parse("1959-4-15"),
                        Genre = "Western",
                        Price = 3.99M
                    }
                );
                context.SaveChanges();
            }
        }
    }
}

```

If there are any movies in the DB, the seed initializer returns.

```
if (context.Movie.Any())
{
    return; // DB has been seeded.
}
```

## Add the seed initializer

Add the seed initializer to the `Main` method in the `Program.cs` file:

```
// Unused usings removed.
using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;
using RazorPagesMovie.Models;
using System;
using Microsoft.EntityFrameworkCore;

namespace RazorPagesMovie
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = BuildWebHost(args);

            using (var scope = host.Services.CreateScope())
            {
                var services = scope.ServiceProvider;

                try
                {
                    var context = services.GetRequiredService<MovieContext>();
                    // requires using Microsoft.EntityFrameworkCore;
                    context.Database.Migrate();
                    // Requires using RazorPagesMovie.Models;
                    SeedData.Initialize(services);
                }
                catch (Exception ex)
                {
                    var logger = services.GetRequiredService<ILogger<Program>>();
                    logger.LogError(ex, "An error occurred seeding the DB.");
                }
            }

            host.Run();
        }

        public static IWebHost BuildWebHost(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>()
                .Build();
    }
}
```

## Test the app

Delete all the records in the DB (So the seed method will run). Stop and start the app to seed the database.

The app shows the seeded data.

[PREVIOUS: ADDING A  
MODEL](#)

[NEXT: UPDATE THE  
PAGES](#)

# Update the generated pages

6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

We have a good start to the movie app, but the presentation isn't ideal. We don't want to see the time (12:00:00 AM in the image below) and **ReleaseDate** should be **Release Date** (two words).

Title	ReleaseDate	Genre	Price
When Harry Met Sally	2/12/1989 12:00:00 AM	Romantic Comedy	7.99
Ghostbusters	3/13/1984 12:00:00 AM	Comedy	8.99
Ghostbusters 2	2/23/1986 12:00:00 AM	Comedy	9.99
Rio Bravo	4/15/1959 12:00:00 AM	Western	3.99

## Update the generated code

Open the *Models/Movie.cs* file and add the highlighted lines shown in the following code:

```
using System;
using System.ComponentModel.DataAnnotations;

namespace RazorPagesMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }

        [Display(Name = "Release Date")]
        [DataType(DataType.Date)]
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}
```

Right click on a red squiggly line > **Quick Actions and Refactorings** on the [Column] attribute and select

```
using System.ComponentModel.DataAnnotations.Schema;
```

The [Column(TypeName = "decimal(18, 2)")] data annotation is required so Entity Framework Core can correctly map Price to currency in the database. For more information, see [Data Types](#).

The completed model:

```
using System;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

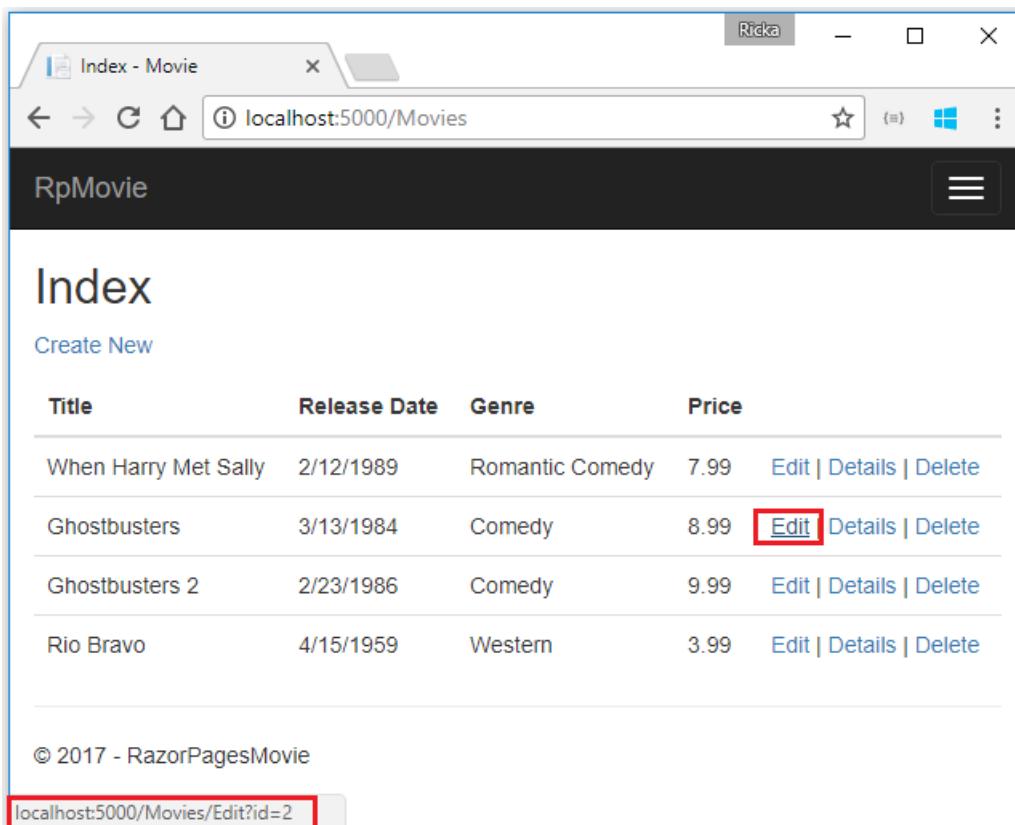
namespace RazorPagesMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }

        [Display(Name = "Release Date")]
        [DataType(DataType.Date)]
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }

        [Column(TypeName = "decimal(18, 2)")]
        public decimal Price { get; set; }
    }
}
```

We'll cover [DataAnnotations](#) in the next tutorial. The [Display](#) attribute specifies what to display for the name of a field (in this case "Release Date" instead of "ReleaseDate"). The [DataType](#) attribute specifies the type of the data (Date), so the time information stored in the field isn't displayed.

Browse to Pages/Movies and hover over an **Edit** link to see the target URL.



The **Edit**, **Details**, and **Delete** links are generated by the [Anchor Tag Helper](#) in the *Pages/Movies/Index.cshtml* file.

```

@foreach (var item in Model.Movie) {
    <tr>
        <td>
            @Html.DisplayFor(modelItem => item.Title)
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.ReleaseDate)
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.Genre)
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.Price)
        </td>
        <td>
            <a asp-page="./Edit" asp-route-id="@item.ID">Edit</a> | 
            <a asp-page="./Details" asp-route-id="@item.ID">Details</a> | 
            <a asp-page="./Delete" asp-route-id="@item.ID">Delete</a>
        </td>
    </tr>
}
</tbody>
</table>

```

Tag Helpers enable server-side code to participate in creating and rendering HTML elements in Razor files. In the preceding code, the `AnchorTagHelper` dynamically generates the HTML `href` attribute value from the Razor Page (the route is relative), the `asp-page`, and the route id (`asp-route-id`). See [URL generation for Pages](#) for more information.

Use **View Source** from your favorite browser to examine the generated markup. A portion of the generated HTML is shown below:

```

<td>
    <a href="/Movies/Edit?id=1">Edit</a> | 
    <a href="/Movies/Details?id=1">Details</a> | 
    <a href="/Movies/Delete?id=1">Delete</a>
</td>

```

The dynamically-generated links pass the movie ID with a query string (for example,

`http://localhost:5000/Movies/Details?id=2`).

Update the Edit, Details, and Delete Razor Pages to use the "`{id:int}`" route template. Change the page directive for each of these pages from `@page` to `@page "{id:int}"`. Run the app and then view source. The generated HTML adds the ID to the path portion of the URL:

```

<td>
    <a href="/Movies/Edit/1">Edit</a> | 
    <a href="/Movies/Details/1">Details</a> | 
    <a href="/Movies/Delete/1">Delete</a>
</td>

```

A request to the page with the "`{id:int}`" route template that does **not** include the integer will return an HTTP 404 (not found) error. For example, `http://localhost:5000/Movies/Details` will return a 404 error. To make the ID optional, append `?` to the route constraint:

```

@page "{id:int?}"

```

## Update concurrency exception handling

Update the `OnPostAsync` method in the `Pages/Movies/Edit.cshtml.cs` file. The following highlighted code shows the changes:

```
public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    _context.Attach(Movie).State = EntityState.Modified;

    try
    {
        await _context.SaveChangesAsync();
    }
    catch (DbUpdateConcurrencyException)
    {
        if (!_context.Movie.Any(e => e.ID == Movie.ID))
        {
            return NotFound();
        }
        else
        {
            throw;
        }
    }

    return RedirectToPage("./Index");
}
```

The previous code only detects concurrency exceptions when the first concurrent client deletes the movie, and the second concurrent client posts changes to the movie.

To test the `catch` block:

- Set a breakpoint on `catch (DbUpdateConcurrencyException)`
- Edit a movie.
- In another browser window, select the **Delete** link for the same movie, and then delete the movie.
- In the previous browser window, post changes to the movie.

Production code would generally detect concurrency conflicts when two or more clients concurrently updated a record. See [Handle concurrency conflicts](#) for more information.

### Posting and binding review

Examine the `Pages/Movies/Edit.cshtml.cs` file:

```
public class EditModel : PageModel
{
    private readonly RazorPagesMovie.Models.MovieContext _context;

    public EditModel(RazorPagesMovie.Models.MovieContext context)
    {
        _context = context;
    }

    [BindProperty]
    public Movie Movie { get; set; }

    public async Task<IActionResult> OnGetAsync(int? id)
    {
        if (id == null)
        {
            return NotFound();
        }

        Movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);

        if (Movie == null)
        {
            return NotFound();
        }
        return Page();
    }

    public async Task<IActionResult> OnPostAsync()
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        _context.Attach(Movie).State = EntityState.Modified;

        try
        {
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!_context.Movie.Any(e => e.ID == Movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }

        return RedirectToPage("./Index");
    }
}
```

```

public class EditModel : PageModel
{
    private readonly RazorPagesMovie.Models.RazorPagesMovieContext _context;

    public EditModel(RazorPagesMovie.Models.RazorPagesMovieContext context)
    {
        _context = context;
    }

    [BindProperty]
    public Movie Movie { get; set; }

    public async Task<IActionResult> OnGetAsync(int? id)
    {
        if (id == null)
        {
            return NotFound();
        }

        Movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);

        if (Movie == null)
        {
            return NotFound();
        }
        return Page();
    }

    public async Task<IActionResult> OnPostAsync()
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        _context.Attach(Movie).State = EntityState.Modified;

        try
        {
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!_context.Movie.Any(e => e.ID == Movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
    }

    return RedirectToPage("./Index");
}
}

```

When an HTTP GET request is made to the Movies/Edit page (for example, `http://localhost:5000/Movies/Edit/2`):

- The `OnGetAsync` method fetches the movie from the database and returns the `Page` method.
- The `Page` method renders the `Pages/Movies/Edit.cshtml` Razor Page. The `Pages/Movies/Edit.cshtml` file contains the model directive (`@model RazorPagesMovie.Pages.Movies.EditModel`), which makes the movie model available on the page.
- The Edit form is displayed with the values from the movie.

When the Movies/Edit page is posted:

- The form values on the page are bound to the `Movie` property. The `[BindProperty]` attribute enables [Model binding](#).

```
[BindProperty]  
public Movie Movie { get; set; }
```

- If there are errors in the model state (for example, `ReleaseDate` cannot be converted to a date), the form is posted again with the submitted values.
- If there are no model errors, the movie is saved.

The HTTP GET methods in the Index, Create, and Delete Razor pages follow a similar pattern. The HTTP POST `OnPostAsync` method in the Create Razor Page follows a similar pattern to the `OnPostAsync` method in the Edit Razor Page.

Search is added in the next tutorial.

[PREVIOUS: WORKING WITH  
SQLLITE](#)

[ADD  
SEARCH](#)

# Add search to an ASP.NET Core Razor Pages app

6/26/2018 • 3 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this document, search capability is added to the Index page that enables searching movies by *genre* or *name*.

Update the Index page's `OnGetAsync` method with the following code:

```
@{  
    Layout = "_Layout";  
}
```

```
public async Task OnGetAsync(string searchString)  
{  
    var movies = from m in _context.Movie  
                 select m;  
  
    if (!String.IsNullOrEmpty(searchString))  
    {  
        movies = movies.Where(s => s.Title.Contains(searchString));  
    }  
  
    Movie = await movies.ToListAsync();  
}
```

The first line of the `OnGetAsync` method creates a [LINQ](#) query to select the movies:

```
var movies = from m in _context.Movie  
             select m;
```

The query is *only* defined at this point, it has **not** been run against the database.

If the `searchString` parameter contains a string, the movies query is modified to filter on the search string:

```
if (!String.IsNullOrEmpty(searchString))  
{  
    movies = movies.Where(s => s.Title.Contains(searchString));  
}
```

The `s => s.Title.Contains()` code is a [Lambda Expression](#). Lambdas are used in method-based [LINQ](#) queries as arguments to standard query operator methods such as the [Where](#) method or `Contains` (used in the preceding code). LINQ queries are not executed when they're defined or when they're modified by calling a method (such as `Where`, `Contains` or `OrderBy`). Rather, query execution is deferred. That means the evaluation of an expression is delayed until its realized value is iterated over or the `ToListAsync` method is called. See [Query Execution](#) for more information.

**Note:** The `Contains` method is run on the database, not in the C# code. The case sensitivity on the query depends on the database and the collation. On SQL Server, `Contains` maps to [SQL LIKE](#), which is case insensitive. In SQLite, with the default collation, it's case sensitive.

Navigate to the Movies page and append a query string such as `?searchString=Ghost` to the URL (for example,

`http://localhost:5000/Movies?searchString=Ghost`). The filtered movies are displayed.

The screenshot shows a browser window titled "Index - Movie". The address bar contains the URL "localhost:5000/Movies?searchString=Ghost". The main content area is titled "RpMovie" and "Index". It features a "Create New" link and a table with columns: Title, Release Date, Genre, and Price. Two rows are present: "Ghostbusters" (Release Date: 3/13/1984, Genre: Comedy, Price: 8.99) and "Ghostbusters 2" (Release Date: 2/23/1986, Genre: Comedy, Price: 9.99). Each row has "Edit | Details | Delete" links. At the bottom, there is a copyright notice: "© 2017 - RazorPagesMovie".

Title	Release Date	Genre	Price
Ghostbusters	3/13/1984	Comedy	8.99
Ghostbusters 2	2/23/1986	Comedy	9.99

If the following route template is added to the Index page, the search string can be passed as a URL segment (for example, `http://localhost:5000/Movies/ghost`).

```
@page "{searchString?}"
```

The preceding route constraint allows searching the title as route data (a URL segment) instead of as a query string value. The `?` in `"{searchString?}"` means this is an optional route parameter.

The screenshot shows a browser window titled "Index - Movie". The address bar contains the URL "localhost:5000/Movies/Ghost". The main content area is titled "RpMovie" and "Index". It features a "Create New" link and a table with columns: Title, Release Date, Genre, and Price. Two rows are present: "Ghostbusters" (Release Date: 3/13/1984, Genre: Comedy, Price: 8.99) and "Ghostbusters 2" (Release Date: 2/23/1986, Genre: Comedy, Price: 9.99). Each row has "Edit | Details | Delete" links. At the bottom, there is a copyright notice: "© 2017 - RazorPagesMovie".

Title	Release Date	Genre	Price
Ghostbusters	3/13/1984	Comedy	8.99
Ghostbusters 2	2/23/1986	Comedy	9.99

However, you can't expect users to modify the URL to search for a movie. In this step, UI is added to filter movies. If you added the route constraint `"{searchString?}"`, remove it.

Open the `Pages/Movies/Index.cshtml` file, and add the `<form>` markup highlighted in the following code:

```

@page
@model RazorPagesMovie.Pages.Movies.IndexModel

 @{
     ViewData["Title"] = "Index";
 }

<h2>Index</h2>

<p>
    <a asp-page="Create">Create New</a>
</p>

<form>
    <p>
        Title: <input type="text" name="SearchString">
        <input type="submit" value="Filter" />
    </p>
</form>

<table class="table">
    @*Markup removed for brevity.*@

```

The HTML `<form>` tag uses the [Form Tag Helper](#). When the form is submitted, the filter string is sent to the `Pages/Movies/Index` page. Save the changes and test the filter.

Title	Release Date	Genre	Price	
Ghostbusters	3/13/1984	Comedy	8.99	Edit   Details   Delete
Ghostbusters 2	2/23/1986	Comedy	9.99	Edit   Details   Delete

© 2017 - RazorPagesMovie

## Search by genre

Add the following highlighted properties to `Pages/Movies/Index.cshtml.cs`:

```

public class IndexModel : PageModel
{
    private readonly RazorPagesMovie.Models.MovieContext _context;

    public IndexModel(RazorPagesMovie.Models.MovieContext context)
    {
        _context = context;
    }

    public IList<Movie> Movie { get; set; }
    public SelectList Genres { get; set; }
    public string MovieGenre { get; set; }

```

The `SelectList Genres` contains the list of genres. This allows the user to select a genre from the list.

The `MovieGenre` property contains the specific genre the user selects (for example, "Western").

Update the `OnGetAsync` method with the following code:

```

// Requires using Microsoft.AspNetCore.Mvc.Rendering;
public async Task OnGetAsync(string movieGenre, string searchString)
{
    // Use LINQ to get list of genres.
    IQueryable<string> genreQuery = from m in _context.Movie
                                         orderby m.Genre
                                         select m.Genre;

    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    if (!String.IsNullOrEmpty(movieGenre))
    {
        movies = movies.Where(x => x.Genre == movieGenre);
    }
    Genres = new SelectList(await genreQuery.Distinct().ToListAsync());
    Movie = await movies.ToListAsync();
}

```

The following code is a LINQ query that retrieves all the genres from the database.

```

// Use LINQ to get list of genres.
IQueryable<string> genreQuery = from m in _context.Movie
                                         orderby m.Genre
                                         select m.Genre;

```

The `SelectList` of genres is created by projecting the distinct genres.

```
Genres = new SelectList(await genreQuery.Distinct().ToListAsync());
```

## Adding search by genre

Update `Index.cshtml` as follows:

```
@page
@model RazorPagesMovie.Pages.Movies.IndexModel

@{
    ViewData["Title"] = "Index";
}

<h2>Index</h2>

<p>
    <a asp-page="Create">Create New</a>
</p>

<form>
    <p>
        <select asp-for="MovieGenre" asp-items="Model.Genres">
            <option value="">All</option>
        </select>

        Title: <input type="text" name="SearchString">
        <input type="submit" value="Filter" />
    </p>
</form>

<table class="table">
    <thead>
```

Test the app by searching by genre, by movie title, and by both.

PREVIOUS: UPDATING THE  
PAGES

NEXT: ADDING A NEW  
FIELD

# Create a web app with ASP.NET Core MVC on macOS with Visual Studio for Mac

6/21/2018 • 2 minutes to read • [Edit Online](#)

This series of tutorials teaches you the basics of building an ASP.NET Core MVC web app using Visual Studio for Mac.

This tutorial teaches ASP.NET Core MVC web development with controllers and views. Razor Pages is a feature of the ASP.NET Core MVC framework that makes building and testing web UI easier and more productive. You can use Razor pages alongside controllers and views in the same project.

After using Razor pages, many developers prefer it over controllers and views. We recommend you try the [Razor Pages](#) tutorial before the MVC/Controller/Views version. The Razor Pages tutorial:

- Is the preferred approach for new application development.
- Is easier to follow.
- Covers more features.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub issue](#).

1. [Get started](#)
2. [Add a controller](#)
3. [Add a view](#)
4. [Add a model](#)
5. [SQLite](#)
6. [Controller methods and views](#)
7. [Add search](#)
8. [Add a new field](#)
9. [Add validation](#)
10. [Examine the Details and Delete methods](#)

# Get started with ASP.NET Core MVC and Visual Studio for Mac

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

This tutorial teaches you the basics of building an ASP.NET Core MVC web app using [Visual Studio for Mac](#).

This tutorial teaches ASP.NET Core MVC web development with controllers and views. Razor Pages is a feature of the ASP.NET Core MVC framework that makes building and testing web UI easier and more productive. You can use Razor pages alongside controllers and views in the same project.

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- Is the preferred approach for new application development.
- Is easier to follow.
- Covers more features.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub issue](#).

There are 3 versions of this tutorial:

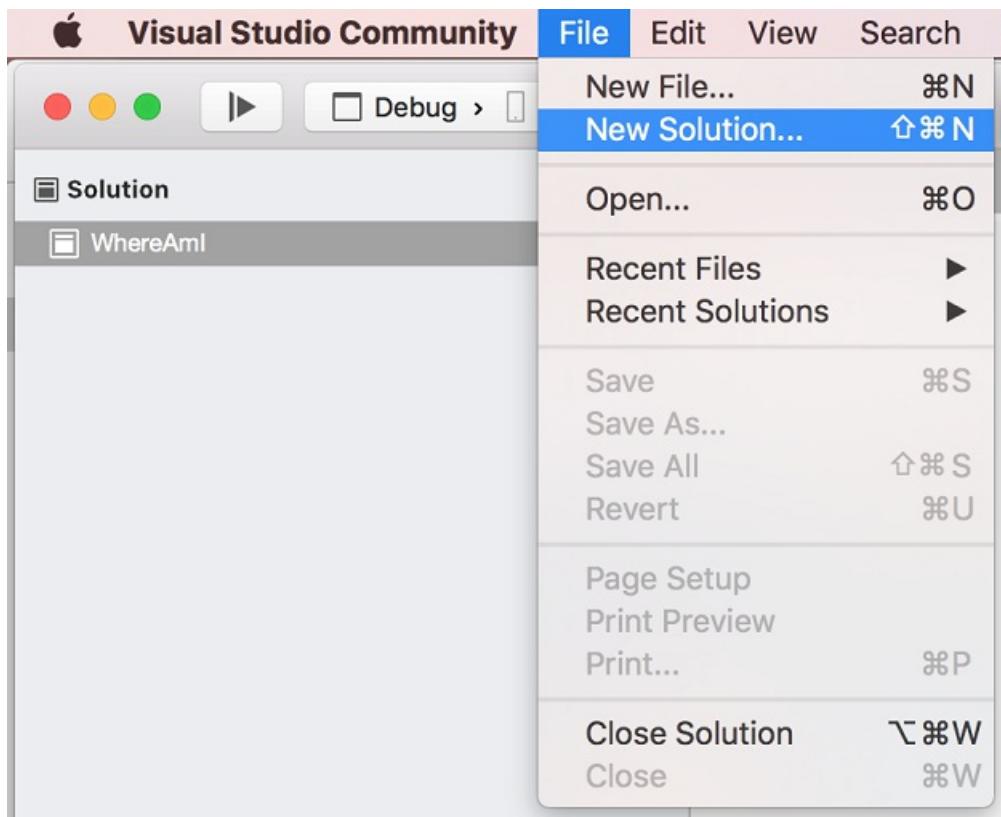
- macOS: [Build an ASP.NET Core MVC app with Visual Studio for Mac](#)
- Windows: [Build an ASP.NET Core MVC app with Visual Studio](#)
- Linux, macOS, and Windows: [Build an ASP.NET Core MVC app with Visual Studio Code](#)

## Prerequisites

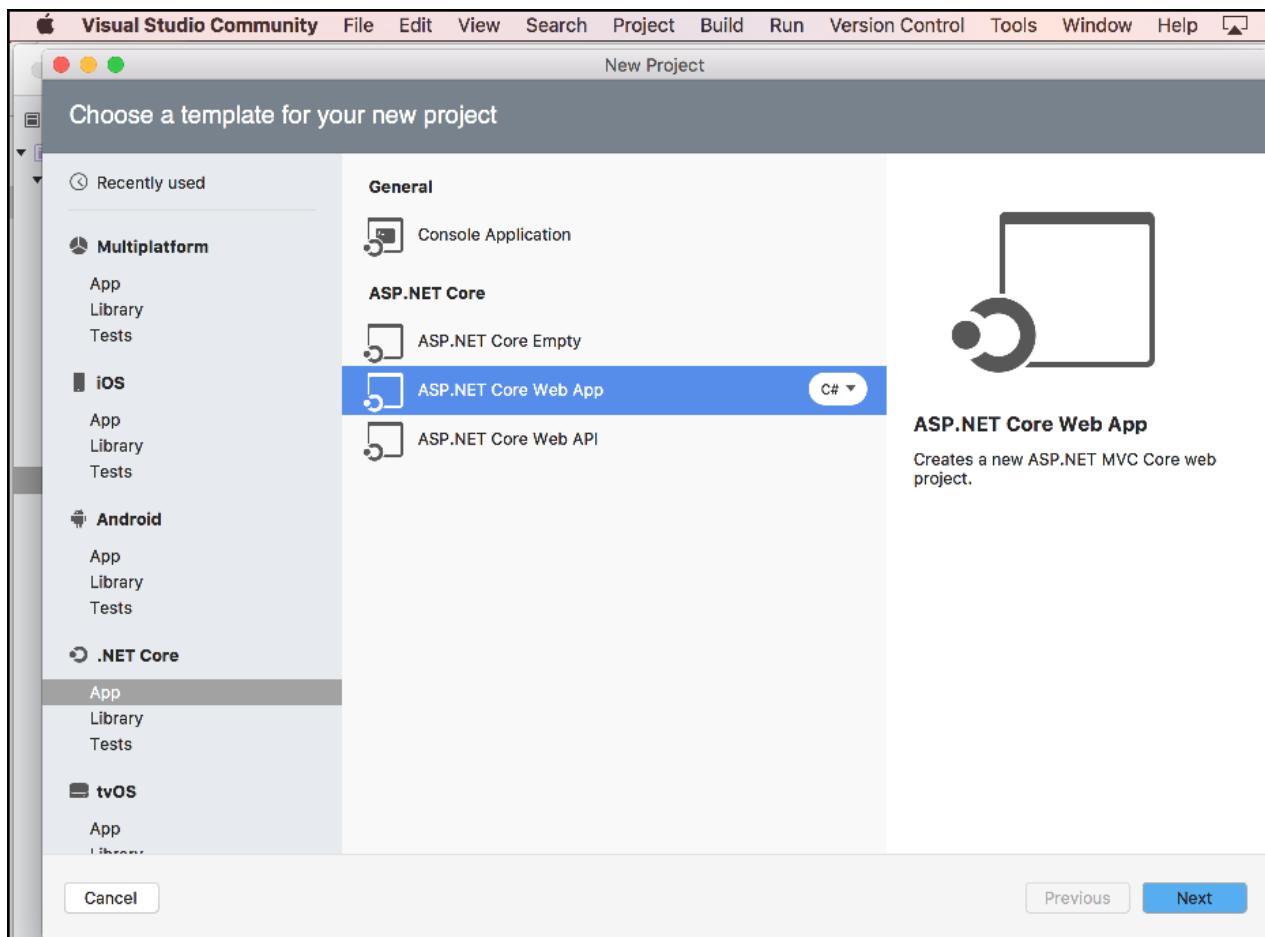
[Visual Studio for Mac](#)

## Create a web app

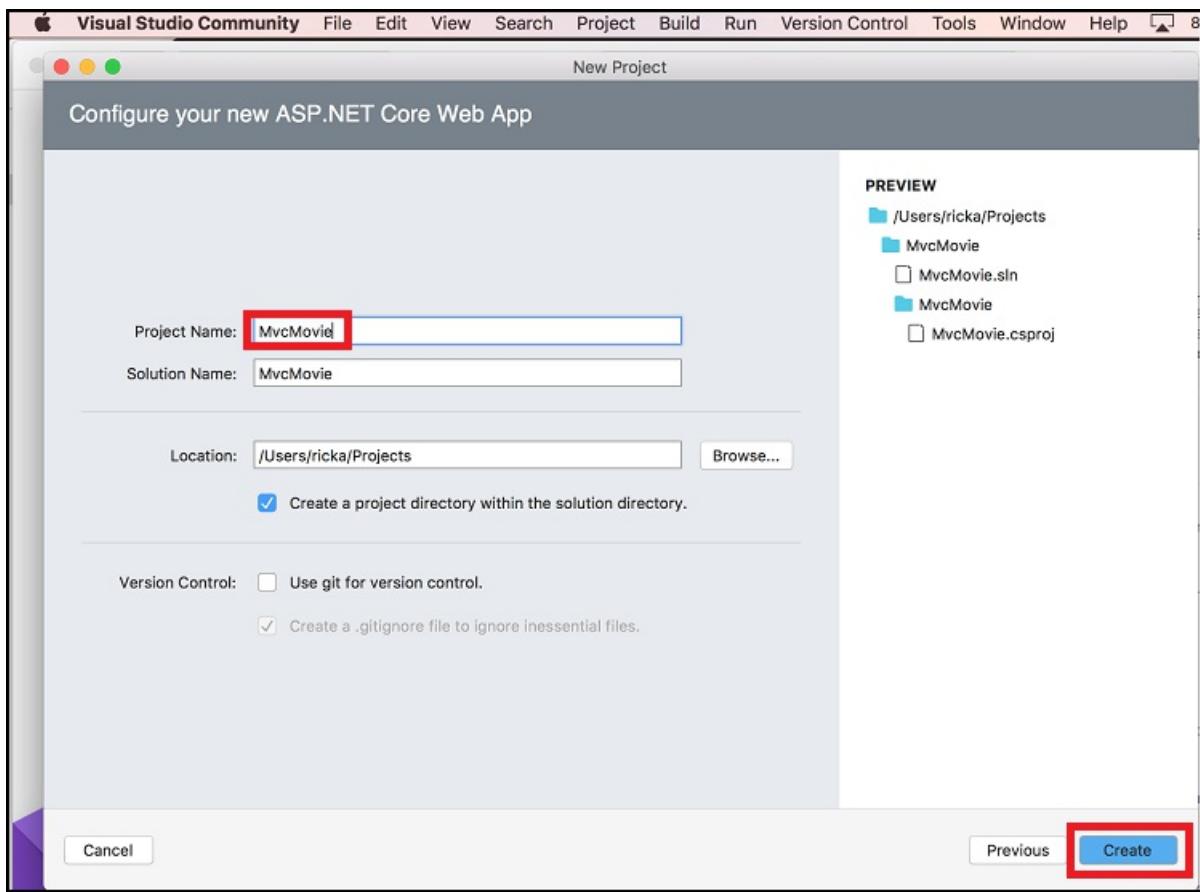
From Visual Studio, select **File > New Solution**.



Select .NET Core App > ASP.NET Core > Web App > Next.

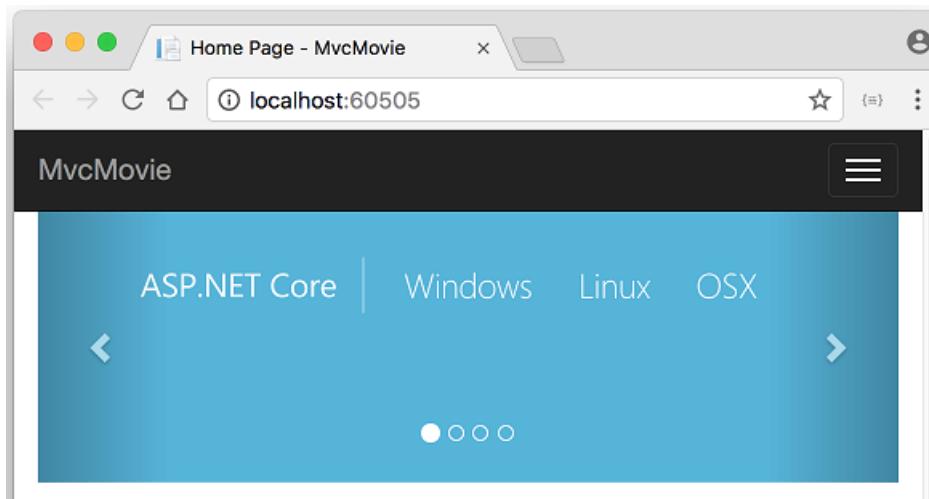


Name the project **MvcMovie**, and then select **Create**.



## Launch the app

In Visual Studio, select **Run > Start Without Debugging** to launch the app. Visual Studio starts **Kestrel**, launches a browser, and navigates to `http://localhost:port`, where *port* is a randomly chosen port number.



## Application uses

- Sample pages using ASP.NET Core MVC
- [Bower](#) for managing client-side libraries
- Theming using [Bootstrap](#)

## How to

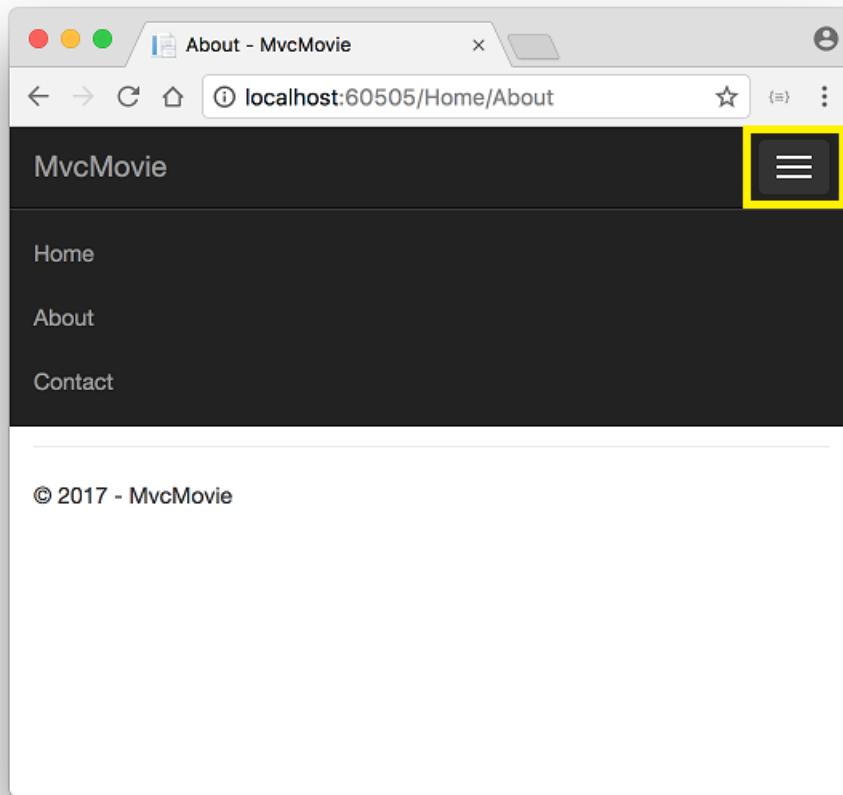
- [Add a Controller and View](#)
- [Manage User Secrets using Secret Manager](#).
- [Use logging to log a message](#).
- [Add packages using NuGet](#).
- [Add client packages using Bower](#).

- The address bar shows `localhost:port#` and not something like `example.com`. That's because `localhost` is the

standard hostname for your local computer. When Visual Studio creates a web project, a random port is used for the web server. When you run the app, you'll see a different port number.

- You can launch the app in debug or non-debug mode from the **Run** menu.

The default template gives you **Home**, **About** and **Contact** links. The browser image above doesn't show these links. Depending on the size of your browser, you might need to click the navigation icon to show them.



In the next part of this tutorial, you learn about MVC and start writing some code.

NEXT

# Add a controller to an ASP.NET Core MVC app with Visual Studio for Mac

6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

The Model-View-Controller (MVC) architectural pattern separates an app into three main components: **Model**, **View**, and **Controller**. The MVC pattern helps you create apps that are more testable and easier to update than traditional monolithic apps. MVC-based apps contain:

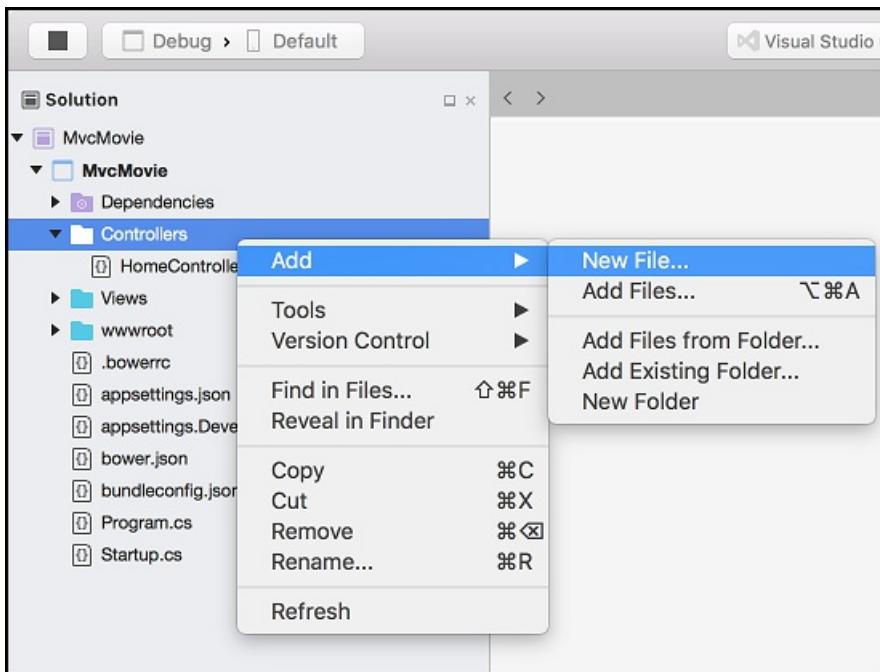
- **Models:** Classes that represent the data of the app. The model classes use validation logic to enforce business rules for that data. Typically, model objects retrieve and store model state in a database. In this tutorial, a `Movie` model retrieves movie data from a database, provides it to the view or updates it. Updated data is written to a database.
- **Views:** Views are the components that display the app's user interface (UI). Generally, this UI displays the model data.
- **Controllers:** Classes that handle browser requests. They retrieve model data and call view templates that return a response. In an MVC app, the view only displays information; the controller handles and responds to user input and interaction. For example, the controller handles route data and query-string values, and passes these values to the model. The model might use these values to query the database. For example, `http://localhost:1234/Home/About` has route data of `Home` (the controller) and `About` (the action method to call on the home controller). `http://localhost:1234/Movies/Edit/5` is a request to edit the movie with ID=5 using the movie controller. We'll talk about route data later in the tutorial.

The MVC pattern helps you create apps that separate the different aspects of the app (input logic, business logic, and UI logic), while providing a loose coupling between these elements. The pattern specifies where each kind of logic should be located in the app. The UI logic belongs in the view. Input logic belongs in the controller. Business logic belongs in the model. This separation helps you manage complexity when you build an app, because it enables you to work on one aspect of the implementation at a time without impacting the code of another. For example, you can work on the view code without depending on the business logic code.

We cover these concepts in this tutorial series and show you how to use them to build a movie app. The MVC project contains folders for the *Controllers* and *Views*.

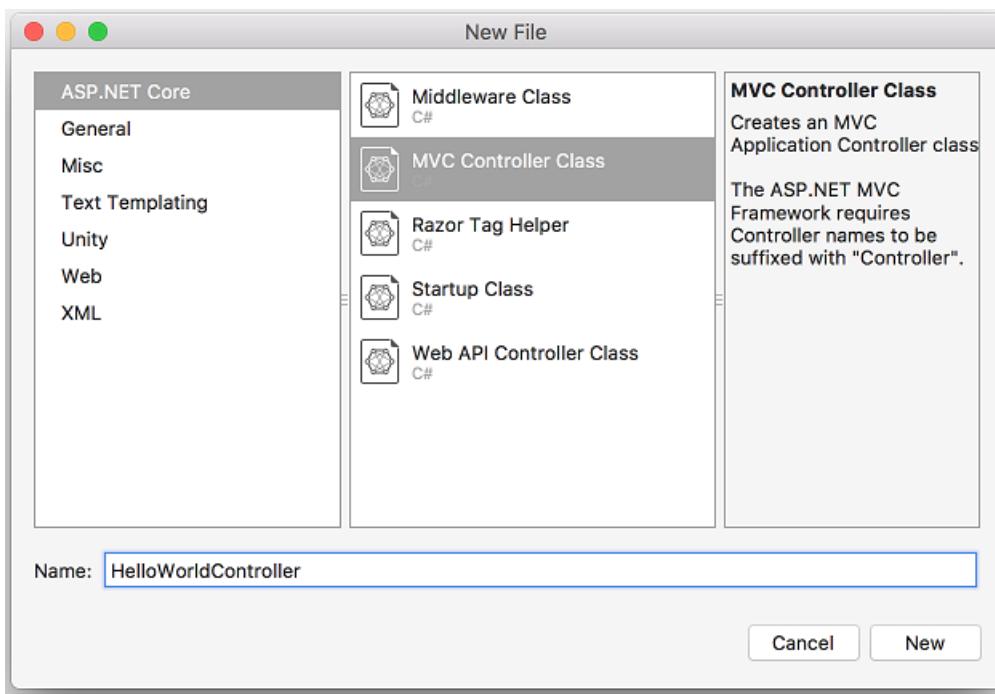
## Add a controller

In **Solution Explorer**, right-click **Controllers** > **Add** > **New File**.



Select **ASP.NET Core** and **MVC Controller Class**.

Name the controller **HelloWorldController**.



Replace the contents of *Controllers/HelloWorldController.cs* with the following:

```

using Microsoft.AspNetCore.Mvc;
using System.Text.Encodings.Web;

namespace MvcMovie.Controllers
{
    public class HelloWorldController : Controller
    {
        //
        // GET: /HelloWorld/

        public string Index()
        {
            return "This is my default action...";
        }

        //
        // GET: /HelloWorld/Welcome/

        public string Welcome()
        {
            return "This is the Welcome action method...";
        }
    }
}

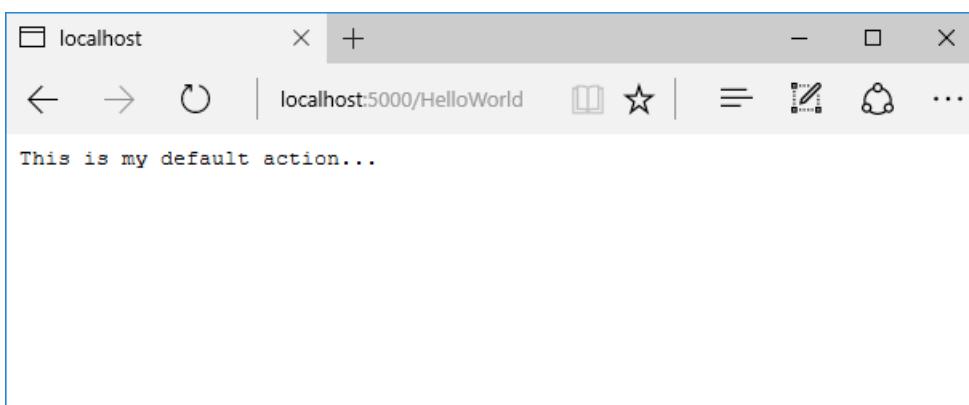
```

Every `public` method in a controller is callable as an HTTP endpoint. In the sample above, both methods return a string. Note the comments preceding each method.

An HTTP endpoint is a targetable URL in the web application, such as `http://localhost:1234/HelloWorld`, and combines the protocol used: `HTTP`, the network location of the web server (including the TCP port): `localhost:1234` and the target URI `HelloWorld`.

The first comment states this is an `HTTP GET` method that's invoked by appending `/HelloWorld/` to the base URL. The second comment specifies an `HTTP GET` method that's invoked by appending `/HelloWorld/Welcome/` to the URL. Later on in the tutorial you'll use the scaffolding engine to generate `HTTP POST` methods.

Run the app in non-debug mode and append "HelloWorld" to the path in the address bar. The `Index` method returns a string.



MVC invokes controller classes (and the action methods within them) depending on the incoming URL. The default [URL routing logic](#) used by MVC uses a format like this to determine what code to invoke:

`/[Controller]/[ActionName]/[Parameters]`

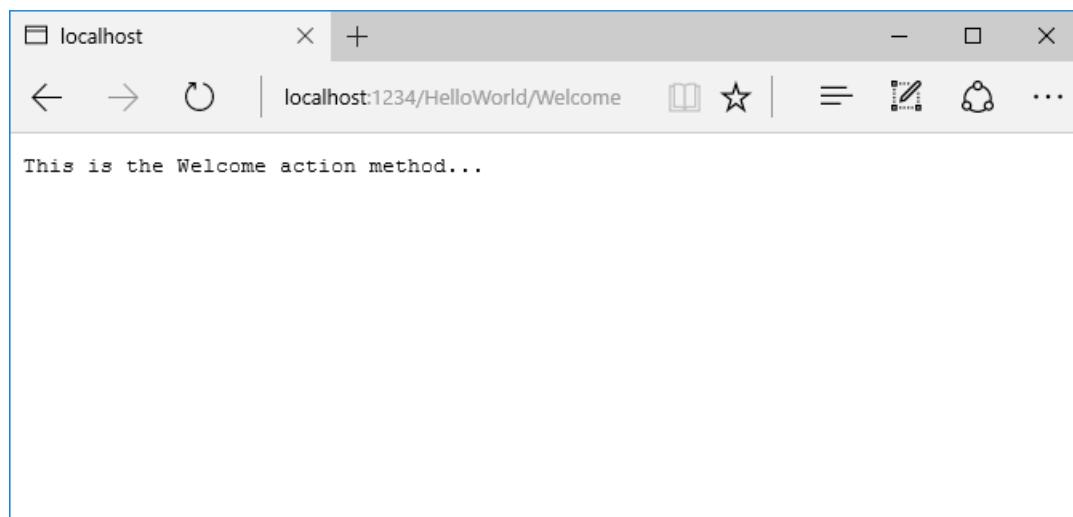
You set the format for routing in the `Configure` method in `Startup.cs` file.

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

When you run the app and don't supply any URL segments, it defaults to the "Home" controller and the "Index" method specified in the template line highlighted above.

The first URL segment determines the controller class to run. So `localhost:xxxx/HelloWorld` maps to the `HelloWorldController` class. The second part of the URL segment determines the action method on the class. So `localhost:xxxx/HelloWorld/Index` would cause the `Index` method of the `HelloWorldController` class to run. Notice that you only had to browse to `localhost:xxxx/HelloWorld` and the `Index` method was called by default. This is because `Index` is the default method that will be called on a controller if a method name isn't explicitly specified. The third part of the URL segment (`id`) is for route data. You'll see route data later on in this tutorial.

Browse to `http://localhost:xxxx/HelloWorld/Welcome`. The `Welcome` method runs and returns the string "This is the Welcome action method...". For this URL, the controller is `HelloWorld` and `Welcome` is the action method. You haven't used the `[Parameters]` part of the URL yet.



Modify the code to pass some parameter information from the URL to the controller. For example, `/HelloWorld/Welcome?name=Rick&numtimes=4`. Change the `Welcome` method to include two parameters as shown in the following code.

```
// GET: /HelloWorld/Welcome/
// Requires using System.Text.Encodings.Web;
public string Welcome(string name, int numTimes = 1)
{
    return HtmlEncoder.Default.Encode($"Hello {name}, NumTimes is: {numTimes}");
}
```

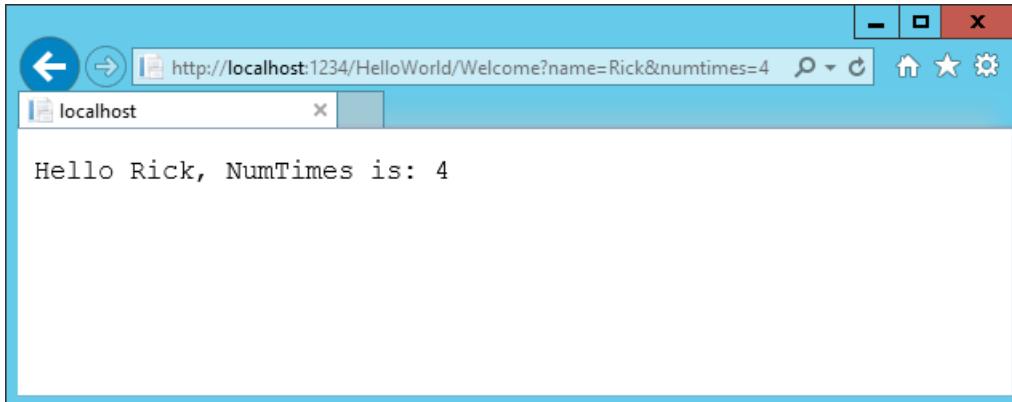
The preceding code:

- Uses the C# optional-parameter feature to indicate that the `numTimes` parameter defaults to 1 if no value is passed for that parameter.
- Uses `HtmlEncoder.Default.Encode` to protect the app from malicious input (namely JavaScript).
- Uses [Interpolated Strings](#).

Run your app and browse to:

```
http://localhost:xxxx/HelloWorld/Welcome?name=Rick&numtimes=4
```

(Replace xxxx with your port number.) You can try different values for `name` and `numtimes` in the URL. The MVC [model binding](#) system automatically maps the named parameters from the query string in the address bar to parameters in your method. See [Model Binding](#) for more information.

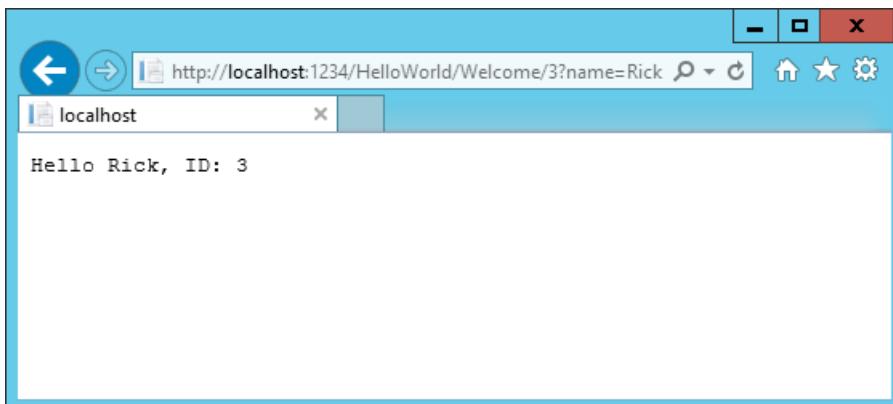


In the image above, the URL segment (`Parameters`) isn't used, the `name` and `numTimes` parameters are passed as [query strings](#). The `?` (question mark) in the above URL is a separator, and the query strings follow. The `&` character separates query strings.

Replace the `Welcome` method with the following code:

```
public string Welcome(string name, int ID = 1)
{
    return HtmlEncoder.Default.Encode($"Hello {name}, ID: {ID}");
}
```

Run the app and enter the following URL: `http://localhost:xxx/HelloWorld/Welcome/3?name=Rick`



This time the third URL segment matched the route parameter `id`. The `Welcome` method contains a parameter `id` that matched the URL template in the `MapRoute` method. The trailing `?` (in `id?`) indicates the `id` parameter is optional.

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

In these examples the controller has been doing the "VC" portion of MVC - that is, the view and controller work. The controller is returning HTML directly. Generally you don't want controllers returning HTML directly, since that becomes very cumbersome to code and maintain. Instead you typically use a separate Razor view template file to

help generate the HTML response. You do that in the next tutorial.

[PREVIOUS](#)

[NEXT](#)

# Add a view to an ASP.NET Core MVC app

6/21/2018 • 8 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section you modify the `HelloWorldController` class to use Razor view template files to cleanly encapsulate the process of generating HTML responses to a client.

You create a view template file using Razor. Razor-based view templates have a `.cshtml` file extension. They provide an elegant way to create HTML output using C#.

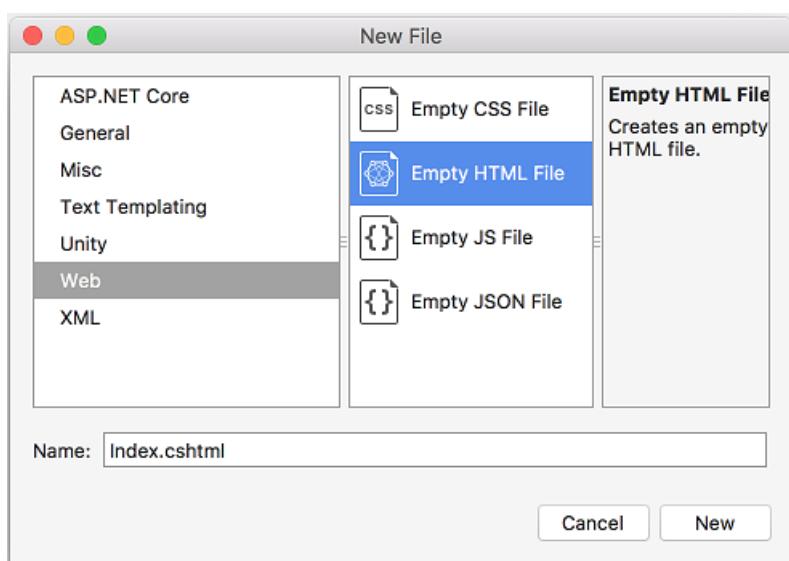
Currently the `Index` method returns a string with a message that's hard-coded in the controller class. In the `HelloWorldController` class, replace the `Index` method with the following code:

```
public IActionResult Index()
{
    return View();
}
```

The preceding code returns a `View` object. It uses a view template to generate an HTML response to the browser. Controller methods (also known as action methods) such as the `Index` method above, generally return an `IActionResult` (or a class derived from `ActionResult`), not a type like `string`.

## Add a view

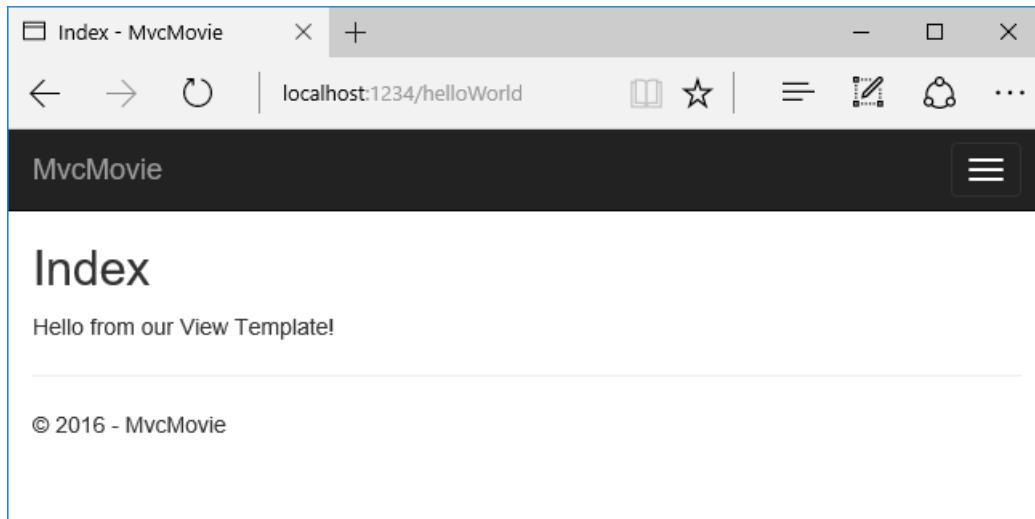
- Right click on the `Views` folder, and then **Add > New Folder** and name the folder `HelloWorld`.
- Right click on the `Views/HelloWorld` folder, and then **Add > New File**.
- In the **New File** dialog:
  - Select **Web** in the left pane.
  - Select **Empty HTML file** in the center pane.
  - Type `Index.cshtml` in the **Name** box.
  - Select **New**.



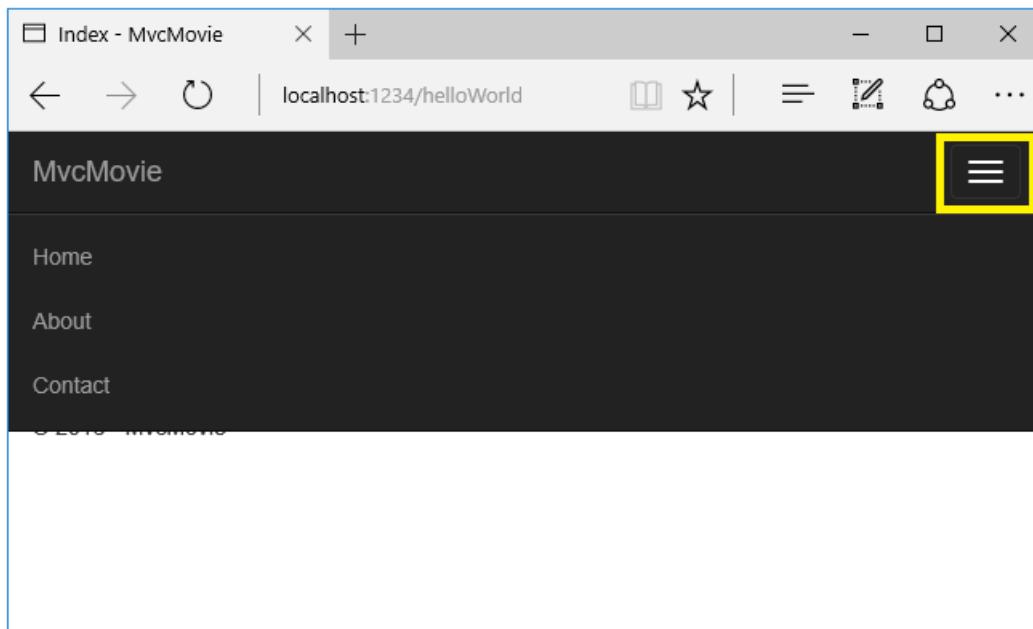
Replace the contents of the `Views/HelloWorld/Index.cshtml` Razor view file with the following:

```
@{  
    ViewData["Title"] = "Index";  
}  
  
<h2>Index</h2>  
  
<p>Hello from our View Template!</p>
```

Navigate to `http://localhost:xxxx/HelloWorld`. The `Index` method in the `HelloWorldController` didn't do much; it ran the statement `return View();`, which specified that the method should use a view template file to render a response to the browser. Because you didn't explicitly specify the name of the view template file, MVC defaulted to using the `Index.cshtml` view file in the `/Views/HelloWorld` folder. The image below shows the string "Hello from our View Template!" hard-coded in the view.



If your browser window is small (for example on a mobile device), you might need to toggle (tap) the [Bootstrap navigation button](#) in the upper right to see the **Home**, **About**, and **Contact** links.



## Changing views and layout pages

Tap the menu links (**MvcMovie**, **Home**, **About**). Each page shows the same menu layout. The menu layout is implemented in the `Views/Shared/_Layout.cshtml` file. Open the `Views/Shared/_Layout.cshtml` file.

Layout templates allow you to specify the HTML container layout of your site in one place and then apply it across multiple pages in your site. Find the `@RenderBody()` line. `RenderBody` is a placeholder where all the view-specific pages you create show up, *wrapped* in the layout page. For example, if you select the **About** link, the **Views/Home/About.cshtml** view is rendered inside the `RenderBody` method.

## Change the title and menu link in the layout file

In the title element, change `MvcMovie` to `Movie App`. Change the anchor text in the layout template from `MvcMovie` to `Movie App` and the controller from `Home` to `Movies` as highlighted below:

```
@inject Microsoft.ApplicationInsights.AspNetCore.JavaScriptSnippet JavaScriptSnippet
<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>@ViewData["Title"] - Movie App</title>

    <environment names="Development">
        <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />
        <link rel="stylesheet" href="~/css/site.css" />
    </environment>
    <environment names="Staging,Production">
        <link rel="stylesheet" href="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/css/bootstrap.min.css"
              asp-fallback-href="~/lib/bootstrap/dist/css/bootstrap.min.css"
              asp-fallback-test-class="sr-only" asp-fallback-test-property="position" asp-fallback-test-
              value="absolute" />
        <link rel="stylesheet" href="~/css/site.min.css" asp-append-version="true" />
    </environment>
    @Html.Raw(JavaScriptSnippet.FullScript)
</head>
<body>
    <nav class="navbar navbar-inverse navbar-fixed-top">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-
collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a asp-area="" asp-controller="Movies" asp-action="Index" class="navbar-brand">Movie App</a>
            </div>
            <div class="navbar-collapse collapse">
                <ul class="nav navbar-nav">
                    <li><a asp-area="" asp-controller="Home" asp-action="Index">Home</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="About">About</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="Contact">Contact</a></li>
                </ul>
            </div>
        </div>
    </nav>
    <div class="container body-content">
        @RenderBody()
        <hr />
        <footer>
            <p>&copy; 2017 - MvcMovie</p>
        </footer>
    </div>

    <environment names="Development">
        <script src="~/lib/jquery/dist/jquery.js"></script>
        <script src="~/lib/bootstrap/dist/js/bootstrap.js"></script>
        <script src="~/js/site.js" asp-append-version="true"></script>
    </environment>

```

```

</environment>
<environment names="Staging,Production">
    <script src="https://ajax.aspnetcdn.com/ajax/jquery/jquery-2.2.0.min.js"
        asp-fallback-src="~/lib/jquery/dist/jquery.min.js"
        asp-fallback-test="window.jQuery"
        crossorigin="anonymous"
        integrity="sha384-K+ctZQ+LL8q6tP7I94W+qzQsfRV2a+AfhII9k8z8l9ggpc8X+Ytst4yBo/hH+8Fk">
    </script>
    <script src="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/bootstrap.min.js"
        asp-fallback-src="~/lib/bootstrap/dist/js/bootstrap.min.js"
        asp-fallback-test="window.jQuery && window.jQuery.fn && window.jQuery.fn.modal"
        crossorigin="anonymous"
        integrity="sha384-sh384-Tc5IQib027qvjSMfHjOMaLkfUWxZxUPnCJA712mCWNIPG9mGCD8wGNICPD7Txa">
    </script>
    <script src="~/js/site.min.js" asp-append-version="true"></script>
</environment>

    @RenderSection("Scripts", required: false)
</body>
</html>

```

```

@inject Microsoft.ApplicationInsights.AspNetCore.JavaScriptSnippet JavaScriptSnippet
<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>@ ViewData["Title"] - Movie App</title>

    <environment names="Development">
        <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />
        <link rel="stylesheet" href="~/css/site.css" />
    </environment>
    <environment names="Staging,Production">
        <link rel="stylesheet" href="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/css/bootstrap.min.css"
            asp-fallback-href="~/lib/bootstrap/dist/css/bootstrap.min.css"
            asp-fallback-test-class="sr-only" asp-fallback-test-property="position" asp-fallback-test-value="absolute" />
        <link rel="stylesheet" href="~/css/site.min.css" asp-append-version="true" />
    </environment>
    @Html.Raw(JavaScriptSnippet.FullScript)
</head>
<body>
    <nav class="navbar navbar-inverse navbar-fixed-top">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a asp-area="" asp-controller="Movies" asp-action="Index" class="navbar-brand">Movie App</a>
            </div>
            <div class="navbar-collapse collapse">
                <ul class="nav navbar-nav">
                    <li><a asp-area="" asp-controller="Home" asp-action="Index">Home</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="About">About</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="Contact">Contact</a></li>
                </ul>
            </div>
        </div>
    </nav>
    <div class="container body-content">
        @RenderBody()
        <hr />
    </div>

```

```

<+footer>
    <p>&copy; 2017 - MvcMovie</p>
</footer>
</div>

<environment names="Development">
    <script src="~/lib/jquery/dist/jquery.js"></script>
    <script src="~/lib/bootstrap/dist/js/bootstrap.js"></script>
    <script src="~/js/site.js" asp-append-version="true"></script>
</environment>
<environment names="Staging,Production">
    <script src="https://ajax.aspnetcdn.com/ajax/jquery/jquery-2.2.0.min.js"
        asp-fallback-src="~/lib/jquery/dist/jquery.min.js"
        asp-fallback-test="window.jQuery"
        crossorigin="anonymous"
        integrity="sha384-K+ctZQ+LL8q6tP7I94W+qzQsfRV2a+AfhII9k8z8l9ggpc8X+Ytst4yBo/hH+8Fk">
    </script>
    <script src="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/bootstrap.min.js"
        asp-fallback-src="~/lib/bootstrap/dist/js/bootstrap.min.js"
        asp-fallback-test="window.jQuery && window.jQuery.fn && window.jQuery.fn.modal"
        crossorigin="anonymous"
        integrity="sha384-Tc5IQib027qvjSMfHjOMaLkfUWVxZxUPnCJA7l2mCWNIPG9mGCD8wGNICPD7Txa">
    </script>
    <script src="~/js/site.min.js" asp-append-version="true"></script>
</environment>

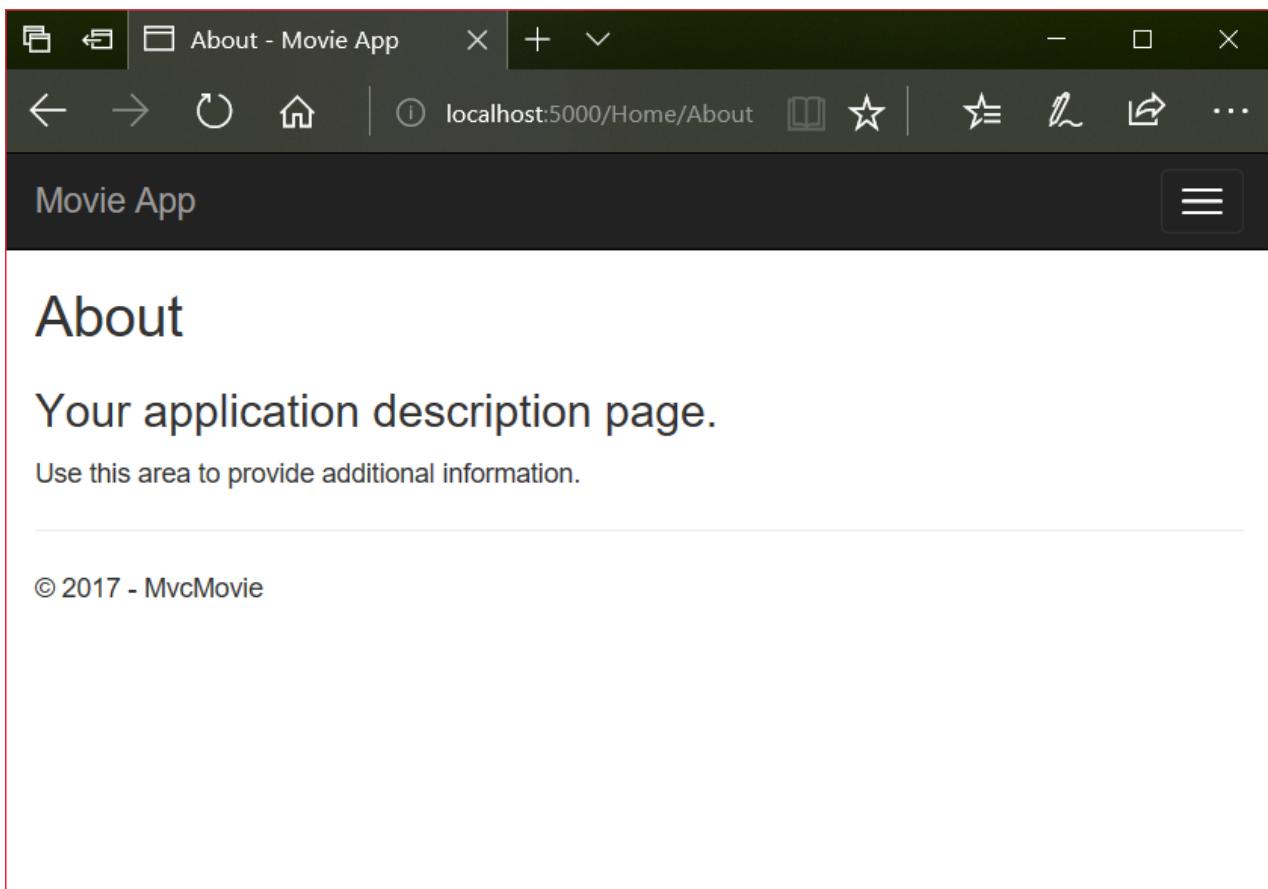
@RenderSection("Scripts", required: false)
</body>
</html>

```

### WARNING

We haven't implemented the `Movies` controller yet, so if you click on that link, you'll get a 404 (Not found) error.

Save your changes and tap the **About** link. Notice how the title on the browser tab now displays **About - Movie App** instead of **About - Mvc Movie**:



Tap the **Contact** link and notice that the title and anchor text also display **Movie App**. We were able to make the change once in the layout template and have all pages on the site reflect the new link text and new title.

Examine the *Views/\_ViewStart.cshtml* file:

```
@{  
    Layout = "_Layout";  
}
```

The *Views/\_ViewStart.cshtml* file brings in the *Views/Shared/\_Layout.cshtml* file to each view. You can use the `Layout` property to set a different layout view, or set it to `null` so no layout file will be used.

Change the title of the `Index` view.

Open *Views/HelloWorld/Index.cshtml*. There are two places to make a change:

- The text that appears in the title of the browser.
- The secondary header (`<h2>` element).

You'll make them slightly different so you can see which bit of code changes which part of the app.

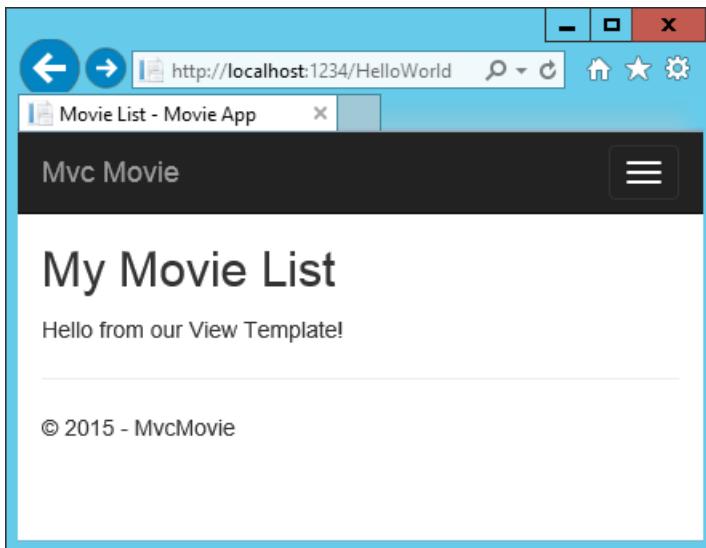
```
@{  
    ViewData["Title"] = "Movie List";  
}  
  
<h2>My Movie List</h2>  
  
<p>Hello from our View Template!</p>
```

`ViewData["Title"] = "Movie List";` in the code above sets the `Title` property of the `ViewData` dictionary to "Movie List". The `Title` property is used in the `<title>` HTML element in the layout page:

```
<title>@ViewData["Title"] - Movie App</title>
```

Save your change and navigate to `http://localhost:xxxx/HelloWorld`. Notice that the browser title, the primary heading, and the secondary headings have changed. (If you don't see changes in the browser, you might be viewing cached content. Press **Ctrl+F5** in your browser to force the response from the server to be loaded.) The browser title is created with `ViewData["Title"]` we set in the *Index.cshtml* view template and the additional "-Movie App" added in the layout file.

Also notice how the content in the *Index.cshtml* view template was merged with the *Views/Shared/\_Layout.cshtml* view template and a single HTML response was sent to the browser. Layout templates make it really easy to make changes that apply across all of the pages in your application. To learn more see [Layout](#).



Our little bit of "data" (in this case the "Hello from our View Template!" message) is hard-coded, though. The MVC application has a "V" (view) and you've got a "C" (controller), but no "M" (model) yet.

## Passing Data from the Controller to the View

Controller actions are invoked in response to an incoming URL request. A controller class is where you write the code that handles the incoming browser requests. The controller retrieves data from a data source and decides what type of response to send back to the browser. View templates can be used from a controller to generate and format an HTML response to the browser.

Controllers are responsible for providing the data required in order for a view template to render a response. A best practice: View templates should **not** perform business logic or interact with a database directly. Rather, a view template should work only with the data that's provided to it by the controller. Maintaining this "separation of concerns" helps keep your code clean, testable, and maintainable.

Currently, the `Welcome` method in the `HelloWorldController` class takes a `name` and a `ID` parameter and then outputs the values directly to the browser. Rather than have the controller render this response as a string, change the controller to use a view template instead. The view template generates a dynamic response, which means that appropriate bits of data must be passed from the controller to the view in order to generate the response. Do this by having the controller put the dynamic data (parameters) that the view template needs in a `ViewData` dictionary that the view template can then access.

Return to the `HelloWorldController.cs` file and change the `Welcome` method to add a `Message` and `NumTimes` value to the `ViewData` dictionary. The `ViewData` dictionary is a dynamic object, which means you can put whatever you want in to it; the `ViewData` object has no defined properties until you put something inside it. The [MVC model binding system](#) automatically maps the named parameters (`name` and `numTimes`) from the query string in the address bar to parameters in your method. The complete `HelloWorldController.cs` file looks like this:

```

using Microsoft.AspNetCore.Mvc;
using System.Text.Encodings.Web;

namespace MvcMovie.Controllers
{
    public class HelloWorldController : Controller
    {
        public IActionResult Index()
        {
            return View();
        }

        public IActionResult Welcome(string name, int numTimes = 1)
        {
            ViewData["Message"] = "Hello " + name;
            ViewData["NumTimes"] = numTimes;

            return View();
        }
    }
}

```

The `ViewData` dictionary object contains data that will be passed to the view.

Create a Welcome view template named `Views/HelloWorld/Welcome.cshtml`.

You'll create a loop in the `Welcome.cshtml` view template that displays "Hello" `NumTimes`. Replace the contents of `Views/HelloWorld/Welcome.cshtml` with the following:

```

@{
    ViewData["Title"] = "Welcome";
}

<h2>Welcome</h2>

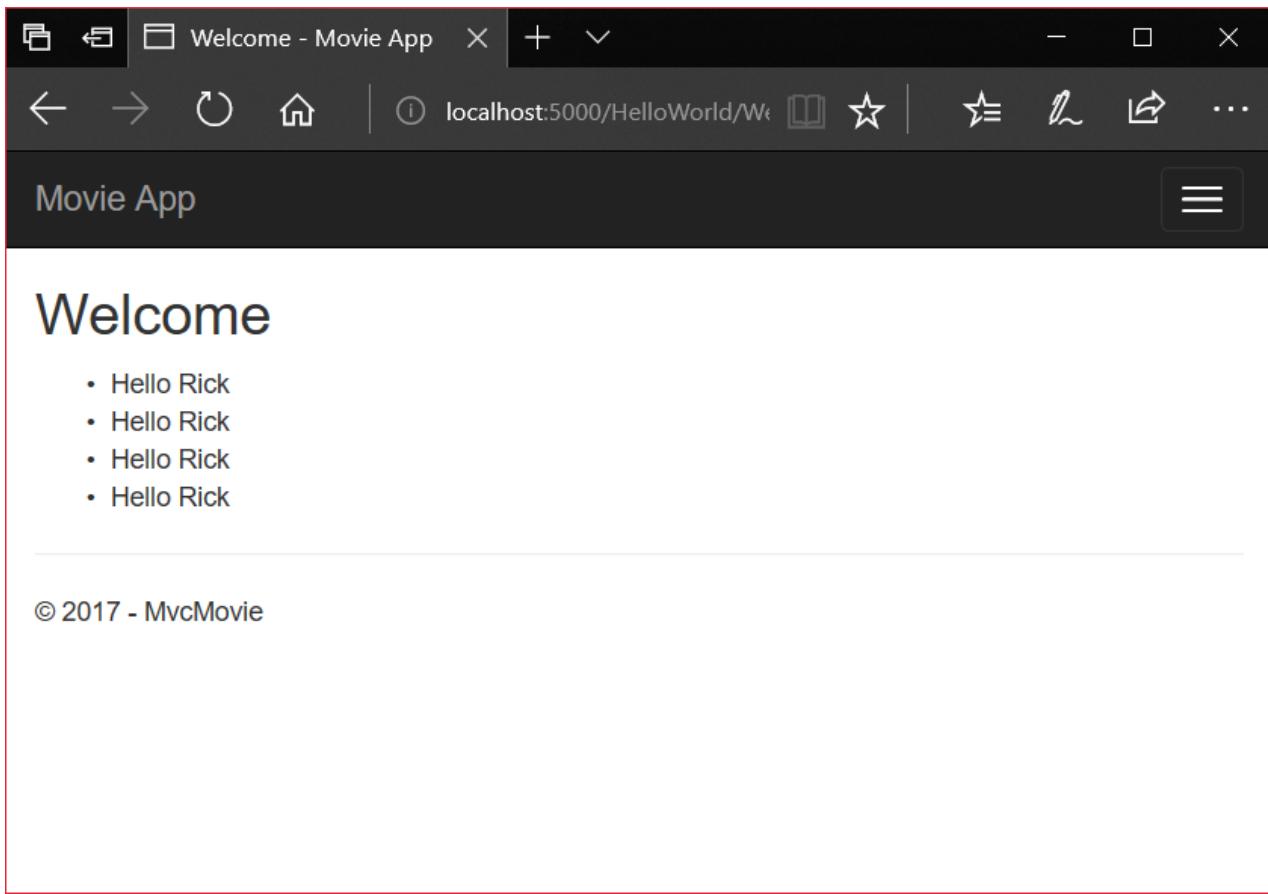
<ul>
    @for (int i = 0; i < (int)ViewData["NumTimes"]; i++)
    {
        <li>@ViewData["Message"]</li>
    }
</ul>

```

Save your changes and browse to the following URL:

`http://localhost:xxxx/HelloWorld/Welcome?name=Rick&numtimes=4`

Data is taken from the URL and passed to the controller using the [MVC model binder](#). The controller packages the data into a `ViewData` dictionary and passes that object to the view. The view then renders the data as HTML to the browser.



In the sample above, we used the `ViewData` dictionary to pass data from the controller to a view. Later in the tutorial, we will use a view model to pass data from a controller to a view. The view model approach to passing data is generally much preferred over the `ViewData` dictionary approach. See [ViewModel vs ViewData vs ViewBag vs TempData vs Session in MVC](#) for more information.

Well, that was a kind of an "M" for model, but not the database kind. Let's take what we've learned and create a database of movies.

[PREVIOUS](#) [NEXT](#)

# Add a model to an ASP.NET Core MVC app

6/26/2018 • 5 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Tom Dykstra](#)

In this section, you'll add some classes for managing movies in a database. These classes will be the "**Model**" part of the **MVC** app.

You use these classes with [Entity Framework Core](#) (EF Core) to work with a database. EF Core is an object-relational mapping (ORM) framework that simplifies the data access code that you have to write. [EF Core supports many database engines](#).

The model classes you'll create are known as POCO classes (from "plain-old CLR objects") because they don't have any dependency on EF Core. They just define the properties of the data that will be stored in the database.

In this tutorial you'll write the model classes first, and EF Core will create the database. An alternate approach not covered here is to generate model classes from an already-existing database. For information about that approach, see [ASP.NET Core - Existing Database](#).

## Add a data model class

- Right-click the *Models* folder, and then select **Add > New File**.
- In the **New File** dialog:
  - Select **General** in the left pane.
  - Select **Empty Class** in the center pain.
  - Name the class **Movie** and select **New**.

Add the following properties to the `Movie` class:

```
using System;

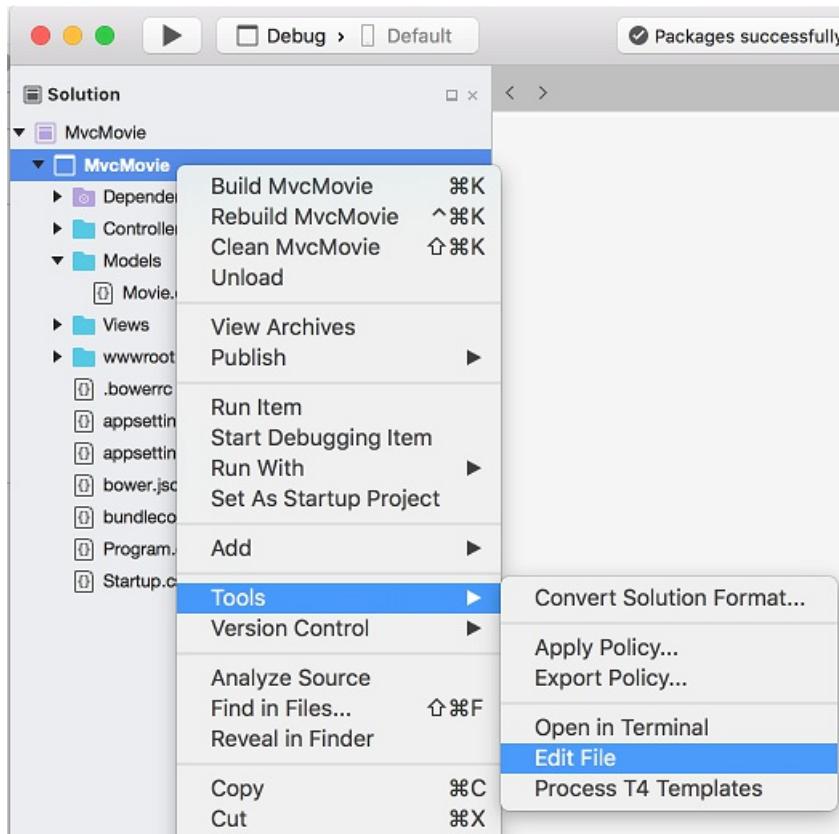
namespace MvcMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}
```

The `ID` field is required by the database for the primary key.

Build the project to verify you don't have any errors. You now have a **Model** in your **MVC** app.

## Prepare the project for scaffolding

- Right click on the project file, and then select **Tools > Edit File**.



- Add the following highlighted NuGet packages to the *MvcMovie.csproj* file:

```
<Project Sdk="Microsoft.NET.Sdk.Web">
<PropertyGroup>
    <TargetFramework>netcoreapp2.0</TargetFramework>
</PropertyGroup>
<ItemGroup>
    <PackageReference Include="Microsoft.AspNetCore.All" Version="2.0.0" />
    <PackageReference Include="Microsoft.VisualStudio.Web.CodeGeneration.Design" Version="2.0.0" />
</ItemGroup>
<ItemGroup>
    <DotNetCliToolReference Include="Microsoft.EntityFrameworkCore.Tools.DotNet" Version="2.0.0" />
    <DotNetCliToolReference Include="Microsoft.VisualStudio.Web.CodeGeneration.Tools" Version="2.0.0" />
</ItemGroup>
</Project>
```

- Save the file.
- Create a *Models/MvcMovieContext.cs* file and add the following `MvcMovieContext` class:

```
using Microsoft.EntityFrameworkCore;

namespace MvcMovie.Models
{
    public class MvcMovieContext : DbContext
    {
        public MvcMovieContext (DbContextOptions<MvcMovieContext> options)
            : base(options)
        {
        }

        public DbSet<MvcMovie.Models.Movie> Movie { get; set; }
    }
}
```

- Open the *Startup.cs* file and add two usings:

```
using Microsoft.EntityFrameworkCore;
using MvcMovie.Models;

namespace MvcMovie
{
    public class Startup
    {
```

- Add the database context to the *Startup.cs* file:

```
public void ConfigureServices(IServiceCollection services)
{
    // Add framework services.
    services.AddMvc();

    services.AddDbContext<MvcMovieContext>(options =>
        options.UseSqlite("Data Source=MvcMovie.db"));

}
```

This tells Entity Framework which model classes are included in the data model. You're defining one *entity set* of Movie objects, which will be represented in the database as a Movie table.

- Build the project to verify there are no errors.

## Scaffold the MovieController

Open a terminal window in the project folder and run the following commands:

```
dotnet restore
dotnet aspnet-codegenerator controller -name MoviesController -m Movie -dc MvcMovieContext --
relativeFolderPath Controllers --useDefaultLayout --referenceScriptLibraries
```

If you get the error `No executable found matching command "dotnet-aspnet-codegenerator"`, verify :

- You are in the project directory. The project directory has the *Program.cs*, *Startup.cs* and *.csproj* files.
- Your dotnet version is 1.1 or higher. Run `dotnet` to get the version.
- You have added the `<DotNetCliToolReference>` element to the [MvcMovie.csproj file](#).

The scaffolding engine creates the following:

- A movies controller (*Controllers/MoviesController.cs*)
- Razor view files for Create, Delete, Details, Edit and Index pages (*Views/Movies/\*.cshtml*)

The automatic creation of **CRUD** (create, read, update, and delete) action methods and views is known as *scaffolding*. You'll soon have a fully functional web application that lets you manage a movie database.

### Add the files to Visual Studio

- Add the *MovieController.cs* file to the Visual Studio project:
  - Right-click on the *Controllers* folder and select **Add > Add Files**.
  - Select the *MovieController.cs* file.
- Add the *Movies* folder and views:
  - Right-click on the *Views* folder and select **Add > Add Existing Folder**.

- Navigate to the *Views* folder, select *Views\Movies*, and then select **Open**.
- In the **Select files to add from Movies** dialog, select **Include All**, and then **OK**.

## Perform initial migration

From the command line, run the following .NET Core CLI commands:

```
dotnet ef migrations add InitialCreate  
dotnet ef database update
```

The `dotnet ef migrations add InitialCreate` command generates code to create the initial database schema. The schema is based on the model specified in the `DbContext` (In the *Models/MvcMovieContext.cs* file). The `Initial` argument is used to name the migrations. You can use any name, but by convention you choose a name that describes the migration. See [Introduction to migrations](#) for more information.

The `dotnet ef database update` command runs the `Up` method in the *Migrations/<time-stamp>\_InitialCreate.cs* file, which creates the database.

## Test the app

- Run the app and tap the **Mvc Movie** link.
- Tap the **Create New** link and create a movie.

The screenshot shows a browser window titled "Create - Movie App" with the URL "localhost:1234/Movies/". The page is titled "MvcMovie" and has a header "Create". The form is for creating a "Movie" with fields: "Title" (Conan), "Release Date" (3/3/2017), "Genre" (Comedy), and "Price" (1.99). A "Create" button is at the bottom.

- You may not be able to enter decimal points or commas in the `Price` field. To support [jQuery validation](#) for non-English locales that use a comma (",") for a decimal point, and non US-English date formats, you must take steps to globalize your app. See <https://github.com/aspnet/Docs/issues/4076> and [Additional resources](#) for more information. For now, just enter whole numbers like 10.
- In some locales you need to specify the date format. See the highlighted code below.

```
using System;
using System.ComponentModel.DataAnnotations;

namespace MvcMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}
```

We'll talk about `DataAnnotations` later in the tutorial.

Tapping **Create** causes the form to be posted to the server, where the movie information is saved in a database. The app redirects to the /Movies URL, where the newly created movie information is displayed.

Index

Create New

Title	Release Date	Genre	Price
Conan	3/3/2017	Comedy	\$1.99

© 2017 - MvcMovie

Create a couple more movie entries. Try the **Edit**, **Details**, and **Delete** links, which are all functional.

You now have a database and pages to display, edit, update and delete data. In the next tutorial, we'll work with the database.

## Additional resources

- [Tag Helpers](#)
- [Globalization and localization](#)

[PREVIOUS ADDING A](#)

[VIEW](#)

[NEXT WORKING WITH](#)

[SQL](#)

# Work with SQLite in an ASP.NET Core MVC app

6/26/2018 • 2 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

The `MvcMovieContext` object handles the task of connecting to the database and mapping `Movie` objects to database records. The database context is registered with the [Dependency Injection](#) container in the `ConfigureServices` method in the `Startup.cs` file:

```
public void ConfigureServices(IServiceCollection services)
{
    // Add framework services.
    services.AddMvc();

    services.AddDbContext<MvcMovieContext>(options =>
        options.UseSqlite("Data Source=MvcMovie.db"));

}
```

## SQLite

The [SQLite](#) website states:

SQLite is a self-contained, high-reliability, embedded, full-featured, public-domain, SQL database engine.  
SQLite is the most used database engine in the world.

There are many third party tools you can download to manage and view a SQLite database. The image below is from [DB Browser for SQLite](#). If you have a favorite SQLite tool, leave a comment on what you like about it.

The screenshot shows the DB Browser for SQLite interface with the following details:

- Toolbar:** New Database, Open Database, Write Changes, Revert Changes.
- Tab Bar:** Database Structure (selected), Browse Data, Edit Pragmas, Execute SQL.
- Sub-Toolbar:** Create Table, Create Index, Modify Table, Delete Table.
- Table List:**
  - Tables (3):**
    - Movie:** Contains columns ID (INTEGER), Genre (TEXT), Price (TEXT), ReleaseDate (TEXT), and Title (TEXT).
    - \_\_EFMigrationsHistory:** Contains column MigrationId (TEXT).
    - sqlite\_sequence:** Contains columns name (TEXT) and seq (INTEGER).
  - Indices (1):** sqlite\_autoindex\_\_EFMigrationsHis...
  - Views (0):** None.
  - Triggers (0):** None.
- Bottom Right:** UTF-8 encoding indicator.

## Seed the database

Create a new class named `SeedData` in the *Models* folder. Replace the generated code with the following:

```

using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using System;
using System.Linq;

namespace MvcMovie.Models
{
    public static class SeedData
    {
        public static void Initialize(IServiceProvider serviceProvider)
        {
            using (var context = new MvcMovieContext(
                serviceProvider.GetRequiredService<DbContextOptions<MvcMovieContext>>()))
            {
                // Look for any movies.
                if (context.Movie.Any())
                {
                    return; // DB has been seeded
                }

                context.Movie.AddRange(
                    new Movie
                    {
                        Title = "When Harry Met Sally",
                        ReleaseDate = DateTime.Parse("1989-1-11"),
                        Genre = "Romantic Comedy",
                        Price = 7.99M
                    },
                    new Movie
                    {
                        Title = "Ghostbusters ",
                        ReleaseDate = DateTime.Parse("1984-3-13"),
                        Genre = "Comedy",
                        Price = 8.99M
                    },
                    new Movie
                    {
                        Title = "Ghostbusters 2",
                        ReleaseDate = DateTime.Parse("1986-2-23"),
                        Genre = "Comedy",
                        Price = 9.99M
                    },
                    new Movie
                    {
                        Title = "Rio Bravo",
                        ReleaseDate = DateTime.Parse("1959-4-15"),
                        Genre = "Western",
                        Price = 3.99M
                    }
                );
                context.SaveChanges();
            }
        }
    }
}

```

If there are any movies in the DB, the seed initializer returns.

```
if (context.Movie.Any())
{
    return; // DB has been seeded.
}
```

## Add the seed initializer

Add the seed initializer to the `Main` method in the `Program.cs` file:

```
using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;
using System;
using Microsoft.EntityFrameworkCore;
using MvcMovie.Models;
using MvcMovie;

namespace MvcMovie
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = CreateWebHostBuilder(args).Build();

            using (var scope = host.Services.CreateScope())
            {
                var services = scope.ServiceProvider;

                try
                {
                    var context = services.GetRequiredService<MvcMovieContext>();
                    context.Database.Migrate();
                    SeedData.Initialize(services);
                }
                catch (Exception ex)
                {
                    var logger = services.GetRequiredService<ILogger<Program>>();
                    logger.LogError(ex, "An error occurred seeding the DB.");
                }
            }

            host.Run();
        }

        public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>();
    }
}
```

```

using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;
using MvcMovie.Models;
using System;

namespace MvcMovie
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = BuildWebHost(args);

            using (var scope = host.Services.CreateScope())
            {
                var services = scope.ServiceProvider;

                try
                {
                    // Requires using MvcMovie.Models;
                    SeedData.Initialize(services);
                }
                catch (Exception ex)
                {
                    var logger = services.GetRequiredService<ILogger<Program>>();
                    logger.LogError(ex, "An error occurred seeding the DB.");
                }
            }

            host.Run();
        }

        public static IWebHost BuildWebHost(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>()
                .Build();
    }
}

```

## Test the app

Delete all the records in the DB (So the seed method will run). Stop and start the app to seed the database.

The app shows the seeded data.

A screenshot of a Microsoft Edge browser window. The title bar says "Ricka - Movie App". The address bar shows "localhost:5000/Movies". The main content area has a dark header with "MvcMovie" and a menu icon. Below it, a table lists four movies:

Title	ReleaseDate	Genre	Price	
When Harry Met Sally	1/11/1989 12:00:00 AM	Romantic Comedy	7.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Ghostbusters	3/13/1984 12:00:00 AM	Comedy	8.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Ghostbusters 2	2/23/1986 12:00:00 AM	Comedy	9.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Rio Bravo	4/15/1959 12:00:00 AM	Western	3.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

At the bottom left, it says "© 2017 - MvcMovie".

[PREVIOUS - ADD A  
MODEL](#)

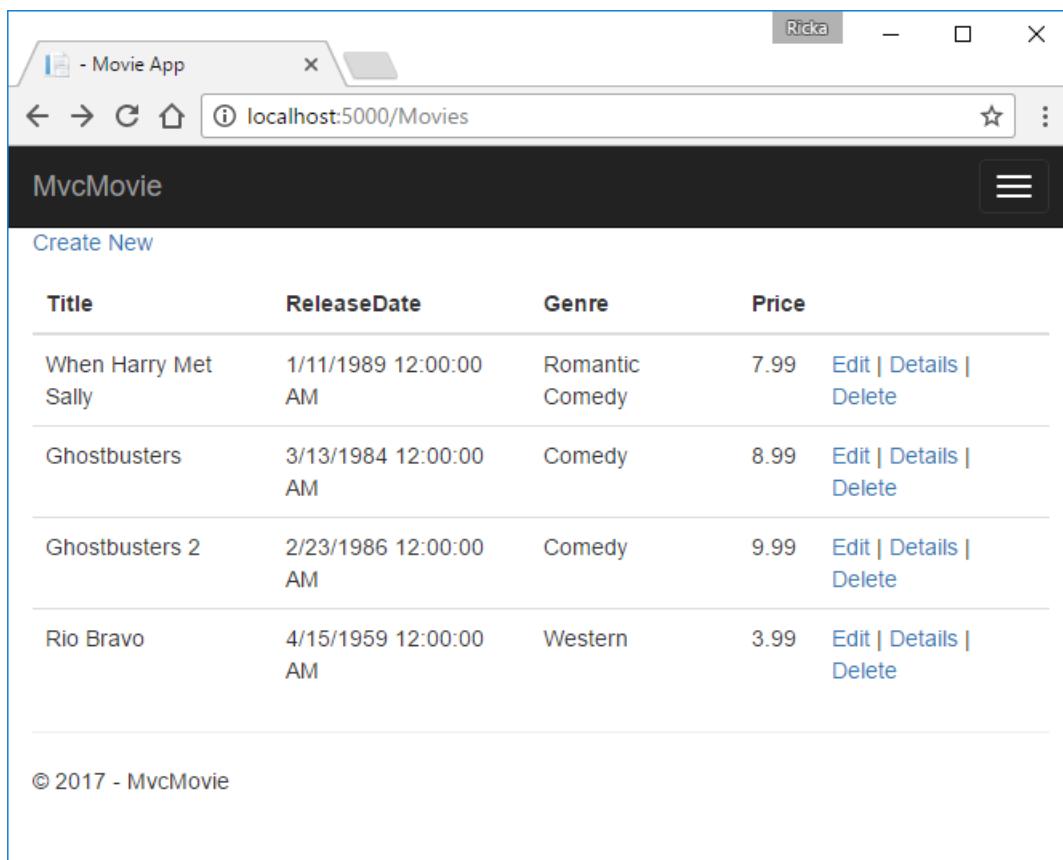
[NEXT - CONTROLLER METHODS AND  
VIEWS](#)

# Controller methods and views in an ASP.NET Core MVC app

6/21/2018 • 10 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

We have a good start to the movie app, but the presentation isn't ideal. We don't want to see the time (12:00:00 AM in the following image) and **ReleaseDate** should be two words.



The screenshot shows a browser window titled "Movie App" with the URL "localhost:5000/Movies". The page has a dark header with the text "MvcMovie" and a "Create New" button. Below the header is a table with four columns: "Title", "ReleaseDate", "Genre", and "Price". The table contains four rows of movie data:

Title	ReleaseDate	Genre	Price
When Harry Met Sally	1/11/1989 12:00:00 AM	Romantic Comedy	7.99
Ghostbusters	3/13/1984 12:00:00 AM	Comedy	8.99
Ghostbusters 2	2/23/1986 12:00:00 AM	Comedy	9.99
Rio Bravo	4/15/1959 12:00:00 AM	Western	3.99

Each row has "Edit | Details | Delete" links in the last column. At the bottom of the page, there is a copyright notice: "© 2017 - MvcMovie".

Open the *Models/Movie.cs* file and add the highlighted lines shown below:

```
using System;
using System.ComponentModel.DataAnnotations;

namespace MvcMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }

        [Display(Name = "Release Date")]
        [DataType(DataType.Date)]
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}
```

Build and run the app.

We cover [DataAnnotations](#) in the next tutorial. The [Display](#) attribute specifies what to display for the name of a field (in this case "Release Date" instead of "ReleaseDate"). The [DataType](#) attribute specifies the type of the data (Date), so the time information stored in the field isn't displayed.

The `[Column(TypeName = "decimal(18, 2)")]` data annotation is required so Entity Framework Core can correctly map `Price` to currency in the database. For more information, see [Data Types](#).

Browse to the `Movies` controller and hold the mouse pointer over an **Edit** link to see the target URL.

Genre	Price	Release Date	Title	
Romantic Comedy	7.99	1/11/1989	When Harry Met Sally	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	8.99	3/13/1984	Ghostbusters	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	9.99	2/23/1986	Ghostbusters 2	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Western	3.99	4/15/1959	Rio Bravo	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

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<http://localhost:1234/Movies/Edit/5>

The **Edit**, **Details**, and **Delete** links are generated by the Core MVC Anchor Tag Helper in the `Views/Movies/Index.cshtml` file.

```
<a asp-action="Edit" asp-route-id="@item.ID">Edit</a> |
<a asp-action="Details" asp-route-id="@item.ID">Details</a> |
<a asp-action="Delete" asp-route-id="@item.ID">Delete</a>
</td>
</tr>
```

[Tag Helpers](#) enable server-side code to participate in creating and rendering HTML elements in Razor files. In the code above, the `AnchorTagHelper` dynamically generates the HTML `href` attribute value from the controller action method and route id. You use **View Source** from your favorite browser or use the developer tools to examine the generated markup. A portion of the generated HTML is shown below:

```
<td>
<a href="/Movies/Edit/4"> Edit </a> |
<a href="/Movies/Details/4"> Details </a> |
<a href="/Movies/Delete/4"> Delete </a>
</td>
```

Recall the format for [routing](#) set in the `Startup.cs` file:

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

ASP.NET Core translates `http://localhost:1234/Movies/Edit/4` into a request to the `Edit` action method of the `Movies` controller with the parameter `Id` of 4. (Controller methods are also known as action methods.)

[Tag Helpers](#) are one of the most popular new features in ASP.NET Core. See [Additional resources](#) for more information.

Open the `Movies` controller and examine the two `Edit` action methods. The following code shows the `HTTP GET Edit` method, which fetches the movie and populates the edit form generated by the `Edit.cshtml` Razor file.

```
// GET: Movies/Edit/5
public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie.FindAsync(id);
    if (movie == null)
    {
        return NotFound();
    }
    return View(movie);
}
```

The following code shows the `HTTP POST Edit` method, which processes the posted movie values:

```

// POST: Movies/Edit/5
// To protect from overposting attacks, please enable the specific properties you want to bind to, for
// more details see http://go.microsoft.com/fwlink/?LinkId=317598.
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction("Index");
    }
    return View(movie);
}

```

```

// GET: Movies/Edit/5
public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }
    return View(movie);
}

```

The following code shows the `HTTP POST Edit` method, which processes the posted movie values:

```
// POST: Movies/Edit/5
// To protect from overposting attacks, please enable the specific properties you want to bind to, for
// more details see http://go.microsoft.com/fwlink/?LinkId=317598.
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction("Index");
    }
    return View(movie);
}
```

The `[Bind]` attribute is one way to protect against [over-posting](#). You should only include properties in the `[Bind]` attribute that you want to change. See [Protect your controller from over-posting](#) for more information.

[ViewModels](#) provide an alternative approach to prevent over-posting.

Notice the second `Edit` action method is preceded by the `[HttpPost]` attribute.

```
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction(nameof(Index));
    }
    return View(movie);
}
```

```

// POST: Movies/Edit/5
// To protect from overposting attacks, please enable the specific properties you want to bind to, for
// more details see http://go.microsoft.com/fwlink/?LinkId=317598.
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction("Index");
    }
    return View(movie);
}

```

The `[HttpPost]` attribute specifies that this `Edit` method can be invoked *only* for `POST` requests. You could apply the `[HttpGet]` attribute to the first edit method, but that's not necessary because `[HttpGet]` is the default.

The `[ValidateAntiForgeryToken]` attribute is used to [prevent forgery of a request](#) and is paired up with an anti-forgery token generated in the edit view file (`Views/Movies/Edit.cshtml`). The edit view file generates the anti-forgery token with the [Form Tag Helper](#).

```
<form asp-action="Edit">
```

The [Form Tag Helper](#) generates a hidden anti-forgery token that must match the `[ValidateAntiForgeryToken]` generated anti-forgery token in the `Edit` method of the Movies controller. For more information, see [Anti-Request Forgery](#).

The `[HttpGet Edit]` method takes the movie `ID` parameter, looks up the movie using the Entity Framework `SingleOrDefaultAsync` method, and returns the selected movie to the Edit view. If a movie cannot be found, `NotFound` (HTTP 404) is returned.

```
// GET: Movies/Edit/5
public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie.FindAsync(id);
    if (movie == null)
    {
        return NotFound();
    }
    return View(movie);
}
```

```
// GET: Movies/Edit/5
public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }
    return View(movie);
}
```

When the scaffolding system created the Edit view, it examined the `Movie` class and created code to render `<label>` and `<input>` elements for each property of the class. The following example shows the Edit view that was generated by the Visual Studio scaffolding system:

```

@model MvcMovie.Models.Movie

 @{
     ViewData["Title"] = "Edit";
 }

<h2>Edit</h2>

<form asp-action="Edit">
    <div class="form-horizontal">
        <h4>Movie</h4>
        <hr />
        <div asp-validation-summary="ModelOnly" class="text-danger"></div>
        <input type="hidden" asp-for="ID" />
        <div class="form-group">
            <label asp-for="Title" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="Title" class="form-control" />
                <span asp-validation-for="Title" class="text-danger"></span>
            </div>
        </div>
        <div class="form-group">
            <label asp-for="ReleaseDate" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="ReleaseDate" class="form-control" />
                <span asp-validation-for="ReleaseDate" class="text-danger"></span>
            </div>
        </div>
        <div class="form-group">
            <label asp-for="Genre" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="Genre" class="form-control" />
                <span asp-validation-for="Genre" class="text-danger"></span>
            </div>
        </div>
        <div class="form-group">
            <label asp-for="Price" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="Price" class="form-control" />
                <span asp-validation-for="Price" class="text-danger"></span>
            </div>
        </div>
        <div class="form-group">
            <div class="col-md-offset-2 col-md-10">
                <input type="submit" value="Save" class="btn btn-default" />
            </div>
        </div>
    </div>
</form>

<div>
    <a asp-action="Index">Back to List</a>
</div>

@section Scripts {
    @{await Html.RenderPartialAsync("_ValidationScriptsPartial");}
}

```

Notice how the view template has a `@model MvcMovie.Models.Movie` statement at the top of the file.

`@model MvcMovie.Models.Movie` specifies that the view expects the model for the view template to be of type `Movie`.

The scaffolded code uses several Tag Helper methods to streamline the HTML markup. The - [Label Tag Helper](#) displays the name of the field ("Title", "ReleaseDate", "Genre", or "Price"). The [Input Tag Helper](#) renders an HTML `<input>` element. The [Validation Tag Helper](#) displays any validation messages associated with that property.

Run the application and navigate to the `/Movies` URL. Click an **Edit** link. In the browser, view the source for the page. The generated HTML for the `<form>` element is shown below.

```
<form action="/Movies/Edit/7" method="post">
    <div class="form-horizontal">
        <h4>Movie</h4>
        <hr />
        <div class="text-danger" />
        <input type="hidden" data-val="true" data-val-required="The ID field is required." id="ID" name="ID" value="7" />
        <div class="form-group">
            <label class="control-label col-md-2" for="Genre" />
            <div class="col-md-10">
                <input class="form-control" type="text" id="Genre" name="Genre" value="Western" />
                <span class="text-danger field-validation-valid" data-valmsg-for="Genre" data-valmsg-replace="true"></span>
            </div>
        </div>
        <div class="form-group">
            <label class="control-label col-md-2" for="Price" />
            <div class="col-md-10">
                <input class="form-control" type="text" data-val="true" data-val-number="The field Price must be a number." data-val-required="The Price field is required." id="Price" name="Price" value="3.99" />
                <span class="text-danger field-validation-valid" data-valmsg-for="Price" data-valmsg-replace="true"></span>
            </div>
        </div>
        <!-- Markup removed for brevity -->
        <div class="form-group">
            <div class="col-md-offset-2 col-md-10">
                <input type="submit" value="Save" class="btn btn-default" />
            </div>
        </div>
    </div>
    <input name="__RequestVerificationToken" type="hidden" value="CfDJ8Inyxp63fRFqUePGvuI5jGZsloJu1L7X9le1gy7NCI1SduCRx9jDQC1rV9pOTTmqUyXnJBXhmrjcUVDJyDUMm7-MF_9rK8aAZdRdl0ri7FmKVkRe_2v5LIHGKFcTjPrWPYnc9AdSbomki0SaTEg7RU" />
</form>
```

The `<input>` elements are in an `HTML <form>` element whose `action` attribute is set to post to the `/Movies/Edit/id` URL. The form data will be posted to the server when the `Save` button is clicked. The last line before the closing `</form>` element shows the hidden **XSRF** token generated by the [Form Tag Helper](#).

## Processing the POST Request

The following listing shows the `[HttpPost]` version of the `Edit` action method.

```
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction(nameof(Index));
    }
    return View(movie);
}
```

```

// POST: Movies/Edit/5
// To protect from overposting attacks, please enable the specific properties you want to bind to, for
// more details see http://go.microsoft.com/fwlink/?LinkId=317598.
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

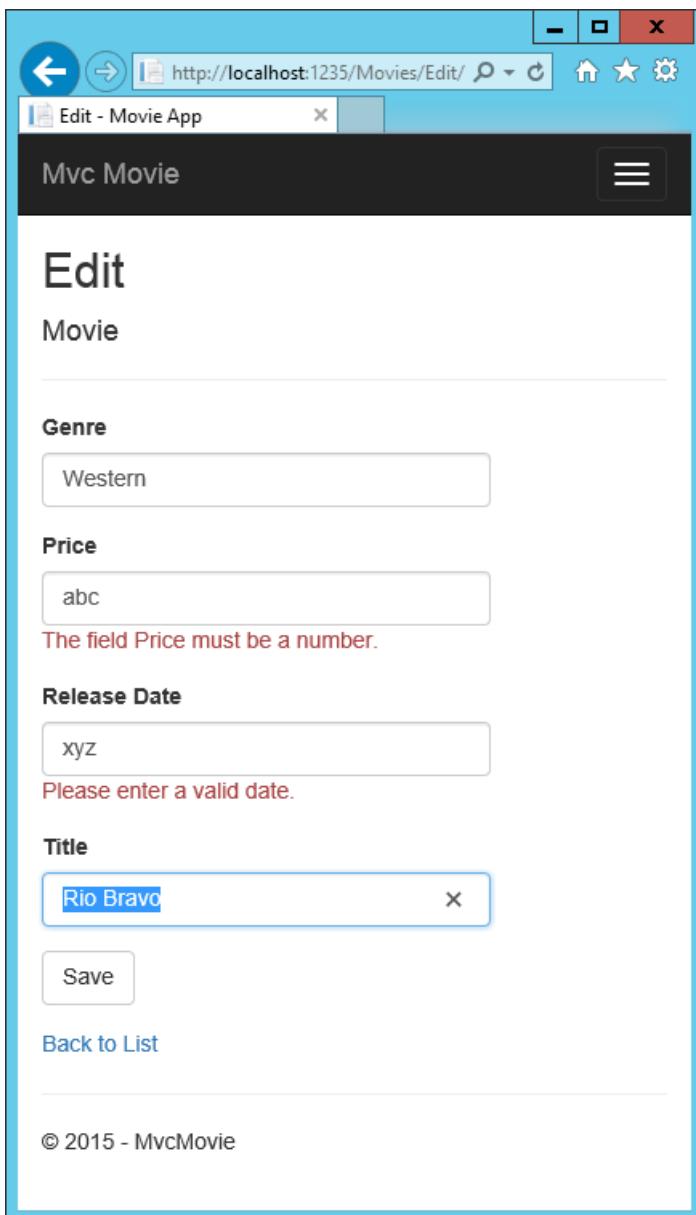
    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction("Index");
    }
    return View(movie);
}

```

The `[ValidateAntiForgeryToken]` attribute validates the hidden [XSRF](#) token generated by the anti-forgery token generator in the [Form Tag Helper](#)

The [model binding](#) system takes the posted form values and creates a `Movie` object that's passed as the `movie` parameter. The `ModelState.IsValid` method verifies that the data submitted in the form can be used to modify (edit or update) a `Movie` object. If the data is valid it's saved. The updated (edited) movie data is saved to the database by calling the `SaveChangesAsync` method of database context. After saving the data, the code redirects the user to the `Index` action method of the `MoviesController` class, which displays the movie collection, including the changes just made.

Before the form is posted to the server, client side validation checks any validation rules on the fields. If there are any validation errors, an error message is displayed and the form isn't posted. If JavaScript is disabled, you won't have client side validation but the server will detect the posted values that are not valid, and the form values will be redisplayed with error messages. Later in the tutorial we examine [Model Validation](#) in more detail. The [Validation Tag Helper](#) in the `Views/Movies/Edit.cshtml` view template takes care of displaying appropriate error messages.



All the `[HttpGet]` methods in the movie controller follow a similar pattern. They get a movie object (or list of objects, in the case of `Index`), and pass the object (model) to the view. The `Create` method passes an empty movie object to the `Create` view. All the methods that create, edit, delete, or otherwise modify data do so in the `[HttpPost]` overload of the method. Modifying data in an `HTTP GET` method is a security risk. Modifying data in an `HTTP GET` method also violates HTTP best practices and the architectural `REST` pattern, which specifies that GET requests shouldn't change the state of your application. In other words, performing a GET operation should be a safe operation that has no side effects and doesn't modify your persisted data.

## Additional resources

- [Globalization and localization](#)
- [Introduction to Tag Helpers](#)
- [Author Tag Helpers](#)
- [Anti-Request Forgery](#)
- Protect your controller from [over-posting](#)
- [ViewModels](#)
- [Form Tag Helper](#)
- [Input Tag Helper](#)
- [Label Tag Helper](#)
- [Select Tag Helper](#)

- Validation Tag Helper

[PREVIOUS - WORKING WITH  
SQLITE](#)

[NEXT - ADD  
SEARCH](#)

# Add search to an ASP.NET Core MVC app

6/26/2018 • 7 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section you add search capability to the `Index` action method that lets you search movies by *genre* or *name*.

Update the `Index` method with the following code:

```
public async Task<IActionResult> Index(string searchString)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    return View(await movies.ToListAsync());
}
```

The first line of the `Index` action method creates a [LINQ](#) query to select the movies:

```
var movies = from m in _context.Movie
             select m;
```

The query is *only* defined at this point, it has **not** been run against the database.

If the `searchString` parameter contains a string, the movies query is modified to filter on the value of the search string:

```
if (!String.IsNullOrEmpty(searchString))
{
    movies = movies.Where(s => s.Title.Contains(searchString));
}
```

The `s => s.Title.Contains()` code above is a [Lambda Expression](#). Lambdas are used in method-based [LINQ](#) queries as arguments to standard query operator methods such as the `Where` method or `Contains` (used in the code above). LINQ queries are not executed when they're defined or when they're modified by calling a method such as `Where`, `Contains` or `OrderBy`. Rather, query execution is deferred. That means that the evaluation of an expression is delayed until its realized value is actually iterated over or the `ToListAsync` method is called. For more information about deferred query execution, see [Query Execution](#).

Note: The `Contains` method is run on the database, not in the c# code shown above. The case sensitivity on the query depends on the database and the collation. On SQL Server, `Contains` maps to [SQL LIKE](#), which is case insensitive. In SQLite, with the default collation, it's case sensitive.

Navigate to `/Movies/Index`. Append a query string such as `?searchString=Ghost` to the URL. The filtered movies are displayed.

Title	Release Date	Genre	Price
Ghostbusters	3/13/1984	Comedy	8.99
Ghostbusters 2	2/23/1986	Comedy	9.99

If you change the signature of the `Index` method to have a parameter named `id`, the `id` parameter will match the optional `{id}` placeholder for the default routes set in `Startup.cs`.

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

Note: SQLite is case sensitive, so you'll need to search for "Ghost" and not "ghost".

The previous `Index` method:

```
public async Task<IActionResult> Index(string searchString)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    return View(await movies.ToListAsync());
}
```

The updated `Index` method with `id` parameter:

```
public async Task<IActionResult> Index(string id)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(id))
    {
        movies = movies.Where(s => s.Title.Contains(id));
    }

    return View(await movies.ToListAsync());
}
```

You can now pass the search title as route data (a URL segment) instead of as a query string value.

Mvc Movie

# Index

Create New

Genre	Price	Release Date	Title	
Comedy	8.99	3/13/1984	Ghostbusters	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	9.99	2/23/1986	Ghostbusters 2	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

© 2015 - MvcMovie

However, you can't expect users to modify the URL every time they want to search for a movie. So now you'll add UI elements to help them filter movies. If you changed the signature of the `Index` method to test how to pass the route-bound `ID` parameter, change it back so that it takes a parameter named `searchString`:

```
public async Task<IActionResult> Index(string searchString)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    return View(await movies.ToListAsync());
}
```

Open the `Views/Movies/Index.cshtml` file, and add the `<form>` markup highlighted below:

```
ViewData["Title"] = "Index";
}

<h2>Index</h2>

<p>
    <a asp-action="Create">Create New</a>
</p>

<form asp-controller="Movies" asp-action="Index">
    <p>
        Title: <input type="text" name="SearchString">
        <input type="submit" value="Filter" />
    </p>
</form>

<table class="table">
    <thead>
```

The HTML `<form>` tag uses the [Form Tag Helper](#), so when you submit the form, the filter string is posted to the `Index` action of the movies controller. Save your changes and then test the filter.

Genre	Price	Release Date	Title	
Romantic Comedy	7.99	1/11/1989	When Harry Met Sally	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	8.99	3/13/1984	Ghostbusters	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	9.99	2/23/1986	Ghostbusters 2	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Western	3.99	4/15/1959	Rio Bravo	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

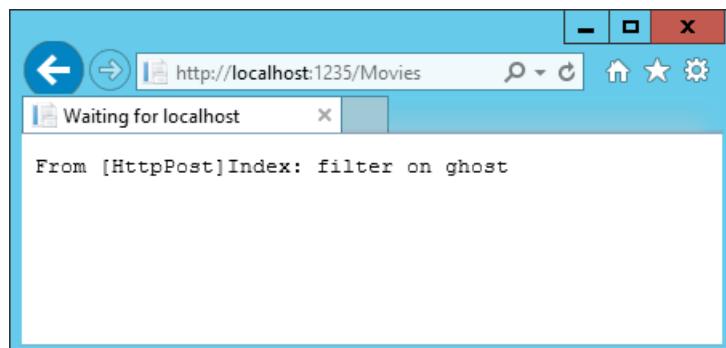
There's no `[HttpPost]` overload of the `Index` method as you might expect. You don't need it, because the method isn't changing the state of the app, just filtering data.

You could add the following `[HttpPost] Index` method.

```
[HttpPost]
public string Index(string searchString, bool notUsed)
{
    return "From [HttpPost]Index: filter on " + searchString;
}
```

The `notUsed` parameter is used to create an overload for the `Index` method. We'll talk about that later in the tutorial.

If you add this method, the action invoker would match the `[HttpPost] Index` method, and the `[HttpPost] Index` method would run as shown in the image below.



However, even if you add this `[HttpPost]` version of the `Index` method, there's a limitation in how this has all been implemented. Imagine that you want to bookmark a particular search or you want to send a link to friends that they can click in order to see the same filtered list of movies. Notice that the URL for the HTTP POST request is the same as the URL for the GET request (`localhost:xxxx/Movies/Index`) -- there's no search information in the

URL. The search string information is sent to the server as a [form field value](#). You can verify that with the browser Developer tools or the excellent [Fiddler tool](#). The image below shows the Chrome browser Developer tools:

The screenshot shows the Chrome Developer Tools Network tab with a red box highlighting the 'Network' tab itself. Below it, another red box highlights the 'Movies' entry in the list of requests. The 'General' section of the request details is also highlighted with a red box, showing the Request URL, Method, Status Code (200 OK), and other headers like Cache-Control, Content-Type, Date, Pragma, Server, and Transfer-Encoding. The 'Form Data' section is also highlighted with a red box, showing the 'SearchString' parameter with the value 'Ghost' and a long 'RequestVerificationToken' parameter.

You can see the search parameter and [XSRF](#) token in the request body. Note, as mentioned in the previous tutorial, the [Form Tag Helper](#) generates an [XSRF](#) anti-forgery token. We're not modifying data, so we don't need to validate the token in the controller method.

Because the search parameter is in the request body and not the URL, you can't capture that search information to bookmark or share with others. We'll fix this by specifying the request should be [HTTP GET](#).

Change the `<form>` tag in the `Views\movie\Index.cshtml` Razor view to specify `method="get"`:

```
<form asp-controller="Movies" asp-action="Index" method="get">
```

Now when you submit a search, the URL contains the search query string. Searching will also go to the `HttpGet Index` action method, even if you have a `HttpPost Index` method.

Genre	Price	Release Date	Title	
Comedy	8.99	3/13/1984	Ghostbusters	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	9.99	2/23/1986	Ghostbusters 2	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

The following markup shows the change to the `form` tag:

```
<form asp-controller="Movies" asp-action="Index" method="get">
```

## Adding Search by genre

Add the following `MovieGenreViewModel` class to the *Models* folder:

```
using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace MvcMovie.Models
{
    public class MovieGenreViewModel
    {
        public List<Movie> movies;
        public SelectList genres;
        public string movieGenre { get; set; }
    }
}
```

The movie-genre view model will contain:

- A list of movies.
- A `selectList` containing the list of genres. This will allow the user to select a genre from the list.
- `movieGenre`, which contains the selected genre.

Replace the `Index` method in `MoviesController.cs` with the following code:

```

// Requires using Microsoft.AspNetCore.Mvc.Rendering;
public async Task<IActionResult> Index(string movieGenre, string searchString)
{
    // Use LINQ to get list of genres.
    IQueryable<string> genreQuery = from m in _context.Movie
                                         orderby m.Genre
                                         select m.Genre;

    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    if (!String.IsNullOrEmpty(movieGenre))
    {
        movies = movies.Where(x => x.Genre == movieGenre);
    }

    var movieGenreVM = new MovieGenreViewModel();
    movieGenreVM.genres = new SelectList(await genreQuery.Distinct().ToListAsync());
    movieGenreVM.movies = await movies.ToListAsync();

    return View(movieGenreVM);
}

```

The following code is a `LINQ` query that retrieves all the genres from the database.

```

// Use LINQ to get list of genres.
IQueryable<string> genreQuery = from m in _context.Movie
                                         orderby m.Genre
                                         select m.Genre;

```

The `SelectList` of genres is created by projecting the distinct genres (we don't want our select list to have duplicate genres).

```
movieGenreVM.genres = new SelectList(await genreQuery.Distinct().ToListAsync())
```

## Adding search by genre to the Index view

Update `Index.cshtml` as follows:

```

@model MvcMovie.Models.MovieGenreViewModel

 @{
     ViewData["Title"] = "Index";
 }

<h2>Index</h2>

<p>
    <a asp-action="Create">Create New</a>
</p>

<form asp-controller="Movies" asp-action="Index" method="get">
    <p>
        <select asp-for="movieGenre" asp-items="Model.genres">
            <option value="">All</option>
        </select>

        Title: <input type="text" name="SearchString">
        <input type="submit" value="Filter" />
    </p>
</form>

<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].ReleaseDate)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Genre)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Price)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model.movies)
        {
            <tr>
                <td>
                    @Html.DisplayFor(modelItem => item.Title)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.ReleaseDate)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Genre)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Price)
                </td>
                <td>
                    <a asp-action="Edit" asp-route-id="@item.ID">Edit</a> |
                    <a asp-action="Details" asp-route-id="@item.ID">Details</a> |
                    <a asp-action="Delete" asp-route-id="@item.ID">Delete</a>
                </td>
            </tr>
        }
    </tbody>
</table>

```

Examine the lambda expression used in the following HTML Helper:

```
@Html.DisplayNameFor(model => model.movies[0].Title)
```

In the preceding code, the `DisplayNameFor` HTML Helper inspects the `Title` property referenced in the lambda expression to determine the display name. Since the lambda expression is inspected rather than evaluated, you don't receive an access violation when `model`, `model.movies`, or `model.movies[0]` are `null` or empty. When the lambda expression is evaluated (for example, `@Html.DisplayFor(modelItem => item.Title)`), the model's property values are evaluated.

Test the app by searching by genre, by movie title, and by both.

[PREVIOUS - CONTROLLER METHODS AND  
VIEWS](#)

[NEXT - ADD A  
FIELD](#)

# Add a new field to an ASP.NET Core MVC app

6/26/2018 • 3 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

This tutorial will add a new field to the `Movies` table. We'll drop the database and create a new one when we change the schema (add a new field). This workflow works well early in development when we don't have any production data to preserve.

Once your app is deployed and you have data that you need to preserve, you can't drop your DB when you need to change the schema. Entity Framework [Code First Migrations](#) allows you to update your schema and migrate the database without losing data. Migrations is a popular feature when using SQL Server, but SQLite doesn't support many migration schema operations, so only very simple migrations are possible. See [SQLite Limitations](#) for more information.

## Adding a Rating Property to the Movie Model

Open the `Models/Movie.cs` file and add a `Rating` property:

```
public class Movie
{
    public int ID { get; set; }
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }
    public string Genre { get; set; }

    [Column(TypeName = "decimal(18, 2)")]
    public decimal Price { get; set; }
    public string Rating { get; set; }
}
```

```
public class Movie
{
    public int ID { get; set; }
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }
    public string Genre { get; set; }
    public decimal Price { get; set; }
    public string Rating { get; set; }
}
```

Because you've added a new field to the `Movie` class, you also need to update the binding whitelist so this new property will be included. In `MoviesController.cs`, update the `[Bind]` attribute for both the `Create` and `Edit` action methods to include the `Rating` property:

```
[Bind("ID,Title,ReleaseDate,Genre,Price,Rating")]
```

You also need to update the view templates in order to display, create, and edit the new `Rating` property in the browser view.

Edit the `/Views/Movies/Index.cshtml` file and add a `Rating` field:

```
<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].ReleaseDate)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Genre)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Price)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Rating)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model.movies)
        {
            <tr>
                <td>
                    @Html.DisplayFor(modelItem => item.Title)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.ReleaseDate)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Genre)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Price)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Rating)
                </td>
                <td>
```

Update the `/Views/Movies/Create.cshtml` with a `Rating` field.

The app won't work until we update the DB to include the new field. If you run it now, you'll get the following `SqliteException`:

```
SqliteException: SQLite Error 1: 'no such column: m.Rating'.
```

You're seeing this error because the updated Movie model class is different than the schema of the Movie table of the existing database. (There's no `Rating` column in the database table.)

There are a few approaches to resolving the error:

1. Drop the database and have the Entity Framework automatically re-create the database based on the new model class schema. With this approach, you lose existing data in the database — so you can't do this with a production database! Using an initializer to automatically seed a database with test data is often a

productive way to develop an app.

2. Manually modify the schema of the existing database so that it matches the model classes. The advantage of this approach is that you keep your data. You can make this change either manually or by creating a database change script.
3. Use Code First Migrations to update the database schema.

For this tutorial, we'll drop and re-create the database when the schema changes. Run the following command from a terminal to drop the db:

```
dotnet ef database drop
```

Update the `SeedData` class so that it provides a value for the new column. A sample change is shown below, but you'll want to make this change for each `new Movie`.

```
new Movie
{
    Title = "When Harry Met Sally",
    ReleaseDate = DateTime.Parse("1989-1-11"),
    Genre = "Romantic Comedy",
    Rating = "R",
    Price = 7.99M
},
```

Add the `Rating` field to the `Edit`, `Details`, and `Delete` view.

Run the app and verify you can create/edit/display movies with a `Rating` field. templates.

PREVIOUS - ADD  
SEARCH

NEXT - ADD  
VALIDATION

# Add validation to an ASP.NET Core MVC app

6/26/2018 • 10 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section you'll add validation logic to the `Movie` model, and you'll ensure that the validation rules are enforced any time a user creates or edits a movie.

## Keeping things DRY

One of the design tenets of MVC is [DRY](#) ("Don't Repeat Yourself"). ASP.NET MVC encourages you to specify functionality or behavior only once, and then have it be reflected everywhere in an app. This reduces the amount of code you need to write and makes the code you do write less error prone, easier to test, and easier to maintain.

The validation support provided by MVC and Entity Framework Core Code First is a good example of the DRY principle in action. You can declaratively specify validation rules in one place (in the model class) and the rules are enforced everywhere in the app.

## Adding validation rules to the movie model

Open the `Movie.cs` file. DataAnnotations provides a built-in set of validation attributes that you apply declaratively to any class or property. (It also contains formatting attributes like `DataType` that help with formatting and don't provide any validation.)

Update the `Movie` class to take advantage of the built-in `Required`, `StringLength`, `RegularExpression`, and `Range` validation attributes.

```
public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3)]
    [Required]
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [Range(1, 100)]
    [DataType(DataType.Currency)]
    [Column(TypeName = "decimal(18, 2)")]
    public decimal Price { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z''"\s-]*$")]
    [Required]
    [StringLength(30)]
    public string Genre { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z0-9'''\s-]*$")]
    [StringLength(5)]
    [Required]
    public string Rating { get; set; }
}
```

```

public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3)]
    [Required]
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [Range(1, 100)]
    [DataType(DataType.Currency)]
    public decimal Price { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z\s-]*$")]
    [Required]
    [StringLength(30)]
    public string Genre { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z0-9\s-]*$")]
    [StringLength(5)]
    [Required]
    public string Rating { get; set; }
}

```

The validation attributes specify behavior that you want to enforce on the model properties they're applied to. The `Required` and `MinimumLength` attributes indicate that a property must have a value; but nothing prevents a user from entering white space to satisfy this validation. The `RegularExpression` attribute is used to limit what characters can be input. In the code above, `Genre` and `Rating` must use only letters (First letter uppercase, white space, numbers and special characters are not allowed). The `Range` attribute constrains a value to within a specified range. The `StringLength` attribute lets you set the maximum length of a string property, and optionally its minimum length. Value types (such as `decimal`, `int`, `float`, `DateTime`) are inherently required and don't need the `[Required]` attribute.

Having validation rules automatically enforced by ASP.NET helps make your app more robust. It also ensures that you can't forget to validate something and inadvertently let bad data into the database.

## Validation Error UI in MVC

Run the app and navigate to the Movies controller.

Tap the **Create New** link to add a new movie. Fill out the form with some invalid values. As soon as jQuery client side validation detects the error, it displays an error message.

The screenshot shows a browser window titled "Create - Movie App" with the URL "localhost:5000/Movies/Create". The page is titled "Create Movie". It contains a form with the following fields and validation errors:

- Title**: An input field with a red border and error message: "The field Title must be a string with a minimum length of 3 and a maximum length of 60."
- Release Date**: An input field with a red border and error message: "The field Release Date is required."
- Genre**: An input field with a red border and error message: "The field Genre is required."
- Price**: An input field with a red border and error message: "The field Price must be a number."
- Rating**: An input field with a red border and error message: "The field Rating must match the regular expression '^([A-Z]+[a-zA-Z-\s]\*)\$'."

At the bottom of the form are two buttons: "Create" and "Back to List".

#### NOTE

You may not be able to enter decimal commas in the `Price` field. To support [jQuery validation](#) for non-English locales that use a comma (",") for a decimal point, and non US-English date formats, you must take steps to globalize your app. This [GitHub issue 4076](#) for instructions on adding decimal comma.

Notice how the form has automatically rendered an appropriate validation error message in each field containing an invalid value. The errors are enforced both client-side (using JavaScript and jQuery) and server-side (in case a user has JavaScript disabled).

A significant benefit is that you didn't need to change a single line of code in the `MoviesController` class or in the `Create.cshtml` view in order to enable this validation UI. The controller and views you created earlier in this tutorial automatically picked up the validation rules that you specified by using validation attributes on the properties of the `Movie` model class. Test validation using the `Edit` action method, and the same validation is applied.

The form data isn't sent to the server until there are no client side validation errors. You can verify this by putting a break point in the `HTTP Post` method, by using the [Fiddler tool](#), or the [F12 Developer tools](#).

## How validation works

You might wonder how the validation UI was generated without any updates to the code in the controller or views. The following code shows the two `Create` methods.

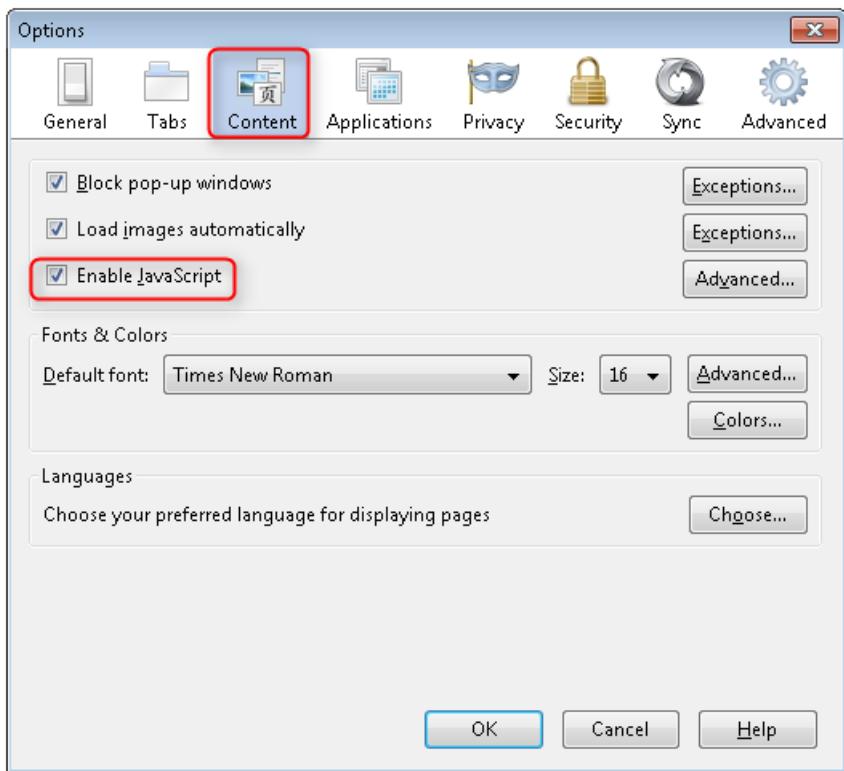
```
// GET: Movies/Create
public IActionResult Create()
{
    return View();
}

// POST: Movies/Create
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Create(
    [Bind("ID,Title,ReleaseDate,Genre,Price, Rating")] Movie movie)
{
    if (ModelState.IsValid)
    {
        _context.Add(movie);
        await _context.SaveChangesAsync();
        return RedirectToAction("Index");
    }
    return View(movie);
}
```

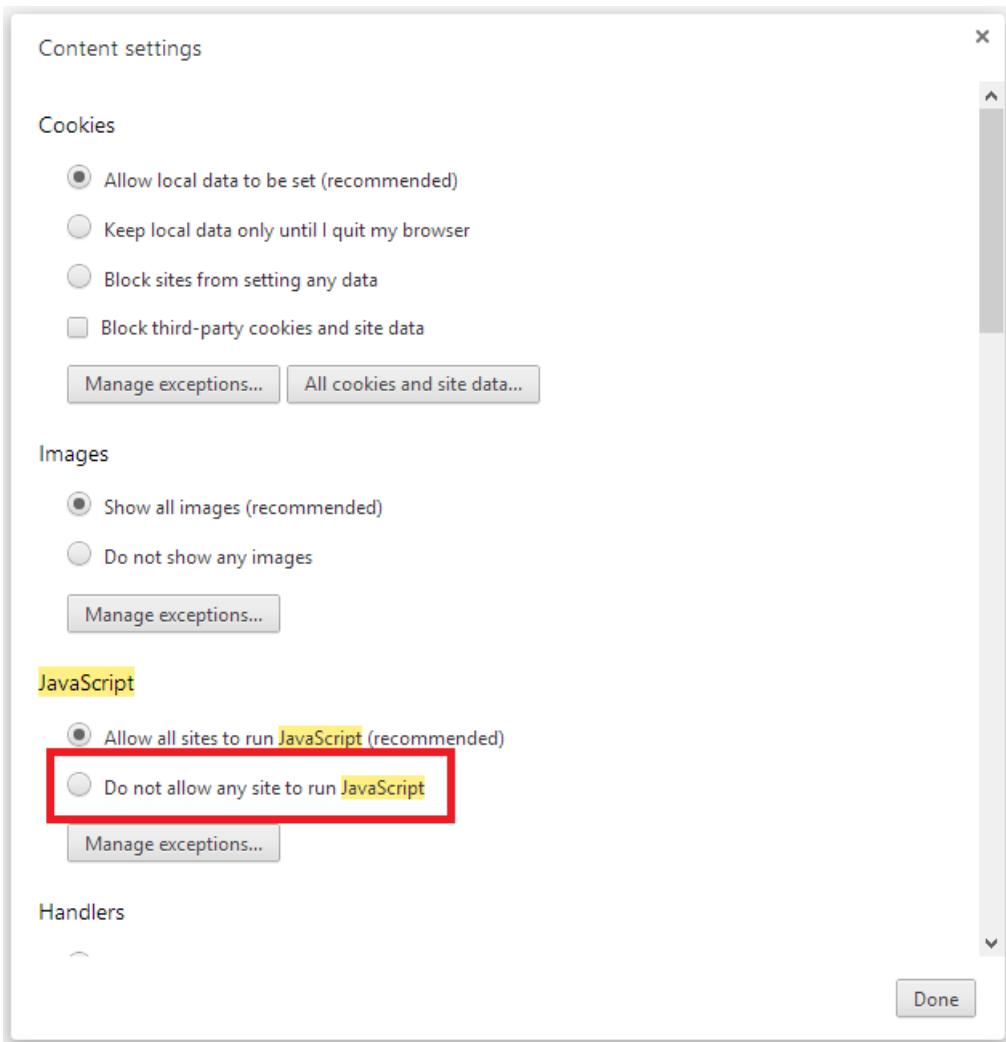
The first (HTTP GET) `Create` action method displays the initial Create form. The second (`[HttpPost]`) version handles the form post. The second `Create` method (The `[HttpPost]` version) calls `ModelState.IsValid` to check whether the movie has any validation errors. Calling this method evaluates any validation attributes that have been applied to the object. If the object has validation errors, the `Create` method re-displays the form. If there are no errors, the method saves the new movie in the database. In our movie example, the form isn't posted to the server when there are validation errors detected on the client side; the second `Create` method is never called when there are client side validation errors. If you disable JavaScript in your browser, client validation is disabled and you can test the HTTP POST `Create` method `ModelState.IsValid` detecting any validation errors.

You can set a break point in the `[HttpPost] Create` method and verify the method is never called, client side validation won't submit the form data when validation errors are detected. If you disable JavaScript in your browser, then submit the form with errors, the break point will be hit. You still get full validation without JavaScript.

The following image shows how to disable JavaScript in the FireFox browser.



The following image shows how to disable JavaScript in the Chrome browser.



After you disable JavaScript, post invalid data and step through the debugger.

```
74     // POST: Movies/Create
75     // To protect from overposting attacks, please enable t
76     // more details see http://go.microsoft.com/fwlink/?LinkID=142072
77     [HttpPost]
78     [ValidateAntiForgeryToken]
79     0 references
80     public async Task<IActionResult> Create([Bind("ID,Title")]
81     {
82         if (ModelState.IsValid)
83         {
84             _context.Add(movie);
85             await _context.SaveChangesAsync();
86             return RedirectToAction("Index");
87         }
88         return View(movie);
89     }

```

Below is portion of the `Create.cshtml` view template that you scaffolded earlier in the tutorial. It's used by the action methods shown above both to display the initial form and to redisplay it in the event of an error.

```
<form asp-action="Create">
    <div class="form-horizontal">
        <h4>Movie</h4>
        <hr />

        <div asp-validation-summary="ModelOnly" class="text-danger"></div>
        <div class="form-group">
            <label asp-for="Title" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="Title" class="form-control" />
                <span asp-validation-for="Title" class="text-danger"></span>
            </div>
        </div>

        @*Markup removed for brevity.*@
    </div>
</form>
```

The [Input Tag Helper](#) uses the [DataAnnotations](#) attributes and produces HTML attributes needed for jQuery Validation on the client side. The [Validation Tag Helper](#) displays validation errors. See [Validation](#) for more information.

What's really nice about this approach is that neither the controller nor the `Create` view template knows anything about the actual validation rules being enforced or about the specific error messages displayed. The validation rules and the error strings are specified only in the `Movie` class. These same validation rules are automatically applied to the `Edit` view and any other views templates you might create that edit your model.

When you need to change validation logic, you can do so in exactly one place by adding validation attributes to the model (in this example, the `Movie` class). You won't have to worry about different parts of the application being inconsistent with how the rules are enforced — all validation logic will be defined in one place and used everywhere. This keeps the code very clean, and makes it easy to maintain and evolve. And it means that you'll be fully honoring the DRY principle.

## Using DataType Attributes

Open the `Movie.cs` file and examine the `Movie` class. The `System.ComponentModel.DataAnnotations` namespace provides formatting attributes in addition to the built-in set of validation attributes. We've already applied a `DataType` enumeration value to the release date and to the price fields. The following code shows the `ReleaseDate` and `Price` properties with the appropriate `DataType` attribute.

```
[Display(Name = "Release Date")]
[DataType(DataType.Date)]
public DateTime ReleaseDate { get; set; }

[Range(1, 100)]
[DataType(DataType.Currency)]
public decimal Price { get; set; }
```

The `DataType` attributes only provide hints for the view engine to format the data (and supplies elements/attributes such as `<a>` for URL's and `<a href="mailto:EmailAddress.com">` for email). You can use the `RegularExpression` attribute to validate the format of the data. The `DataType` attribute is used to specify a data type that's more specific than the database intrinsic type, they're not validation attributes. In this case we only want to keep track of the date, not the time. The `DataType` Enumeration provides for many data types, such as Date, Time, PhoneNumber, Currency, EmailAddress and more. The `DataType` attribute can also enable the application to automatically provide type-specific features. For example, a `mailto:` link can be created for `DataType.EmailAddress`, and a date selector can be provided for `DataType.Date` in browsers that support HTML5. The `DataType` attributes emits HTML 5 `data-` (pronounced data dash) attributes that HTML 5 browsers can understand. The `DataType` attributes do **not** provide any validation.

`DataType.Date` doesn't specify the format of the date that's displayed. By default, the data field is displayed according to the default formats based on the server's `CultureInfo`.

The `DisplayFormat` attribute is used to explicitly specify the date format:

```
[DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
public DateTime ReleaseDate { get; set; }
```

The `ApplyFormatInEditMode` setting specifies that the formatting should also be applied when the value is displayed in a text box for editing. (You might not want that for some fields — for example, for currency values, you probably don't want the currency symbol in the text box for editing.)

You can use the `DisplayFormat` attribute by itself, but it's generally a good idea to use the `DataType` attribute. The `DataType` attribute conveys the semantics of the data as opposed to how to render it on a screen, and provides the following benefits that you don't get with `DisplayFormat`:

- The browser can enable HTML5 features (for example to show a calendar control, the locale-appropriate currency symbol, email links, etc.)
- By default, the browser will render data using the correct format based on your locale.
- The `DataType` attribute can enable MVC to choose the right field template to render the data (the `DisplayFormat` if used by itself uses the string template).

#### NOTE

jQuery validation doesn't work with the `Range` attribute and `DateTime`. For example, the following code will always display a client side validation error, even when the date is in the specified range:

```
[Range(typeof(DateTime), "1/1/1966", "1/1/2020")]
```

You will need to disable jQuery date validation to use the `Range` attribute with `DateTime`. It's generally not a good practice to compile hard dates in your models, so using the `Range` attribute and `DateTime` is discouraged.

The following code shows combining attributes on one line:

```

public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3)]
    public string Title { get; set; }

    [Display(Name = "Release Date"), DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [RegularExpression(@"^([A-Z]+[a-zA-Z\s-]*)$"), Required, StringLength(30)]
    public string Genre { get; set; }

    [Range(1, 100), DataType(DataType.Currency)]
    [Column(TypeName = "decimal(18, 2)")]
    public decimal Price { get; set; }

    [RegularExpression(@"^([A-Z]+[a-zA-Z0-9\s-]*)$"), StringLength(5)]
    public string Rating { get; set; }
}

```

```

public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3), Required]
    public string Title { get; set; }

    [Display(Name = "Release Date"), DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [RegularExpression(@"^([A-Z]+[a-zA-Z\s-]*)$"), Required, StringLength(30)]
    public string Genre { get; set; }

    [Range(1, 100), DataType(DataType.Currency)]
    public decimal Price { get; set; }

    [RegularExpression(@"^([A-Z]+[a-zA-Z0-9\s-]*)$"), Required, StringLength(5)]
    public string Rating { get; set; }
}

```

In the next part of the series, we'll review the application and make some improvements to the automatically generated `Details` and `Delete` methods.

## Additional resources

- [Working with Forms](#)
- [Globalization and localization](#)
- [Introduction to Tag Helpers](#)
- [Author Tag Helpers](#)

[PREVIOUS - ADD A  
FIELD](#)

[NEXT - EXAMINE THE DETAILS AND DELETE  
METHODS](#)

# Examine the Details and Delete methods of an ASP.NET Core app

6/21/2018 • 3 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

Open the Movie controller and examine the `Details` method:

```
// GET: Movies/Details/5
public async Task<IActionResult> Details(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie
        .FirstOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }

    return View(movie);
}
```

```
// GET: Movies/Details/5
public async Task<IActionResult> Details(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie
        .SingleOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }

    return View(movie);
}
```

The MVC scaffolding engine that created this action method adds a comment showing an HTTP request that invokes the method. In this case it's a GET request with three URL segments, the `Movies` controller, the `Details` method and an `id` value. Recall these segments are defined in *Startup.cs*.

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

EF makes it easy to search for data using the `SingleOrDefaultAsync` method. An important security feature built into the method is that the code verifies that the search method has found a movie before it tries to do anything with it. For example, a hacker could introduce errors into the site by changing the URL created by the links from `http://localhost:xxxx/Movies/Details/1` to something like `http://localhost:xxxx/Movies/Details/12345` (or some other value that doesn't represent an actual movie). If you didn't check for a null movie, the app would throw an exception.

Examine the `Delete` and `DeleteConfirmed` methods.

```
// GET: Movies/Delete/5
public async Task<IActionResult> Delete(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie
        .FirstOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }

    return View(movie);
}

// POST: Movies/Delete/5
[HttpPost, ActionName("Delete")]
[ValidateAntiForgeryToken]
public async Task<IActionResult> DeleteConfirmed(int id)
{
    var movie = await _context.Movie.FindAsync(id);
    _context.Movie.Remove(movie);
    await _context.SaveChangesAsync();
    return RedirectToAction(nameof(Index));
}
```

```

// GET: Movies/Delete/5
public async Task<IActionResult> Delete(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie
        .SingleOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }

    return View(movie);
}

// POST: Movies/Delete/5
[HttpPost, ActionName("Delete")]
[ValidateAntiForgeryToken]
public async Task<IActionResult> DeleteConfirmed(int id)
{
    var movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);
    _context.Movie.Remove(movie);
    await _context.SaveChangesAsync();
    return RedirectToAction("Index");
}

```

Note that the `HTTP GET Delete` method doesn't delete the specified movie, it returns a view of the movie where you can submit (`HttpPost`) the deletion. Performing a delete operation in response to a GET request (or for that matter, performing an edit operation, create operation, or any other operation that changes data) opens up a security hole.

The `[HttpPost]` method that deletes the data is named `DeleteConfirmed` to give the HTTP POST method a unique signature or name. The two method signatures are shown below:

```

// GET: Movies/Delete/5
public async Task<IActionResult> Delete(int? id)
{
```

```

// POST: Movies/Delete/5
[HttpPost, ActionName("Delete")]
[ValidateAntiForgeryToken]
public async Task<IActionResult> DeleteConfirmed(int id)
{
```

The common language runtime (CLR) requires overloaded methods to have a unique parameter signature (same method name but different list of parameters). However, here you need two `Delete` methods -- one for GET and one for POST -- that both have the same parameter signature. (They both need to accept a single integer as a parameter.)

There are two approaches to this problem, one is to give the methods different names. That's what the scaffolding mechanism did in the preceding example. However, this introduces a small problem: ASP.NET maps segments of a URL to action methods by name, and if you rename a method, routing normally wouldn't be able to find that method. The solution is what you see in the example, which is to add the `ActionName("Delete")` attribute to the `DeleteConfirmed` method. That attribute performs mapping for the routing system so that a URL that includes `/Delete/` for a POST request will find the `DeleteConfirmed` method.

Another common work around for methods that have identical names and signatures is to artificially change the

signature of the POST method to include an extra (unused) parameter. That's what we did in a previous post when we added the `notUsed` parameter. You could do the same thing here for the `[HttpPost] Delete` method:

```
// POST: Movies/Delete/6
[ValidateAntiForgeryToken]
public async Task<IActionResult> Delete(int id, bool notUsed)
```

## Publish to Azure

See [Publish an ASP.NET Core web app to Azure App Service using Visual Studio](#) for instructions on how to publish this app to Azure using Visual Studio. The app can also be published from the [command line](#).

[PREVIOUS](#)

# Create an ASP.NET Core MVC app with Visual Studio Code

6/21/2018 • 2 minutes to read • [Edit Online](#)

This series of tutorials teaches you the basics of building an ASP.NET Core MVC web app using Visual Studio Code.

This tutorial teaches ASP.NET Core MVC web development with controllers and views. Razor Pages is a feature of the ASP.NET Core MVC framework that makes building and testing web UI easier and more productive. You can use Razor pages alongside controllers and views in the same project.

After using Razor pages, many developers prefer it over controllers and views. We recommend you try the [Razor Pages](#) tutorial before the MVC/Controller/Views version. The Razor Pages tutorial:

- Is the preferred approach for new application development.
- Is easier to follow.
- Covers more features.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub issue](#).

1. [Get started](#)
2. [Add a controller](#)
3. [Add a view](#)
4. [Add a model](#)
5. [Work with SQLite](#)
6. [Controller methods and views](#)
7. [Add search](#)
8. [Add a new field](#)
9. [Add validation](#)
10. [Examine the Details and Delete methods](#)

# Introduction to ASP.NET Core MVC on macOS, Linux, or Windows

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

This tutorial will teach you the basics of building an ASP.NET Core MVC web app using [Visual Studio Code \(VS Code\)](#). The tutorial assumes familiarity with VS Code. See [Getting started with VS Code](#) and [Visual Studio Code help](#) for more information.

This tutorial teaches ASP.NET Core MVC web development with controllers and views. Razor Pages is a feature of the ASP.NET Core MVC framework that makes building and testing web UI easier and more productive. You can use Razor pages alongside controllers and views in the same project.

After using Razor pages, many developers prefer it over controllers and views. We recommend you try the [Razor Pages](#) tutorial before the MVC/Controller/Views version. The Razor Pages tutorial:

- Is the preferred approach for new application development.
- Is easier to follow.
- Covers more features.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub issue](#).

There are 3 versions of this tutorial:

- macOS: [Create an ASP.NET Core MVC app with Visual Studio for Mac](#)
- Windows: [Create an ASP.NET Core MVC app with Visual Studio](#)
- macOS, Linux, and Windows: [Create an ASP.NET Core MVC app with Visual Studio Code](#)

## Prerequisites

Install the following:

- [.NET Core SDK 2.0 or later](#)
- [Visual Studio Code](#)
- [C# for Visual Studio Code](#)
- [.NET Core 2.1 SDK or later](#)
- [Visual Studio Code](#)
- [C# for Visual Studio Code](#)

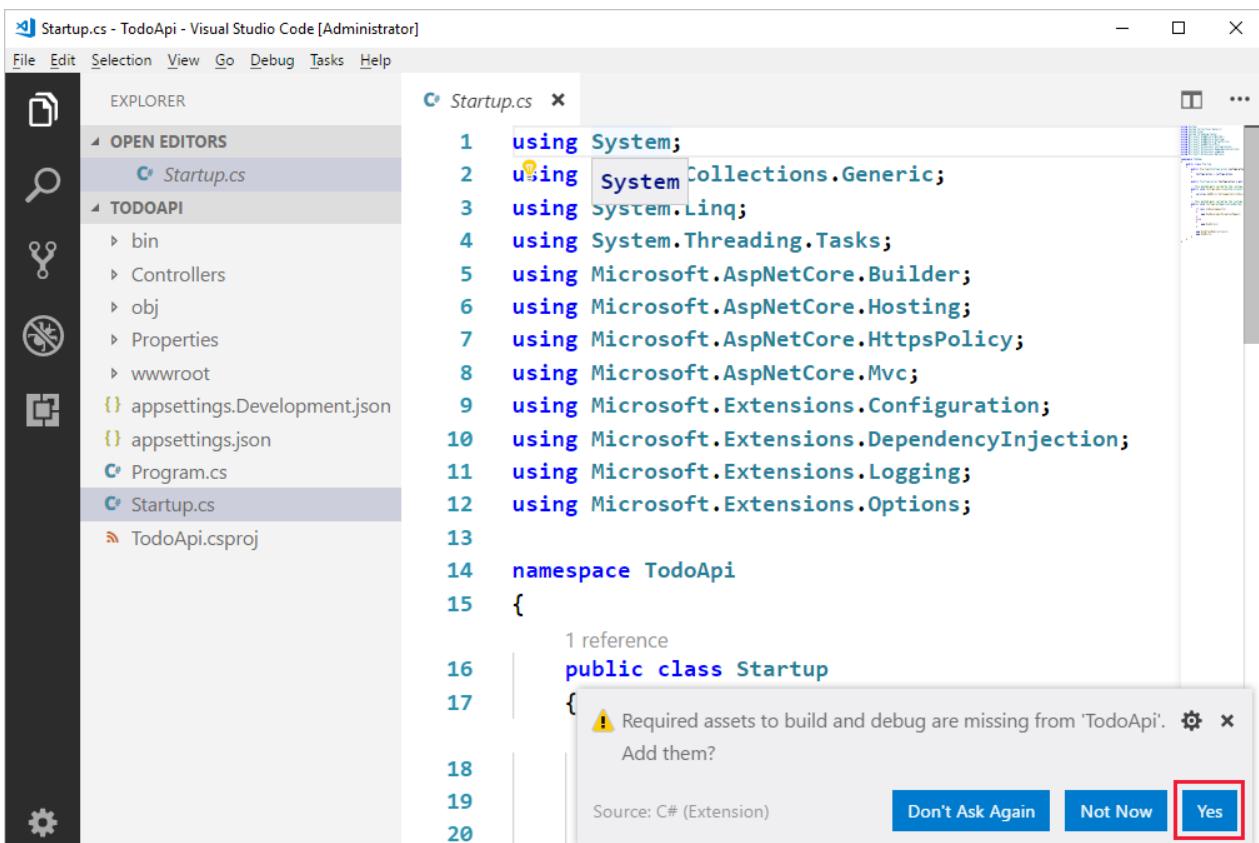
## Create a web app with dotnet

From a terminal, run the following commands:

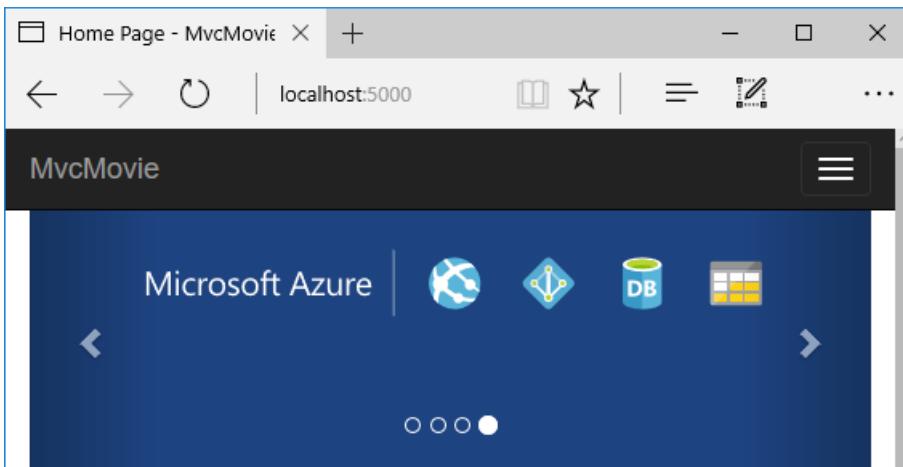
```
mkdir MvcMovie  
cd MvcMovie  
dotnet new mvc
```

Open the *MvcMovie* folder in Visual Studio Code (VS Code) and select the *Startup.cs* file.

- Select **Yes** to the **Warn** message "Required assets to build and debug are missing from 'MvcMovie'. Add them?"
- Select **Restore** to the **Info** message "There are unresolved dependencies".



Press **Debug** (F5) to build and run the program.



## Application uses

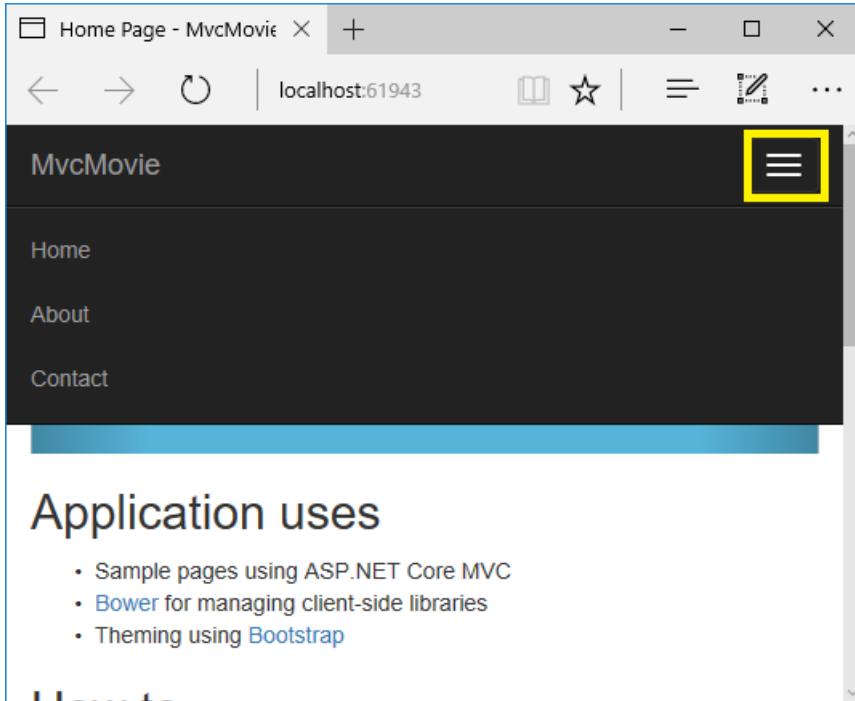
- Sample pages using ASP.NET Core MVC
- Bower for managing client-side libraries
- Theming using Bootstrap

## How to

- Add a Controller and View
- Manage User Secrets using Secret Manager
- Use logging to log a message
- Add packages using NuGet

VS Code starts the **Kestrel** web server and runs your app. Notice that the address bar shows `localhost:5000` and not something like `example.com`. That's because `localhost` is the standard hostname for your local computer.

The default template gives you working **Home**, **About** and **Contact** links. The browser image above doesn't show these links. Depending on the size of your browser, you might need to click the navigation icon to show them.



In the next part of this tutorial, we'll learn about MVC and start writing some code.

## Visual Studio Code help

- [Getting started](#)
- [Debugging](#)
- [Integrated terminal](#)
- [Keyboard shortcuts](#)
  - [macOS keyboard shortcuts](#)
  - [Linux keyboard shortcuts](#)
  - [Windows keyboard shortcuts](#)

[NEXT - ADD A](#)

[CONTROLLER](#)

# Add a controller to an ASP.NET Core app

6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

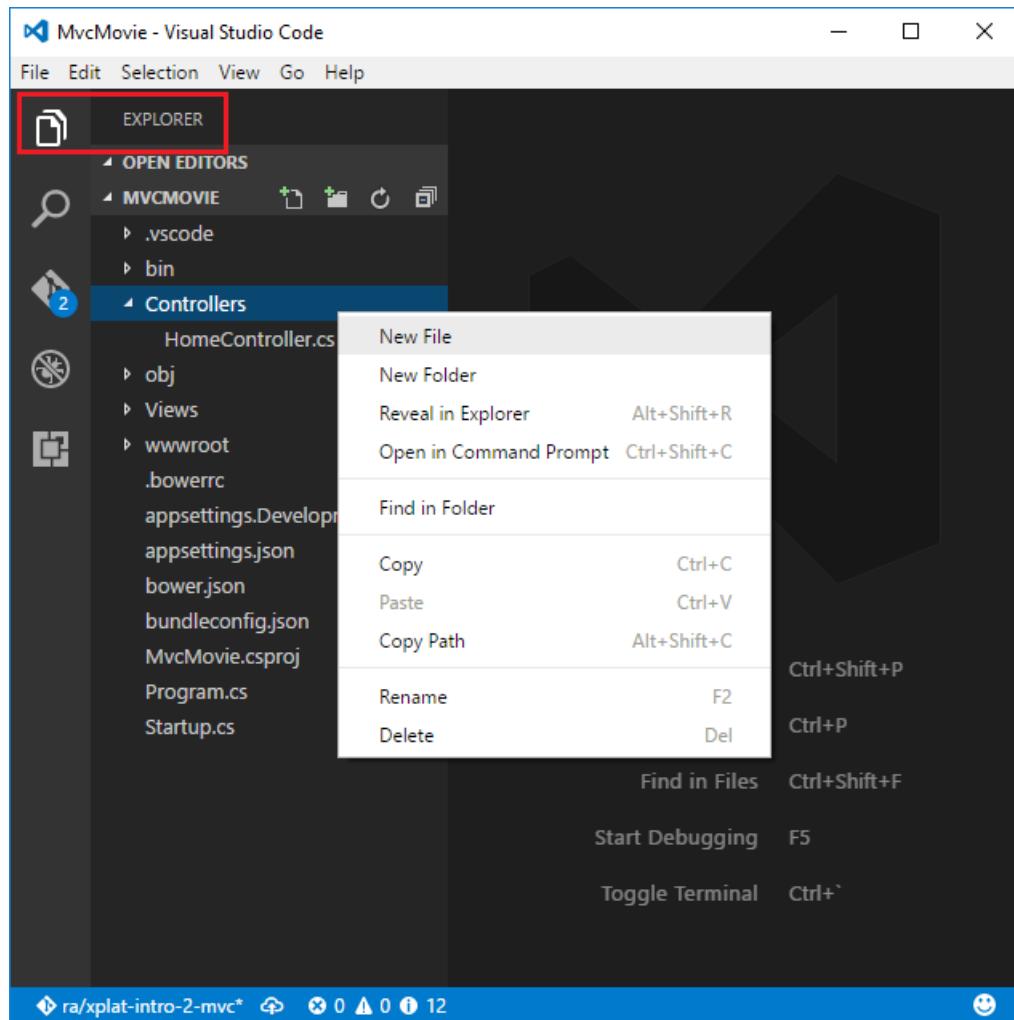
The Model-View-Controller (MVC) architectural pattern separates an app into three main components: **Model**, **View**, and **Controller**. The MVC pattern helps you create apps that are more testable and easier to update than traditional monolithic apps. MVC-based apps contain:

- **Models:** Classes that represent the data of the app. The model classes use validation logic to enforce business rules for that data. Typically, model objects retrieve and store model state in a database. In this tutorial, a `Movie` model retrieves movie data from a database, provides it to the view or updates it. Updated data is written to a database.
- **Views:** Views are the components that display the app's user interface (UI). Generally, this UI displays the model data.
- **Controllers:** Classes that handle browser requests. They retrieve model data and call view templates that return a response. In an MVC app, the view only displays information; the controller handles and responds to user input and interaction. For example, the controller handles route data and query-string values, and passes these values to the model. The model might use these values to query the database. For example,  
`http://localhost:1234/Home/About` has route data of `Home` (the controller) and `About` (the action method to call on the home controller). `http://localhost:1234/Movies/Edit/5` is a request to edit the movie with ID=5 using the movie controller. We'll talk about route data later in the tutorial.

The MVC pattern helps you create apps that separate the different aspects of the app (input logic, business logic, and UI logic), while providing a loose coupling between these elements. The pattern specifies where each kind of logic should be located in the app. The UI logic belongs in the view. Input logic belongs in the controller. Business logic belongs in the model. This separation helps you manage complexity when you build an app, because it enables you to work on one aspect of the implementation at a time without impacting the code of another. For example, you can work on the view code without depending on the business logic code.

We cover these concepts in this tutorial series and show you how to use them to build a movie app. The MVC project contains folders for the *Controllers* and *Views*.

- In **VS Code**, select the **EXPLORER** icon and then control-click (right-click) **Controllers > New File** and name the new file `HelloWorldController.cs`.



Replace the contents of *Controllers/HelloWorldController.cs* with the following:

```
using Microsoft.AspNetCore.Mvc;
using System.Text.Encodings.Web;

namespace MvcMovie.Controllers
{
    public class HelloWorldController : Controller
    {
        //
        // GET: /HelloWorld/

        public string Index()
        {
            return "This is my default action...";
        }

        //
        // GET: /HelloWorld/Welcome/

        public string Welcome()
        {
            return "This is the Welcome action method...";
        }
    }
}
```

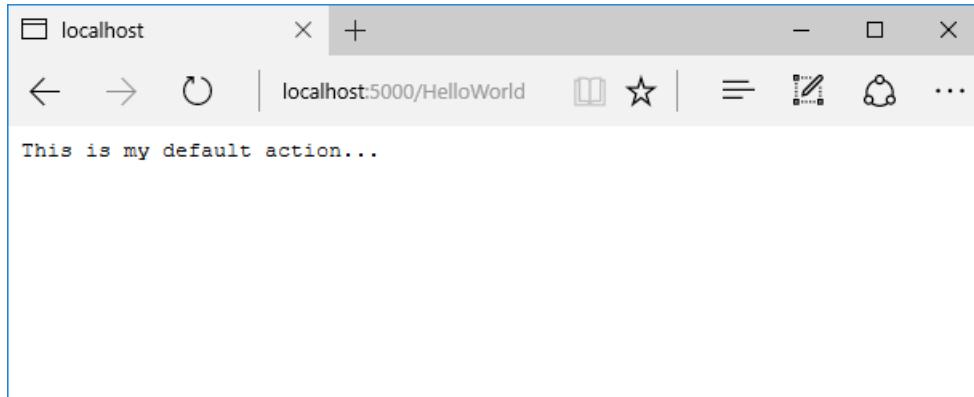
Every `public` method in a controller is callable as an HTTP endpoint. In the sample above, both methods return a string. Note the comments preceding each method.

An HTTP endpoint is a targetable URL in the web application, such as `http://localhost:1234/HelloWorld`, and

combines the protocol used: `HTTP`, the network location of the web server (including the TCP port): `localhost:1234` and the target URI `HelloWorld`.

The first comment states this is an `HTTP GET` method that's invoked by appending `/HelloWorld/` to the base URL. The second comment specifies an `HTTP GET` method that's invoked by appending `/HelloWorld/Welcome/` to the URL. Later on in the tutorial you'll use the scaffolding engine to generate `HTTP POST` methods.

Run the app in non-debug mode and append `"HelloWorld"` to the path in the address bar. The `Index` method returns a string.



MVC invokes controller classes (and the action methods within them) depending on the incoming URL. The [default URL routing logic](#) used by MVC uses a format like this to determine what code to invoke:

```
/[Controller]/[ActionName]/[Parameters]
```

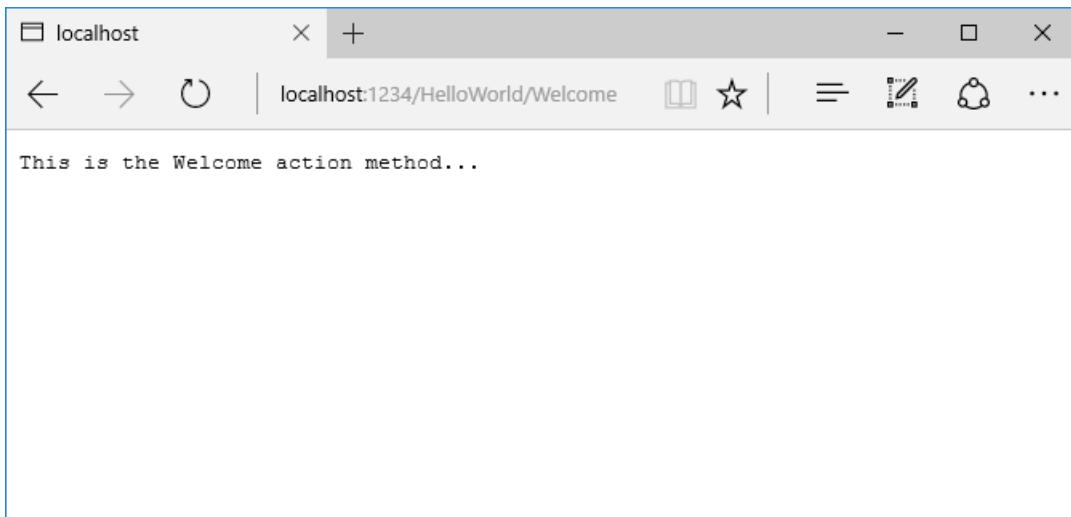
You set the format for routing in the `Configure` method in `Startup.cs` file.

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

When you run the app and don't supply any URL segments, it defaults to the "Home" controller and the "Index" method specified in the template line highlighted above.

The first URL segment determines the controller class to run. So `localhost:xxxx/HelloWorld` maps to the `HelloWorldController` class. The second part of the URL segment determines the action method on the class. So `localhost:xxxx/HelloWorld/Index` would cause the `Index` method of the `HelloWorldController` class to run. Notice that you only had to browse to `localhost:xxxx/HelloWorld` and the `Index` method was called by default. This is because `Index` is the default method that will be called on a controller if a method name isn't explicitly specified. The third part of the URL segment (`id`) is for route data. You'll see route data later on in this tutorial.

Browse to `http://localhost:xxxx/HelloWorld/Welcome`. The `Welcome` method runs and returns the string "This is the Welcome action method...". For this URL, the controller is `HelloWorld` and `Welcome` is the action method. You haven't used the `[Parameters]` part of the URL yet.



Modify the code to pass some parameter information from the URL to the controller. For example, `/HelloWorld/Welcome?name=Rick&numtimes=4`. Change the `Welcome` method to include two parameters as shown in the following code.

```
// GET: /HelloWorld/Welcome/
// Requires using System.Text.Encodings.Web;
public string Welcome(string name, int numTimes = 1)
{
    return HtmlEncoder.Default.Encode($"Hello {name}, NumTimes is: {numTimes}");
}
```

The preceding code:

- Uses the C# optional-parameter feature to indicate that the `numTimes` parameter defaults to 1 if no value is passed for that parameter.
- Uses `HtmlEncoder.Default.Encode` to protect the app from malicious input (namely JavaScript).
- Uses [Interpolated Strings](#).

Run your app and browse to:

```
http://localhost:xxxx>HelloWorld/Welcome?name=Rick&numtimes=4
```

(Replace xxxx with your port number.) You can try different values for `name` and `numtimes` in the URL. The MVC [model binding](#) system automatically maps the named parameters from the query string in the address bar to parameters in your method. See [Model Binding](#) for more information.

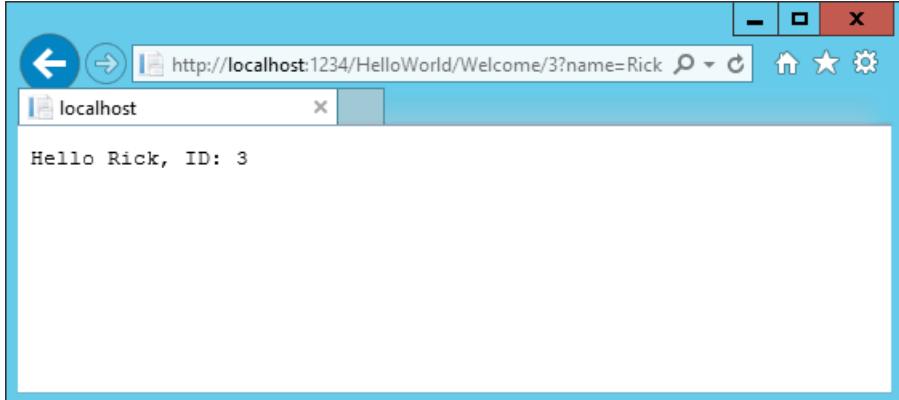


In the image above, the URL segment (`Parameters`) isn't used, the `name` and `numTimes` parameters are passed as [query strings](#). The `?` (question mark) in the above URL is a separator, and the query strings follow. The `&` character separates query strings.

Replace the `Welcome` method with the following code:

```
public string Welcome(string name, int ID = 1)
{
    return HtmlEncoder.Default.Encode($"Hello {name}, ID: {ID}");
}
```

Run the app and enter the following URL: `http://localhost:xxx/HelloWorld/Welcome/3?name=Rick`



This time the third URL segment matched the route parameter `id`. The `Welcome` method contains a parameter `id` that matched the URL template in the `MapRoute` method. The trailing `?` (in `id?`) indicates the `id` parameter is optional.

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

In these examples the controller has been doing the "VC" portion of MVC - that is, the view and controller work. The controller is returning HTML directly. Generally you don't want controllers returning HTML directly, since that becomes very cumbersome to code and maintain. Instead you typically use a separate Razor view template file to help generate the HTML response. You do that in the next tutorial.

[PREVIOUS - ADD A](#)

[CONTROLLER](#)

[NEXT - ADD A](#)

[VIEW](#)

# Add a view to an ASP.NET Core MVC app

6/26/2018 • 8 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section you modify the `HelloWorldController` class to use Razor view template files to cleanly encapsulate the process of generating HTML responses to a client.

You create a view template file using Razor. Razor-based view templates have a `.cshtml` file extension. They provide an elegant way to create HTML output using C#.

Currently the `Index` method returns a string with a message that's hard-coded in the controller class. In the `HelloWorldController` class, replace the `Index` method with the following code:

```
public IActionResult Index()
{
    return View();
}
```

The preceding code returns a `View` object. It uses a view template to generate an HTML response to the browser. Controller methods (also known as action methods) such as the `Index` method above, generally return an `IActionResult` (or a class derived from `ActionResult`), not a type like `string`.

Add an `Index` view for the `HelloWorldController`.

- Add a new folder named `Views/HelloWorld`.
- Add a new file to the `Views/HelloWorld` folder name `Index.cshtml`.

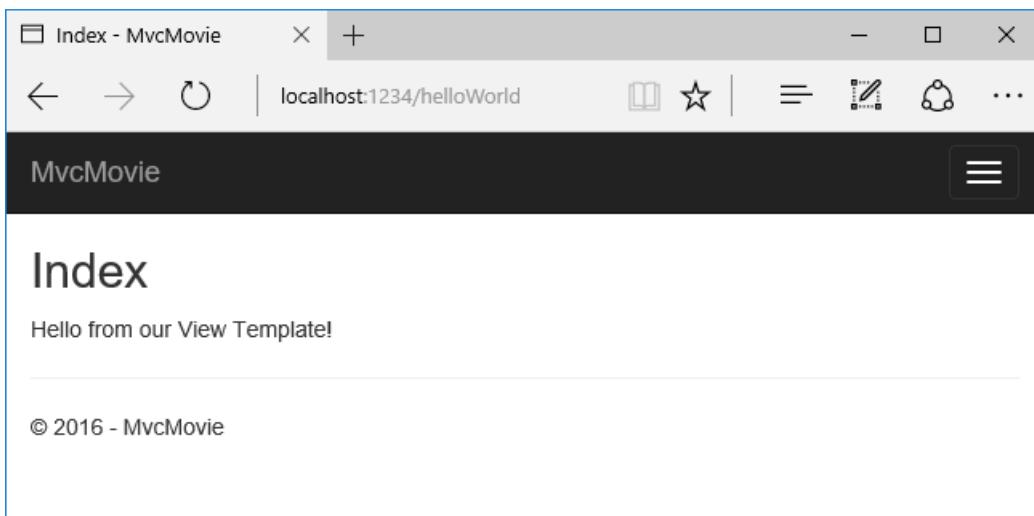
Replace the contents of the `Views/HelloWorld/Index.cshtml` Razor view file with the following:

```
@{
    ViewData["Title"] = "Index";
}

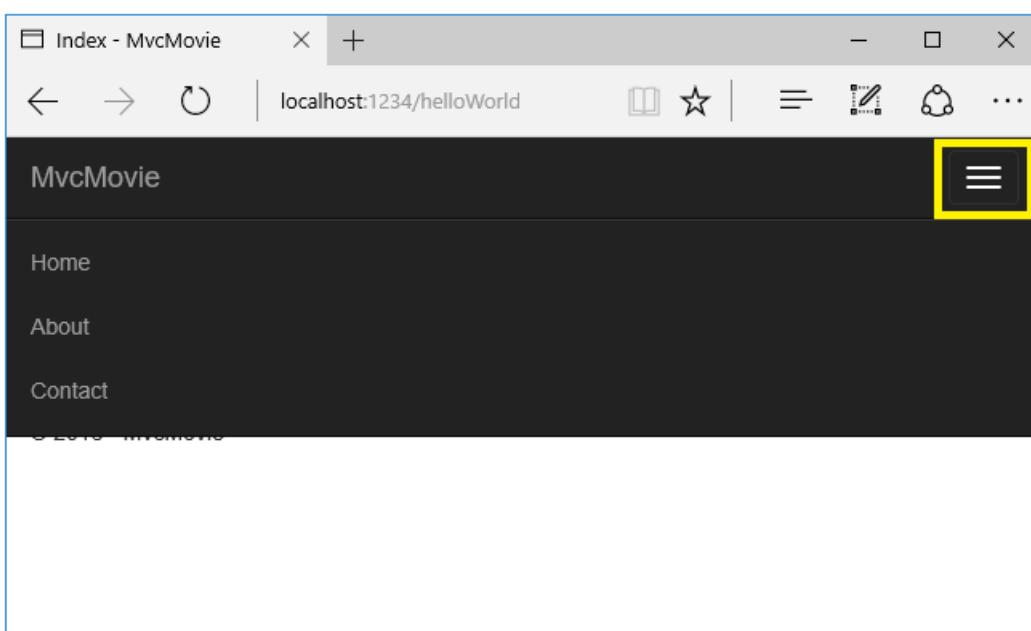
<h2>Index</h2>

<p>Hello from our View Template!</p>
```

Navigate to `http://localhost:xxxx>HelloWorld`. The `Index` method in the `HelloWorldController` didn't do much; it ran the statement `return View();`, which specified that the method should use a view template file to render a response to the browser. Because you didn't explicitly specify the name of the view template file, MVC defaulted to using the `Index.cshtml` view file in the `/Views/HelloWorld` folder. The image below shows the string "Hello from our View Template!" hard-coded in the view.



If your browser window is small (for example on a mobile device), you might need to toggle (tap) the [Bootstrap navigation button](#) in the upper right to see the **Home**, **About**, and **Contact** links.



## Changing views and layout pages

Tap the menu links (**MvcMovie**, **Home**, **About**). Each page shows the same menu layout. The menu layout is implemented in the *Views/Shared/\_Layout.cshtml* file. Open the *Views/Shared/\_Layout.cshtml* file.

[Layout](#) templates allow you to specify the HTML container layout of your site in one place and then apply it across multiple pages in your site. Find the `@RenderBody()` line. `RenderBody` is a placeholder where all the view-specific pages you create show up, *wrapped* in the layout page. For example, if you select the **About** link, the **Views/Home/About.cshtml** view is rendered inside the `RenderBody` method.

## Change the title and menu link in the layout file

In the title element, change `MvcMovie` to `Movie App`. Change the anchor text in the layout template from `MvcMovie` to `Movie App` and the controller from `Home` to `Movies` as highlighted below:

```
@inject Microsoft.ApplicationInsights.AspNetCore.JavaScriptSnippet JavaScriptSnippet
<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
```

```

<meta name="viewport" content="width=device-width, initial-scale=1.0" />
<title>@ ViewData["Title"] - Movie App</title>

<environment names="Development">
    <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />
    <link rel="stylesheet" href="~/css/site.css" />
</environment>
<environment names="Staging,Production">
    <link rel="stylesheet" href="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/css/bootstrap.min.css"
        asp-fallback-href="~/lib/bootstrap/dist/css/bootstrap.min.css"
        asp-fallback-test-class="sr-only" asp-fallback-test-property="position" asp-fallback-test-
        value="absolute" />
    <link rel="stylesheet" href="~/css/site.min.css" asp-append-version="true" />
</environment>
@Html.Raw(JavaScriptSnippet.FullScript)
</head>
<body>
    <nav class="navbar navbar-inverse navbar-fixed-top">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-
collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a asp-area="" asp-controller="Movies" asp-action="Index" class="navbar-brand">Movie App</a>
            </div>
            <div class="navbar-collapse collapse">
                <ul class="nav navbar-nav">
                    <li><a asp-area="" asp-controller="Home" asp-action="Index">Home</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="About">About</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="Contact">Contact</a></li>
                </ul>
            </div>
        </div>
    </nav>
    <div class="container body-content">
        @RenderBody()
        <hr />
        <footer>
            <p>&copy; 2017 - MvcMovie</p>
        </footer>
    </div>

    <environment names="Development">
        <script src="~/lib/jquery/dist/jquery.js"></script>
        <script src="~/lib/bootstrap/dist/js/bootstrap.js"></script>
        <script src="~/js/site.js" asp-append-version="true"></script>
    </environment>
    <environment names="Staging,Production">
        <script src="https://ajax.aspnetcdn.com/ajax/jquery/jquery-2.2.0.min.js"
            asp-fallback-src="~/lib/jquery/dist/jquery.min.js"
            asp-fallback-test="window.jQuery"
            crossorigin="anonymous"
            integrity="sha384-K+ctZQ+LL8q6tP7I94W+qzQsfRV2a+AfhI9k8z8l9ggpc8X+Ytst4yBo/hH+8Fk">
        </script>
        <script src="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/bootstrap.min.js"
            asp-fallback-src="~/lib/bootstrap/dist/js/bootstrap.min.js"
            asp-fallback-test="window.jQuery && window.jQuery.fn && window.jQuery.fn.modal"
            crossorigin="anonymous"
            integrity="sha384-Tc5IQib027qvyjSMfHjOMaLkfUWVxZxUPnCJA712mCWNIPG9mGCD8wGNICPD7Txa">
        </script>
        <script src="~/js/site.min.js" asp-append-version="true"></script>
    </environment>

        @RenderSection("Scripts", required: false)
    </body>

```

```

</html>

@inject Microsoft.ApplicationInsights.AspNetCore.JavaScriptSnippet JavaScriptSnippet
<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>@ViewData["Title"] - Movie App</title>

    <environment names="Development">
        <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />
        <link rel="stylesheet" href="~/css/site.css" />
    </environment>
    <environment names="Staging,Production">
        <link rel="stylesheet" href="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/css/bootstrap.min.css"
              asp-fallback-href="~/lib/bootstrap/dist/css/bootstrap.min.css"
              asp-fallback-test-class="sr-only" asp-fallback-test-property="position" asp-fallback-test-
              value="absolute" />
        <link rel="stylesheet" href="~/css/site.min.css" asp-append-version="true" />
    </environment>
    @Html.Raw(JavaScriptSnippet.FullScript)
</head>
<body>
    <nav class="navbar navbar-inverse navbar-fixed-top">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-
collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a asp-area="" asp-controller="Movies" asp-action="Index" class="navbar-brand">Movie App</a>
            </div>
            <div class="navbar-collapse collapse">
                <ul class="nav navbar-nav">
                    <li><a asp-area="" asp-controller="Home" asp-action="Index">Home</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="About">About</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="Contact">Contact</a></li>
                </ul>
            </div>
        </div>
    </nav>
    <div class="container body-content">
        @RenderBody()
        <hr />
        <footer>
            <p>&copy; 2017 - MvcMovie</p>
        </footer>
    </div>

    <environment names="Development">
        <script src="~/lib/jquery/dist/jquery.js"></script>
        <script src="~/lib/bootstrap/dist/js/bootstrap.js"></script>
        <script src="~/js/site.js" asp-append-version="true"></script>
    </environment>
    <environment names="Staging,Production">
        <script src="https://ajax.aspnetcdn.com/ajax/jquery/jquery-2.2.0.min.js"
               asp-fallback-src="~/lib/jquery/dist/jquery.min.js"
               asp-fallback-test="window.jQuery"
               crossorigin="anonymous"
               integrity="sha384-K+ctZQ+LL8q6tP7I94W+qzQsfRV2a+AfhII9k8z8l9ggpc8X+Ytst4yBo/hH+8Fk">
        </script>
        <script src="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/bootstrap.min.js"
               asp-fallback-src="~/lib/bootstrap/dist/js/bootstrap.min.js"
               asp-fallback-test="window.jQuery && window.jQuery.fn.modal">
        </script>
    </environment>

```

```

asp-partial-view-test= window.jQuery && window.jQuery.fn && window.jQuery.fn.mousedown
crossorigin="anonymous"
integrity="sha384-Tc5IQib027qvyjSMfHjOMaLkfWVxZxUPnCJA712mCWNIPG9mGCD8wGNICPD7Txa">
</script>
<script src="~/js/site.min.js" asp-append-version="true"></script>
</environment>

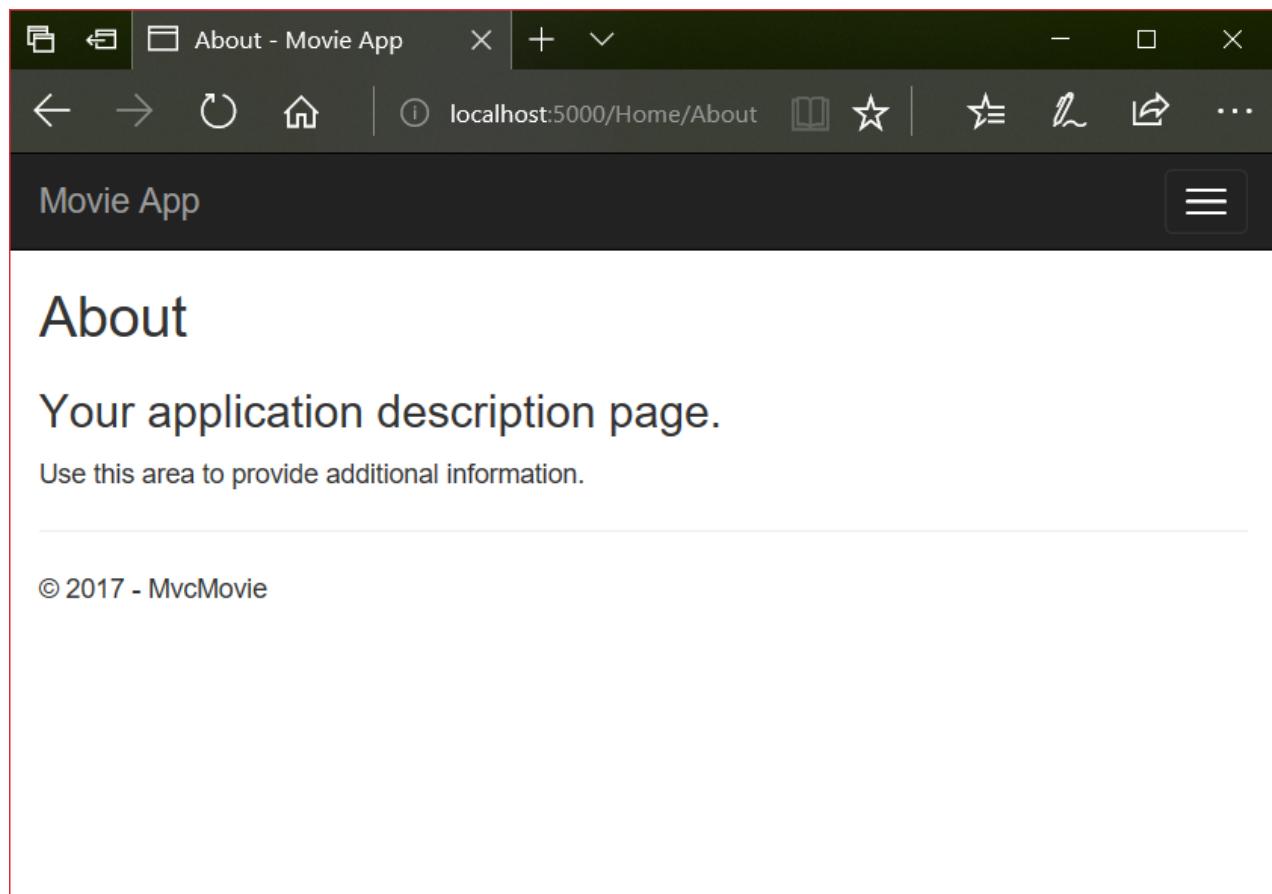
@RenderSection("Scripts", required: false)
</body>
</html>

```

### WARNING

We haven't implemented the `Movies` controller yet, so if you click on that link, you'll get a 404 (Not found) error.

Save your changes and tap the **About** link. Notice how the title on the browser tab now displays **About - Movie App** instead of **About - Mvc Movie**:



Tap the **Contact** link and notice that the title and anchor text also display **Movie App**. We were able to make the change once in the layout template and have all pages on the site reflect the new link text and new title.

Examine the `Views/_ViewStart.cshtml` file:

```

@{
    Layout = "_Layout";
}

```

The `Views/_ViewStart.cshtml` file brings in the `Views/Shared/_Layout.cshtml` file to each view. You can use the `Layout` property to set a different layout view, or set it to `null` so no layout file will be used.

Change the title of the `Index` view.

Open `Views/HelloWorld/Index.cshtml`. There are two places to make a change:

- The text that appears in the title of the browser.
- The secondary header (`<h2>` element).

You'll make them slightly different so you can see which bit of code changes which part of the app.

```
@{
    ViewData["Title"] = "Movie List";
}

<h2>My Movie List</h2>

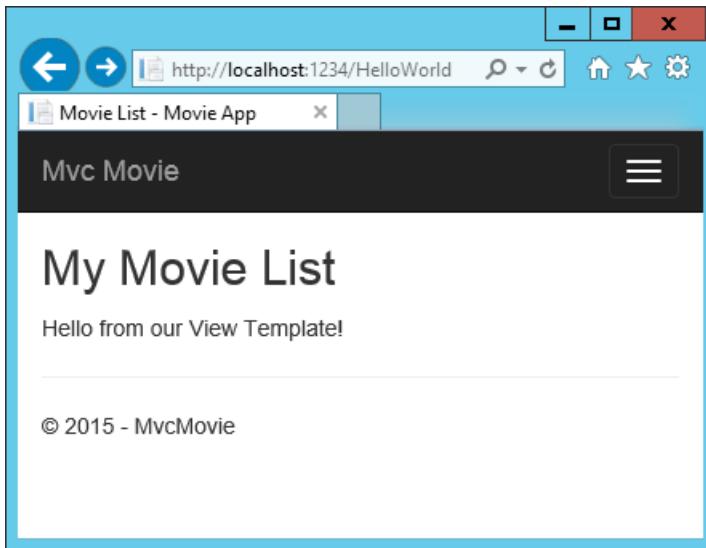
<p>Hello from our View Template!</p>
```

`ViewData["Title"] = "Movie List";` in the code above sets the `Title` property of the `ViewData` dictionary to "Movie List". The `Title` property is used in the `<title>` HTML element in the layout page:

```
<title>@ViewData["Title"] - Movie App</title>
```

Save your change and navigate to `http://localhost:xxxx/HelloWorld`. Notice that the browser title, the primary heading, and the secondary headings have changed. (If you don't see changes in the browser, you might be viewing cached content. Press `Ctrl+F5` in your browser to force the response from the server to be loaded.) The browser title is created with `ViewData["Title"]` we set in the `Index.cshtml` view template and the additional "- Movie App" added in the layout file.

Also notice how the content in the `Index.cshtml` view template was merged with the `Views/Shared/_Layout.cshtml` view template and a single HTML response was sent to the browser. Layout templates make it really easy to make changes that apply across all of the pages in your application. To learn more see [Layout](#).



Our little bit of "data" (in this case the "Hello from our View Template!" message) is hard-coded, though. The MVC application has a "V" (view) and you've got a "C" (controller), but no "M" (model) yet.

## Passing Data from the Controller to the View

Controller actions are invoked in response to an incoming URL request. A controller class is where you write the code that handles the incoming browser requests. The controller retrieves data from a data source and decides what type of response to send back to the browser. View templates can be used from a controller to generate and format an HTML response to the browser.

Controllers are responsible for providing the data required in order for a view template to render a response. A

best practice: View templates should **not** perform business logic or interact with a database directly. Rather, a view template should work only with the data that's provided to it by the controller. Maintaining this "separation of concerns" helps keep your code clean, testable, and maintainable.

Currently, the `Welcome` method in the `HelloWorldController` class takes a `name` and a `ID` parameter and then outputs the values directly to the browser. Rather than have the controller render this response as a string, change the controller to use a view template instead. The view template generates a dynamic response, which means that appropriate bits of data must be passed from the controller to the view in order to generate the response. Do this by having the controller put the dynamic data (parameters) that the view template needs in a `ViewData` dictionary that the view template can then access.

Return to the `HelloWorldController.cs` file and change the `Welcome` method to add a `Message` and `NumTimes` value to the `ViewData` dictionary. The `ViewData` dictionary is a dynamic object, which means you can put whatever you want in to it; the `ViewData` object has no defined properties until you put something inside it. The [MVC model binding system](#) automatically maps the named parameters (`name` and `numTimes`) from the query string in the address bar to parameters in your method. The complete `HelloWorldController.cs` file looks like this:

```
using Microsoft.AspNetCore.Mvc;
using System.Text.Encodings.Web;

namespace MvcMovie.Controllers
{
    public class HelloWorldController : Controller
    {
        public IActionResult Index()
        {
            return View();
        }

        public IActionResult Welcome(string name, int numTimes = 1)
        {
            ViewData["Message"] = "Hello " + name;
            ViewData["NumTimes"] = numTimes;

            return View();
        }
    }
}
```

The `ViewData` dictionary object contains data that will be passed to the view.

Create a `Welcome` view template named `Views/HelloWorld/Welcome.cshtml`.

You'll create a loop in the `Welcome.cshtml` view template that displays "Hello" `NumTimes`. Replace the contents of `Views/HelloWorld/Welcome.cshtml` with the following:

```
@{
    ViewData["Title"] = "Welcome";
}

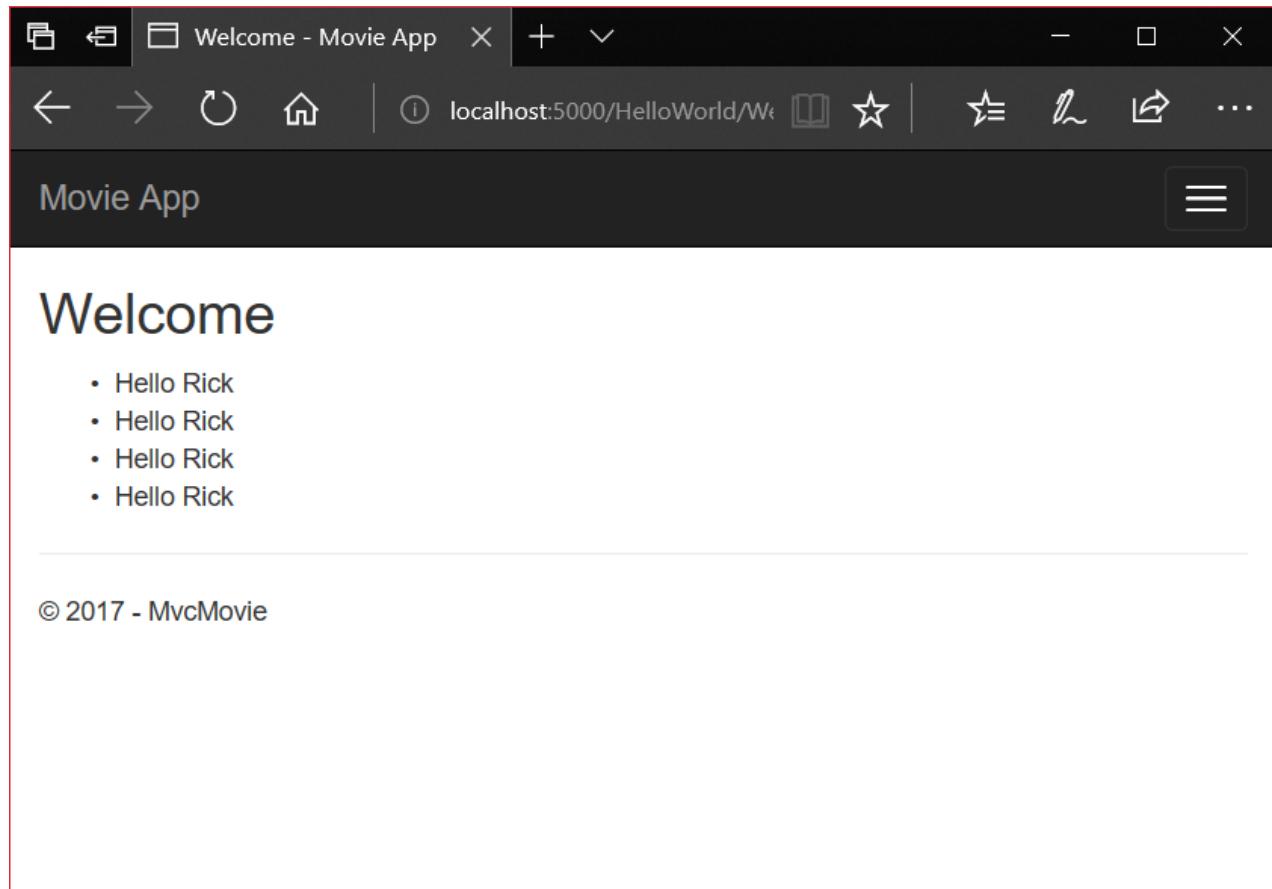
<h2>Welcome</h2>

<ul>
    @for (int i = 0; i < (int)ViewData["NumTimes"]; i++)
    {
        <li>@ViewData["Message"]</li>
    }
</ul>
```

Save your changes and browse to the following URL:

<http://localhost:xxxx/HelloWorld/Welcome?name=Rick&numtimes=4>

Data is taken from the URL and passed to the controller using the [MVC model binder](#). The controller packages the data into a `viewData` dictionary and passes that object to the view. The view then renders the data as HTML to the browser.



In the sample above, we used the `ViewData` dictionary to pass data from the controller to a view. Later in the tutorial, we will use a view model to pass data from a controller to a view. The view model approach to passing data is generally much preferred over the `ViewData` dictionary approach. See [ViewModel vs ViewData vs ViewBag vs TempData vs Session in MVC](#) for more information.

Well, that was a kind of an "M" for model, but not the database kind. Let's take what we've learned and create a database of movies.

[PREVIOUS - ADD A  
CONTROLLER](#)

[NEXT - ADD A  
MODEL](#)

# Add a model to an ASP.NET Core MVC app

6/26/2018 • 4 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Tom Dykstra](#)

In this section, you'll add some classes for managing movies in a database. These classes will be the "Model" part of the **MVC** app.

You use these classes with [Entity Framework Core](#) (EF Core) to work with a database. EF Core is an object-relational mapping (ORM) framework that simplifies the data access code that you have to write. [EF Core supports many database engines](#).

The model classes you'll create are known as POCO classes (from "plain-old CLR objects") because they don't have any dependency on EF Core. They just define the properties of the data that will be stored in the database.

In this tutorial you'll write the model classes first, and EF Core will create the database. An alternate approach not covered here is to generate model classes from an already-existing database. For information about that approach, see [ASP.NET Core - Existing Database](#).

## Add a data model class

- Add a class to the *Models* folder named *Movie.cs*.
- Add the following code to the *Models/Movie.cs* file:

```
using System;

namespace MvcMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}
```

The `ID` field is required by the database for the primary key.

Build the app to verify you don't have any errors, and you've finally added a **Model** to your **MVC** app.

## Prepare the project for scaffolding

- Add the following highlighted NuGet packages to the *MvcMovie.csproj* file:

```

<Project Sdk="Microsoft.NET.Sdk.Web">
  <PropertyGroup>
    <TargetFramework>netcoreapp2.0</TargetFramework>
  </PropertyGroup>
  <ItemGroup>
    <PackageReference Include="Microsoft.AspNetCore.All" Version="2.0.0" />
    <PackageReference Include="Microsoft.VisualStudio.Web.CodeGeneration.Design" Version="2.0.0" />
  </ItemGroup>
  <ItemGroup>
    <DotNetCliToolReference Include="Microsoft.EntityFrameworkCore.Tools.DotNet" Version="2.0.0" />
    <DotNetCliToolReference Include="Microsoft.VisualStudio.Web.CodeGeneration.Tools" Version="2.0.0" />
  </ItemGroup>
</Project>

```

- Save the file and select **Restore** to the **Info** message "There are unresolved dependencies".
- Create a *Models/MvcMovieContext.cs* file and add the following `MvcMovieContext` class:

```

using Microsoft.EntityFrameworkCore;

namespace MvcMovie.Models
{
    public class MvcMovieContext : DbContext
    {
        public MvcMovieContext (DbContextOptions<MvcMovieContext> options)
            : base(options)
        {
        }

        public DbSet<MvcMovie.Models.Movie> Movie { get; set; }
    }
}

```

- Open the *Startup.cs* file and add two usings:

```

using Microsoft.EntityFrameworkCore;
using MvcMovie.Models;

namespace MvcMovie
{
    public class Startup
    {

```

- Add the database context to the *Startup.cs* file:

```

        public void ConfigureServices(IServiceCollection services)
        {
            // Add framework services.
            services.AddMvc();

            services.AddDbContext<MvcMovieContext>(options =>
                options.UseSqlite("Data Source=MvcMovie.db"));
        }

```

This tells Entity Framework which model classes are included in the data model. You're defining one *entity set* of Movie objects, which will be represented in the database as a Movie table.

- Build the project to verify there are no errors.

## Scaffold the MovieController

Open a terminal window in the project folder and run the following commands:

```
dotnet restore  
dotnet aspnet-codegenerator controller -name MoviesController -m Movie -dc MvcMovieContext --  
relativeFolderPath Controllers --useDefaultLayout --referenceScriptLibraries
```

The scaffolding engine creates the following:

- A movies controller (*Controllers/MoviesController.cs*)
- Razor view files for Create, Delete, Details, Edit and Index pages (*Views/Movies/\*.cshtml*)

The automatic creation of **CRUD** (create, read, update, and delete) action methods and views is known as *scaffolding*. You'll soon have a fully functional web application that lets you manage a movie database.

## Perform initial migration

From the command line, run the following .NET Core CLI commands:

```
dotnet ef migrations add InitialCreate  
dotnet ef database update
```

The `dotnet ef migrations add InitialCreate` command generates code to create the initial database schema. The schema is based on the model specified in the `DbContext` (In the *Models/MvcMovieContext.cs* file). The `Initial` argument is used to name the migrations. You can use any name, but by convention you choose a name that describes the migration. See [Introduction to migrations](#) for more information.

The `dotnet ef database update` command runs the `Up` method in the *Migrations/<time-stamp>\_InitialCreate.cs* file, which creates the database.

## Test the app

- Run the app and tap the **Mvc Movie** link.
- Tap the **Create New** link and create a movie.

The screenshot shows a browser window titled "Create - Movie App" with the URL "localhost:1234/Movies/". The page is titled "MvcMovie" and has a header "Create". The form is for creating a "Movie" with fields: "Title" (Conan), "Release Date" (3/3/2017), "Genre" (Comedy), and "Price" (1.99). A "Create" button is at the bottom.

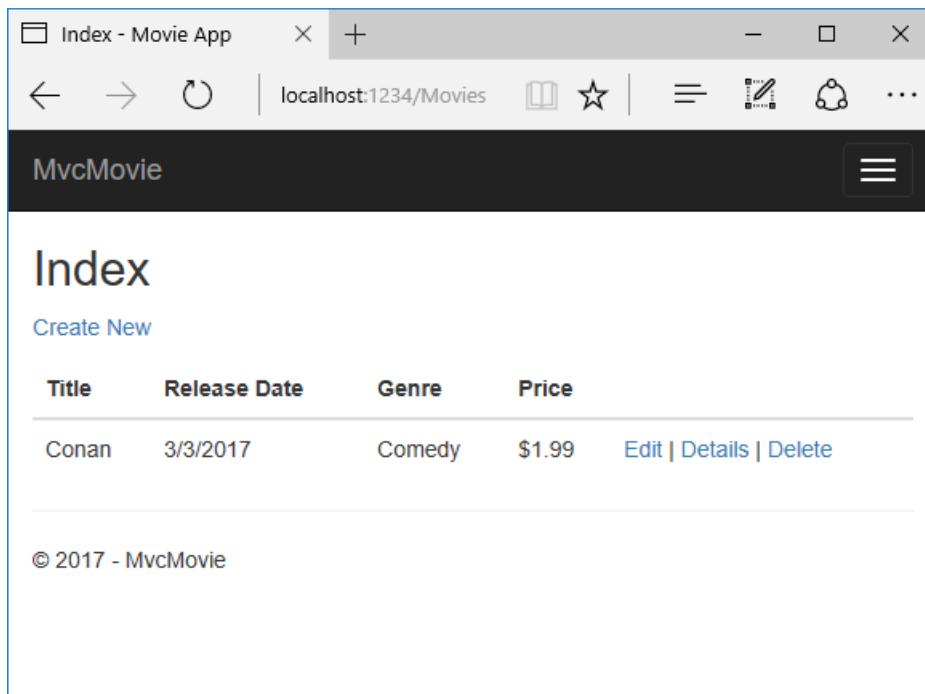
- You may not be able to enter decimal points or commas in the `Price` field. To support [jQuery validation](#) for non-English locales that use a comma (",") for a decimal point, and non US-English date formats, you must take steps to globalize your app. See <https://github.com/aspnet/Docs/issues/4076> and [Additional resources](#) for more information. For now, just enter whole numbers like 10.
- In some locales you need to specify the date format. See the highlighted code below.

```
using System;
using System.ComponentModel.DataAnnotations;

namespace MvcMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }
        [DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}
```

We'll talk about `DataAnnotations` later in the tutorial.

Tapping **Create** causes the form to be posted to the server, where the movie information is saved in a database. The app redirects to the /Movies URL, where the newly created movie information is displayed.



The screenshot shows a mobile browser window titled "Index - Movie App". The address bar indicates the URL is "localhost:1234/Movies". The main content area is titled "MvcMovie" and contains the word "Index". Below this, there is a link "Create New". A table lists a single movie entry:

Title	Release Date	Genre	Price	Action
Conan	3/3/2017	Comedy	\$1.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

At the bottom of the page, there is a copyright notice: "© 2017 - MvcMovie".

Create a couple more movie entries. Try the **Edit**, **Details**, and **Delete** links, which are all functional.

You now have a database and pages to display, edit, update and delete data. In the next tutorial, we'll work with the database.

### Additional resources

- [Tag Helpers](#)
- [Globalization and localization](#)

[PREVIOUS - ADD A  
VIEW](#)

[NEXT - WORKING WITH  
SQLITE](#)

# Work with SQLite in an ASP.NET Core MVC app

6/26/2018 • 2 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

The `MvcMovieContext` object handles the task of connecting to the database and mapping `Movie` objects to database records. The database context is registered with the [Dependency Injection](#) container in the `ConfigureServices` method in the `Startup.cs` file:

```
public void ConfigureServices(IServiceCollection services)
{
    // Add framework services.
    services.AddMvc();

    services.AddDbContext<MvcMovieContext>(options =>
        options.UseSqlite("Data Source=MvcMovie.db"));

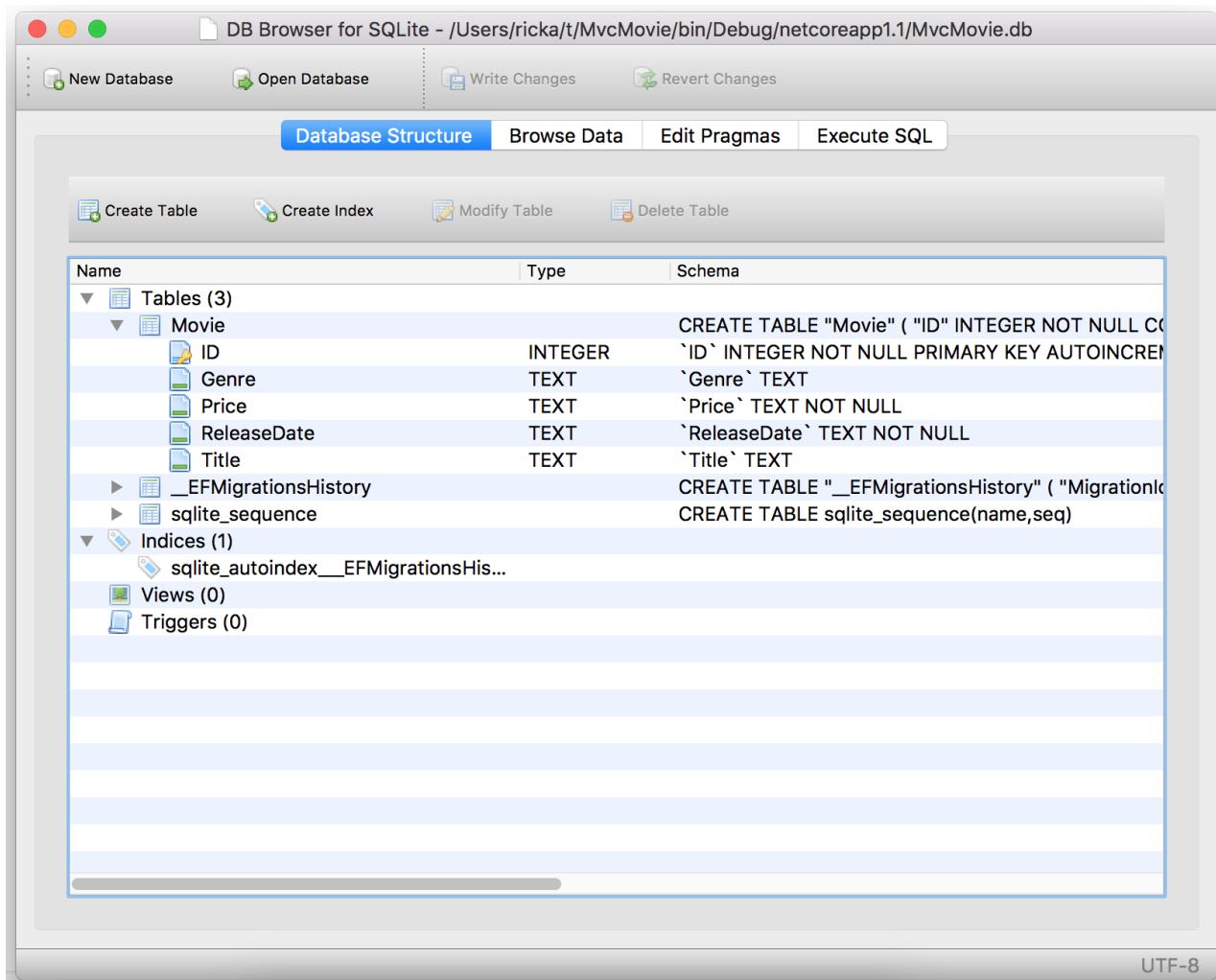
}
```

## SQLite

The [SQLite](#) website states:

SQLite is a self-contained, high-reliability, embedded, full-featured, public-domain, SQL database engine. SQLite is the most used database engine in the world.

There are many third party tools you can download to manage and view a SQLite database. The image below is from [DB Browser for SQLite](#). If you have a favorite SQLite tool, leave a comment on what you like about it.



## Seed the database

Create a new class named `SeedData` in the *Models* folder. Replace the generated code with the following:

```

using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using System;
using System.Linq;

namespace MvcMovie.Models
{
    public static class SeedData
    {
        public static void Initialize(IServiceProvider serviceProvider)
        {
            using (var context = new MvcMovieContext(
                serviceProvider.GetRequiredService<DbContextOptions<MvcMovieContext>>()))
            {
                // Look for any movies.
                if (context.Movie.Any())
                {
                    return; // DB has been seeded
                }

                context.Movie.AddRange(
                    new Movie
                    {
                        Title = "When Harry Met Sally",
                        ReleaseDate = DateTime.Parse("1989-1-11"),
                        Genre = "Romantic Comedy",
                        Price = 7.99M
                    },
                    new Movie
                    {
                        Title = "Ghostbusters ",
                        ReleaseDate = DateTime.Parse("1984-3-13"),
                        Genre = "Comedy",
                        Price = 8.99M
                    },
                    new Movie
                    {
                        Title = "Ghostbusters 2",
                        ReleaseDate = DateTime.Parse("1986-2-23"),
                        Genre = "Comedy",
                        Price = 9.99M
                    },
                    new Movie
                    {
                        Title = "Rio Bravo",
                        ReleaseDate = DateTime.Parse("1959-4-15"),
                        Genre = "Western",
                        Price = 3.99M
                    }
                );
                context.SaveChanges();
            }
        }
    }
}

```

If there are any movies in the DB, the seed initializer returns.

```
if (context.Movie.Any())
{
    return; // DB has been seeded.
}
```

## Add the seed initializer

Add the seed initializer to the `Main` method in the `Program.cs` file:

```
using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;
using System;
using Microsoft.EntityFrameworkCore;
using MvcMovie.Models;
using MvcMovie;

namespace MvcMovie
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = CreateWebHostBuilder(args).Build();

            using (var scope = host.Services.CreateScope())
            {
                var services = scope.ServiceProvider;

                try
                {
                    var context = services.GetRequiredService<MvcMovieContext>();
                    context.Database.Migrate();
                    SeedData.Initialize(services);
                }
                catch (Exception ex)
                {
                    var logger = services.GetRequiredService<ILogger<Program>>();
                    logger.LogError(ex, "An error occurred seeding the DB.");
                }
            }

            host.Run();
        }

        public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>();
    }
}
```

```

using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;
using MvcMovie.Models;
using System;

namespace MvcMovie
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = BuildWebHost(args);

            using (var scope = host.Services.CreateScope())
            {
                var services = scope.ServiceProvider;

                try
                {
                    // Requires using MvcMovie.Models;
                    SeedData.Initialize(services);
                }
                catch (Exception ex)
                {
                    var logger = services.GetRequiredService<ILogger<Program>>();
                    logger.LogError(ex, "An error occurred seeding the DB.");
                }
            }

            host.Run();
        }

        public static IWebHost BuildWebHost(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>()
                .Build();
    }
}

```

## Test the app

Delete all the records in the DB (So the seed method will run). Stop and start the app to seed the database.

The app shows the seeded data.

A screenshot of a Microsoft Edge browser window. The title bar says "Ricka - Movie App". The address bar shows "localhost:5000/Movies". The main content area is titled "MvcMovie" with a "Create New" link. Below is a table listing four movies:

Title	ReleaseDate	Genre	Price	
When Harry Met Sally	1/11/1989 12:00:00 AM	Romantic Comedy	7.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Ghostbusters	3/13/1984 12:00:00 AM	Comedy	8.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Ghostbusters 2	2/23/1986 12:00:00 AM	Comedy	9.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Rio Bravo	4/15/1959 12:00:00 AM	Western	3.99	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

At the bottom left, it says "© 2017 - MvcMovie".

PREVIOUS - ADD A  
MODEL

NEXT - CONTROLLER METHODS AND  
VIEWS

# Controller methods and views in ASP.NET Core

6/21/2018 • 10 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

We have a good start to the movie app, but the presentation isn't ideal. We don't want to see the time (12:00:00 AM in the image below) and **ReleaseDate** should be two words.

Title	ReleaseDate	Genre	Price
When Harry Met Sally	1/11/1989 12:00:00 AM	Romantic Comedy	7.99
Ghostbusters	3/13/1984 12:00:00 AM	Comedy	8.99
Ghostbusters 2	2/23/1986 12:00:00 AM	Comedy	9.99
Rio Bravo	4/15/1959 12:00:00 AM	Western	3.99

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Open the *Models/Movie.cs* file and add the highlighted lines shown below:

```
using System;
using System.ComponentModel.DataAnnotations;

namespace MvcMovie.Models
{
    public class Movie
    {
        public int ID { get; set; }
        public string Title { get; set; }

        [Display(Name = "Release Date")]
        [DataType(DataType.Date)]
        public DateTime ReleaseDate { get; set; }
        public string Genre { get; set; }
        public decimal Price { get; set; }
    }
}
```

Build and run the app.

We cover [DataAnnotations](#) in the next tutorial. The [Display](#) attribute specifies what to display for the name of a

field (in this case "Release Date" instead of "ReleaseDate"). The `DataType` attribute specifies the type of the data (Date), so the time information stored in the field isn't displayed.

The `[Column(TypeName = "decimal(18, 2)")]` data annotation is required so Entity Framework Core can correctly map `Price` to currency in the database. For more information, see [Data Types](#).

Browse to the `Movies` controller and hold the mouse pointer over an **Edit** link to see the target URL.

Genre	Price	Release Date	Title	
Romantic Comedy	7.99	1/11/1989	When Harry Met Sally	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	8.99	3/13/1984	Ghostbusters	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	9.99	2/23/1986	Ghostbusters 2	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Western	3.99	4/15/1959	Rio Bravo	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

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<http://localhost:1234/Movies/Edit/5>

The **Edit**, **Details**, and **Delete** links are generated by the Core MVC Anchor Tag Helper in the `Views/Movies/Index.cshtml` file.

```
<a asp-action="Edit" asp-route-id="@item.ID">Edit</a> |
<a asp-action="Details" asp-route-id="@item.ID">Details</a> |
<a asp-action="Delete" asp-route-id="@item.ID">Delete</a>
</td>
</tr>
```

[Tag Helpers](#) enable server-side code to participate in creating and rendering HTML elements in Razor files. In the code above, the `AnchorTagHelper` dynamically generates the HTML `href` attribute value from the controller action method and route id. You use **View Source** from your favorite browser or use the developer tools to examine the generated markup. A portion of the generated HTML is shown below:

```
<td>
<a href="/Movies/Edit/4"> Edit </a> |
<a href="/Movies/Details/4"> Details </a> |
<a href="/Movies/Delete/4"> Delete </a>
</td>
```

Recall the format for [routing](#) set in the `Startup.cs` file:

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

ASP.NET Core translates `http://localhost:1234/Movies/Edit/4` into a request to the `Edit` action method of the `Movies` controller with the parameter `Id` of 4. (Controller methods are also known as action methods.)

[Tag Helpers](#) are one of the most popular new features in ASP.NET Core. See [Additional resources](#) for more information.

Open the `Movies` controller and examine the two `Edit` action methods. The following code shows the `HTTP GET Edit` method, which fetches the movie and populates the edit form generated by the `Edit.cshtml` Razor file.

```
// GET: Movies/Edit/5
public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie.FindAsync(id);
    if (movie == null)
    {
        return NotFound();
    }
    return View(movie);
}
```

The following code shows the `HTTP POST Edit` method, which processes the posted movie values:

```

// POST: Movies/Edit/5
// To protect from overposting attacks, please enable the specific properties you want to bind to, for
// more details see http://go.microsoft.com/fwlink/?LinkId=317598.
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction("Index");
    }
    return View(movie);
}

```

```

// GET: Movies/Edit/5
public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }
    return View(movie);
}

```

The following code shows the `HTTP POST Edit` method, which processes the posted movie values:

```
// POST: Movies/Edit/5
// To protect from overposting attacks, please enable the specific properties you want to bind to, for
// more details see http://go.microsoft.com/fwlink/?LinkId=317598.
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction("Index");
    }
    return View(movie);
}
```

The `[Bind]` attribute is one way to protect against [over-posting](#). You should only include properties in the `[Bind]` attribute that you want to change. See [Protect your controller from over-posting](#) for more information.

[ViewModels](#) provide an alternative approach to prevent over-posting.

Notice the second `Edit` action method is preceded by the `[HttpPost]` attribute.

```
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction(nameof(Index));
    }
    return View(movie);
}
```

```

// POST: Movies/Edit/5
// To protect from overposting attacks, please enable the specific properties you want to bind to, for
// more details see http://go.microsoft.com/fwlink/?LinkId=317598.
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction("Index");
    }
    return View(movie);
}

```

The `[HttpPost]` attribute specifies that this `Edit` method can be invoked *only* for `POST` requests. You could apply the `[HttpGet]` attribute to the first edit method, but that's not necessary because `[HttpGet]` is the default.

The `[ValidateAntiForgeryToken]` attribute is used to [prevent forgery of a request](#) and is paired up with an anti-forgery token generated in the edit view file (`Views/Movies/Edit.cshtml`). The edit view file generates the anti-forgery token with the [Form Tag Helper](#).

```
<form asp-action="Edit">
```

The [Form Tag Helper](#) generates a hidden anti-forgery token that must match the `[ValidateAntiForgeryToken]` generated anti-forgery token in the `Edit` method of the Movies controller. For more information, see [Anti-Request Forgery](#).

The `[HttpGet Edit]` method takes the movie `ID` parameter, looks up the movie using the Entity Framework `SingleOrDefaultAsync` method, and returns the selected movie to the Edit view. If a movie cannot be found, `NotFound` (HTTP 404) is returned.

```
// GET: Movies/Edit/5
public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie.FindAsync(id);
    if (movie == null)
    {
        return NotFound();
    }
    return View(movie);
}
```

```
// GET: Movies/Edit/5
public async Task<IActionResult> Edit(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }
    return View(movie);
}
```

When the scaffolding system created the Edit view, it examined the `Movie` class and created code to render `<label>` and `<input>` elements for each property of the class. The following example shows the Edit view that was generated by the Visual Studio scaffolding system:

```

@model MvcMovie.Models.Movie

 @{
     ViewData["Title"] = "Edit";
 }

<h2>Edit</h2>

<form asp-action="Edit">
    <div class="form-horizontal">
        <h4>Movie</h4>
        <hr />
        <div asp-validation-summary="ModelOnly" class="text-danger"></div>
        <input type="hidden" asp-for="ID" />
        <div class="form-group">
            <label asp-for="Title" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="Title" class="form-control" />
                <span asp-validation-for="Title" class="text-danger"></span>
            </div>
        </div>
        <div class="form-group">
            <label asp-for="ReleaseDate" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="ReleaseDate" class="form-control" />
                <span asp-validation-for="ReleaseDate" class="text-danger"></span>
            </div>
        </div>
        <div class="form-group">
            <label asp-for="Genre" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="Genre" class="form-control" />
                <span asp-validation-for="Genre" class="text-danger"></span>
            </div>
        </div>
        <div class="form-group">
            <label asp-for="Price" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="Price" class="form-control" />
                <span asp-validation-for="Price" class="text-danger"></span>
            </div>
        </div>
        <div class="form-group">
            <div class="col-md-offset-2 col-md-10">
                <input type="submit" value="Save" class="btn btn-default" />
            </div>
        </div>
    </div>
</form>

<div>
    <a asp-action="Index">Back to List</a>
</div>

@section Scripts {
    @{await Html.RenderPartialAsync("_ValidationScriptsPartial");}
}

```

Notice how the view template has a `@model MvcMovie.Models.Movie` statement at the top of the file.

`@model MvcMovie.Models.Movie` specifies that the view expects the model for the view template to be of type `Movie`.

The scaffolded code uses several Tag Helper methods to streamline the HTML markup. The - [Label Tag Helper](#) displays the name of the field ("Title", "ReleaseDate", "Genre", or "Price"). The [Input Tag Helper](#) renders an HTML `<input>` element. The [Validation Tag Helper](#) displays any validation messages associated with that property.

Run the application and navigate to the `/Movies` URL. Click an **Edit** link. In the browser, view the source for the page. The generated HTML for the `<form>` element is shown below.

```
<form action="/Movies/Edit/7" method="post">
    <div class="form-horizontal">
        <h4>Movie</h4>
        <hr />
        <div class="text-danger" />
        <input type="hidden" data-val="true" data-val-required="The ID field is required." id="ID" name="ID" value="7" />
        <div class="form-group">
            <label class="control-label col-md-2" for="Genre" />
            <div class="col-md-10">
                <input class="form-control" type="text" id="Genre" name="Genre" value="Western" />
                <span class="text-danger field-validation-valid" data-valmsg-for="Genre" data-valmsg-replace="true"></span>
            </div>
        </div>
        <div class="form-group">
            <label class="control-label col-md-2" for="Price" />
            <div class="col-md-10">
                <input class="form-control" type="text" data-val="true" data-val-number="The field Price must be a number." data-val-required="The Price field is required." id="Price" name="Price" value="3.99" />
                <span class="text-danger field-validation-valid" data-valmsg-for="Price" data-valmsg-replace="true"></span>
            </div>
        </div>
        <!-- Markup removed for brevity -->
        <div class="form-group">
            <div class="col-md-offset-2 col-md-10">
                <input type="submit" value="Save" class="btn btn-default" />
            </div>
        </div>
    </div>
    <input name="__RequestVerificationToken" type="hidden" value="CfDJ8Inyxp63fRFqUePGvuI5jGZsloJu1L7X9le1gy7NCI1SduCRx9jDQC1rV9pOTTmqUyXnJBXhmrjcUVDJyDUMm7-MF_9rK8aAZdRdl0ri7FmKVkRe_2v5LIHGKFcTjPrWPYnc9AdSbomki0SaTEg7RU" />
</form>
```

The `<input>` elements are in an `HTML <form>` element whose `action` attribute is set to post to the `/Movies/Edit/id` URL. The form data will be posted to the server when the `Save` button is clicked. The last line before the closing `</form>` element shows the hidden **XSRF** token generated by the [Form Tag Helper](#).

## Processing the POST Request

The following listing shows the `[HttpPost]` version of the `Edit` action method.

```
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction(nameof(Index));
    }
    return View(movie);
}
```

```

// POST: Movies/Edit/5
// To protect from overposting attacks, please enable the specific properties you want to bind to, for
// more details see http://go.microsoft.com/fwlink/?LinkId=317598.
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Edit(int id, [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (id != movie.ID)
    {
        return NotFound();
    }

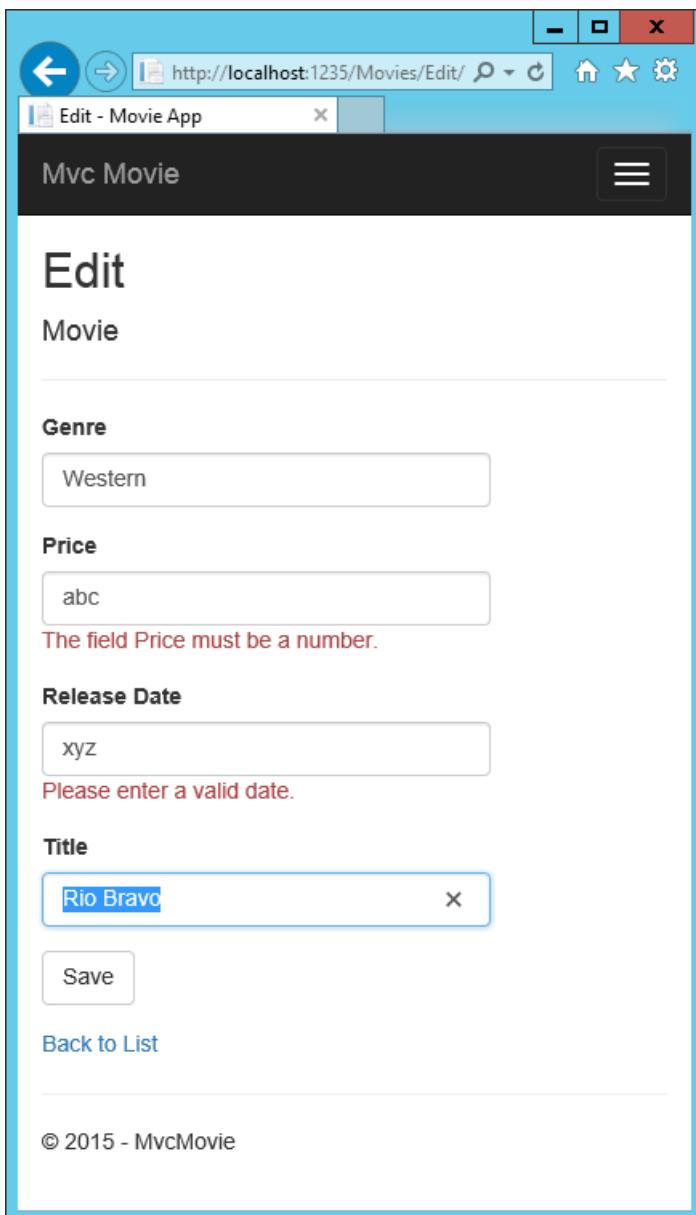
    if (ModelState.IsValid)
    {
        try
        {
            _context.Update(movie);
            await _context.SaveChangesAsync();
        }
        catch (DbUpdateConcurrencyException)
        {
            if (!MovieExists(movie.ID))
            {
                return NotFound();
            }
            else
            {
                throw;
            }
        }
        return RedirectToAction("Index");
    }
    return View(movie);
}

```

The `[ValidateAntiForgeryToken]` attribute validates the hidden [XSRF](#) token generated by the anti-forgery token generator in the [Form Tag Helper](#)

The [model binding](#) system takes the posted form values and creates a `Movie` object that's passed as the `movie` parameter. The `ModelState.IsValid` method verifies that the data submitted in the form can be used to modify (edit or update) a `Movie` object. If the data is valid it's saved. The updated (edited) movie data is saved to the database by calling the `SaveChangesAsync` method of database context. After saving the data, the code redirects the user to the `Index` action method of the `MoviesController` class, which displays the movie collection, including the changes just made.

Before the form is posted to the server, client side validation checks any validation rules on the fields. If there are any validation errors, an error message is displayed and the form isn't posted. If JavaScript is disabled, you won't have client side validation but the server will detect the posted values that are not valid, and the form values will be redisplayed with error messages. Later in the tutorial we examine [Model Validation](#) in more detail. The [Validation Tag Helper](#) in the `Views/Movies/Edit.cshtml` view template takes care of displaying appropriate error messages.



All the `[HttpGet]` methods in the movie controller follow a similar pattern. They get a movie object (or list of objects, in the case of `Index`), and pass the object (model) to the view. The `Create` method passes an empty movie object to the `Create` view. All the methods that create, edit, delete, or otherwise modify data do so in the `[HttpPost]` overload of the method. Modifying data in an `HTTP GET` method is a security risk. Modifying data in an `HTTP GET` method also violates HTTP best practices and the architectural `REST` pattern, which specifies that GET requests shouldn't change the state of your application. In other words, performing a GET operation should be a safe operation that has no side effects and doesn't modify your persisted data.

## Additional resources

- [Globalization and localization](#)
- [Introduction to Tag Helpers](#)
- [Author Tag Helpers](#)
- [Anti-Request Forgery](#)
- Protect your controller from [over-posting](#)
- [ViewModels](#)
- [Form Tag Helper](#)
- [Input Tag Helper](#)
- [Label Tag Helper](#)
- [Select Tag Helper](#)

- Validation Tag Helper

[PREVIOUS - WORKING WITH  
SQLITE](#)

[NEXT - ADD  
SEARCH](#)

# Add search to an ASP.NET Core MVC app

6/26/2018 • 7 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section you add search capability to the `Index` action method that lets you search movies by *genre* or *name*.

Update the `Index` method with the following code:

```
public async Task<IActionResult> Index(string searchString)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    return View(await movies.ToListAsync());
}
```

The first line of the `Index` action method creates a [LINQ](#) query to select the movies:

```
var movies = from m in _context.Movie
             select m;
```

The query is *only* defined at this point, it has **not** been run against the database.

If the `searchString` parameter contains a string, the movies query is modified to filter on the value of the search string:

```
if (!String.IsNullOrEmpty(searchString))
{
    movies = movies.Where(s => s.Title.Contains(searchString));
}
```

The `s => s.Title.Contains()` code above is a [Lambda Expression](#). Lambdas are used in method-based [LINQ](#) queries as arguments to standard query operator methods such as the `Where` method or `Contains` (used in the code above). LINQ queries are not executed when they're defined or when they're modified by calling a method such as `Where`, `Contains` or `OrderBy`. Rather, query execution is deferred. That means that the evaluation of an expression is delayed until its realized value is actually iterated over or the `ToListAsync` method is called. For more information about deferred query execution, see [Query Execution](#).

Note: The `Contains` method is run on the database, not in the c# code shown above. The case sensitivity on the query depends on the database and the collation. On SQL Server, `Contains` maps to [SQL LIKE](#), which is case insensitive. In SQLite, with the default collation, it's case sensitive.

Navigate to `/Movies/Index`. Append a query string such as `?searchString=Ghost` to the URL. The filtered movies are displayed.

Title	Release Date	Genre	Price
Ghostbusters	3/13/1984	Comedy	8.99
Ghostbusters 2	2/23/1986	Comedy	9.99

If you change the signature of the `Index` method to have a parameter named `id`, the `id` parameter will match the optional `{id}` placeholder for the default routes set in `Startup.cs`.

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

Note: SQLite is case sensitive, so you'll need to search for "Ghost" and not "ghost".

The previous `Index` method:

```
public async Task<IActionResult> Index(string searchString)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    return View(await movies.ToListAsync());
}
```

The updated `Index` method with `id` parameter:

```
public async Task<IActionResult> Index(string id)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(id))
    {
        movies = movies.Where(s => s.Title.Contains(id));
    }

    return View(await movies.ToListAsync());
}
```

You can now pass the search title as route data (a URL segment) instead of as a query string value.

Mvc Movie

# Index

Create New

Genre	Price	Release Date	Title	
Comedy	8.99	3/13/1984	Ghostbusters	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	9.99	2/23/1986	Ghostbusters 2	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

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However, you can't expect users to modify the URL every time they want to search for a movie. So now you'll add UI elements to help them filter movies. If you changed the signature of the `Index` method to test how to pass the route-bound `ID` parameter, change it back so that it takes a parameter named `searchString`:

```
public async Task<IActionResult> Index(string searchString)
{
    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    return View(await movies.ToListAsync());
}
```

Open the `Views/Movies/Index.cshtml` file, and add the `<form>` markup highlighted below:

```
ViewData["Title"] = "Index";
}

<h2>Index</h2>

<p>
    <a asp-action="Create">Create New</a>
</p>

<form asp-controller="Movies" asp-action="Index">
    <p>
        Title: <input type="text" name="SearchString">
        <input type="submit" value="Filter" />
    </p>
</form>

<table class="table">
    <thead>
```

The HTML `<form>` tag uses the [Form Tag Helper](#), so when you submit the form, the filter string is posted to the `Index` action of the movies controller. Save your changes and then test the filter.

Genre	Price	Release Date	Title	
Romantic Comedy	7.99	1/11/1989	When Harry Met Sally	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	8.99	3/13/1984	Ghostbusters	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	9.99	2/23/1986	Ghostbusters 2	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Western	3.99	4/15/1959	Rio Bravo	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

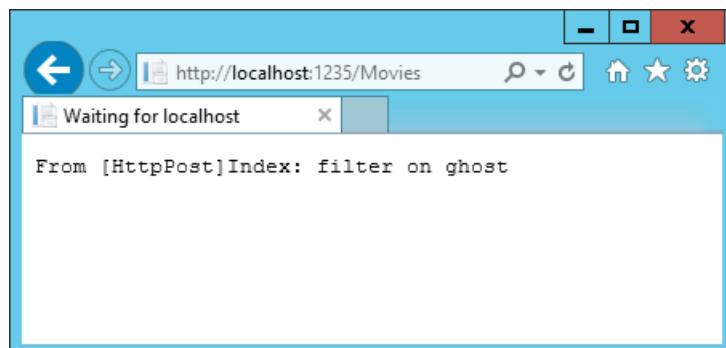
There's no `[HttpPost]` overload of the `Index` method as you might expect. You don't need it, because the method isn't changing the state of the app, just filtering data.

You could add the following `[HttpPost] Index` method.

```
[HttpPost]
public string Index(string searchString, bool notUsed)
{
    return "From [HttpPost]Index: filter on " + searchString;
}
```

The `notUsed` parameter is used to create an overload for the `Index` method. We'll talk about that later in the tutorial.

If you add this method, the action invoker would match the `[HttpPost] Index` method, and the `[HttpPost] Index` method would run as shown in the image below.



However, even if you add this `[HttpPost]` version of the `Index` method, there's a limitation in how this has all been implemented. Imagine that you want to bookmark a particular search or you want to send a link to friends that they can click in order to see the same filtered list of movies. Notice that the URL for the HTTP POST request is the same as the URL for the GET request (`localhost:xxxx/Movies/Index`) -- there's no search information in the

URL. The search string information is sent to the server as a [form field value](#). You can verify that with the browser Developer tools or the excellent [Fiddler tool](#). The image below shows the Chrome browser Developer tools:

The screenshot shows the Chrome Developer Tools Network tab with a red box highlighting the 'Network' tab itself. Below it, another red box highlights the 'Movies' entry in the list of requests. The 'General' section of the request details is also highlighted with a red box, showing the Request URL, Method, Status Code (200 OK), and other headers like Cache-Control, Content-Type, Date, Pragma, Server, and Transfer-Encoding. The 'Form Data' section is also highlighted with a red box, showing the 'SearchString' parameter with the value 'Ghost' and a long 'RequestVerificationToken' parameter.

You can see the search parameter and [XSRF](#) token in the request body. Note, as mentioned in the previous tutorial, the [Form Tag Helper](#) generates an [XSRF](#) anti-forgery token. We're not modifying data, so we don't need to validate the token in the controller method.

Because the search parameter is in the request body and not the URL, you can't capture that search information to bookmark or share with others. We'll fix this by specifying the request should be [HTTP GET](#).

Change the `<form>` tag in the `Views\movie\Index.cshtml` Razor view to specify `method="get"`:

```
<form asp-controller="Movies" asp-action="Index" method="get">
```

Now when you submit a search, the URL contains the search query string. Searching will also go to the `HttpGet Index` action method, even if you have a `HttpPost Index` method.

Genre	Price	Release Date	Title	
Comedy	8.99	3/13/1984	Ghostbusters	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
Comedy	9.99	2/23/1986	Ghostbusters 2	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

The following markup shows the change to the `form` tag:

```
<form asp-controller="Movies" asp-action="Index" method="get">
```

## Adding Search by genre

Add the following `MovieGenreViewModel` class to the *Models* folder:

```
using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace MvcMovie.Models
{
    public class MovieGenreViewModel
    {
        public List<Movie> movies;
        public SelectList genres;
        public string movieGenre { get; set; }
    }
}
```

The movie-genre view model will contain:

- A list of movies.
- A `selectList` containing the list of genres. This will allow the user to select a genre from the list.
- `movieGenre`, which contains the selected genre.

Replace the `Index` method in `MoviesController.cs` with the following code:

```

// Requires using Microsoft.AspNetCore.Mvc.Rendering;
public async Task<IActionResult> Index(string movieGenre, string searchString)
{
    // Use LINQ to get list of genres.
    IQueryable<string> genreQuery = from m in _context.Movie
                                         orderby m.Genre
                                         select m.Genre;

    var movies = from m in _context.Movie
                 select m;

    if (!String.IsNullOrEmpty(searchString))
    {
        movies = movies.Where(s => s.Title.Contains(searchString));
    }

    if (!String.IsNullOrEmpty(movieGenre))
    {
        movies = movies.Where(x => x.Genre == movieGenre);
    }

    var movieGenreVM = new MovieGenreViewModel();
    movieGenreVM.genres = new SelectList(await genreQuery.Distinct().ToListAsync());
    movieGenreVM.movies = await movies.ToListAsync();

    return View(movieGenreVM);
}

```

The following code is a `LINQ` query that retrieves all the genres from the database.

```

// Use LINQ to get list of genres.
IQueryable<string> genreQuery = from m in _context.Movie
                                         orderby m.Genre
                                         select m.Genre;

```

The `SelectList` of genres is created by projecting the distinct genres (we don't want our select list to have duplicate genres).

```
movieGenreVM.genres = new SelectList(await genreQuery.Distinct().ToListAsync())
```

## Adding search by genre to the Index view

Update `Index.cshtml` as follows:

```

@model MvcMovie.Models.MovieGenreViewModel

 @{
     ViewData["Title"] = "Index";
 }

<h2>Index</h2>

<p>
    <a asp-action="Create">Create New</a>
</p>

<form asp-controller="Movies" asp-action="Index" method="get">
    <p>
        <select asp-for="movieGenre" asp-items="Model.genres">
            <option value="">All</option>
        </select>

        Title: <input type="text" name="SearchString">
        <input type="submit" value="Filter" />
    </p>
</form>

<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].ReleaseDate)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Genre)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Price)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model.movies)
        {
            <tr>
                <td>
                    @Html.DisplayFor(modelItem => item.Title)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.ReleaseDate)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Genre)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Price)
                </td>
                <td>
                    <a asp-action="Edit" asp-route-id="@item.ID">Edit</a> |
                    <a asp-action="Details" asp-route-id="@item.ID">Details</a> |
                    <a asp-action="Delete" asp-route-id="@item.ID">Delete</a>
                </td>
            </tr>
        }
    </tbody>
</table>

```

Examine the lambda expression used in the following HTML Helper:

```
@Html.DisplayNameFor(model => model.movies[0].Title)
```

In the preceding code, the `DisplayNameFor` HTML Helper inspects the `Title` property referenced in the lambda expression to determine the display name. Since the lambda expression is inspected rather than evaluated, you don't receive an access violation when `model`, `model.movies`, or `model.movies[0]` are `null` or empty. When the lambda expression is evaluated (for example, `@Html.DisplayFor(modelItem => item.Title)`), the model's property values are evaluated.

Test the app by searching by genre, by movie title, and by both.

[PREVIOUS - CONTROLLER METHODS AND  
VIEWS](#)

[NEXT - ADD A  
FIELD](#)

# Add a new field to an ASP.NET Core MVC app

6/26/2018 • 3 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

This tutorial will add a new field to the `Movies` table. We'll drop the database and create a new one when we change the schema (add a new field). This workflow works well early in development when we don't have any production data to preserve.

Once your app is deployed and you have data that you need to preserve, you can't drop your DB when you need to change the schema. Entity Framework [Code First Migrations](#) allows you to update your schema and migrate the database without losing data. Migrations is a popular feature when using SQL Server, but SQLite doesn't support many migration schema operations, so only very simple migrations are possible. See [SQLite Limitations](#) for more information.

## Adding a Rating Property to the Movie Model

Open the `Models/Movie.cs` file and add a `Rating` property:

```
public class Movie
{
    public int ID { get; set; }
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }
    public string Genre { get; set; }

    [Column(TypeName = "decimal(18, 2)")]
    public decimal Price { get; set; }
    public string Rating { get; set; }
}
```

```
public class Movie
{
    public int ID { get; set; }
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }
    public string Genre { get; set; }
    public decimal Price { get; set; }
    public string Rating { get; set; }
}
```

Because you've added a new field to the `Movie` class, you also need to update the binding whitelist so this new property will be included. In `MoviesController.cs`, update the `[Bind]` attribute for both the `Create` and `Edit` action methods to include the `Rating` property:

```
[Bind("ID,Title,ReleaseDate,Genre,Price,Rating")]
```

You also need to update the view templates in order to display, create, and edit the new `Rating` property in the browser view.

Edit the `/Views/Movies/Index.cshtml` file and add a `Rating` field:

```
<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].ReleaseDate)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Genre)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Price)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.movies[0].Rating)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model.movies)
        {
            <tr>
                <td>
                    @Html.DisplayFor(modelItem => item.Title)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.ReleaseDate)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Genre)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Price)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Rating)
                </td>
                <td>
```

Update the `/Views/Movies/Create.cshtml` with a `Rating` field.

The app won't work until we update the DB to include the new field. If you run it now, you'll get the following `SqliteException`:

```
SqliteException: SQLite Error 1: 'no such column: m.Rating'.
```

You're seeing this error because the updated Movie model class is different than the schema of the Movie table of the existing database. (There's no `Rating` column in the database table.)

There are a few approaches to resolving the error:

1. Drop the database and have the Entity Framework automatically re-create the database based on the new model class schema. With this approach, you lose existing data in the database — so you can't do this with a production database! Using an initializer to automatically seed a database with test data is often a

productive way to develop an app.

2. Manually modify the schema of the existing database so that it matches the model classes. The advantage of this approach is that you keep your data. You can make this change either manually or by creating a database change script.
3. Use Code First Migrations to update the database schema.

For this tutorial, we'll drop and re-create the database when the schema changes. Run the following command from a terminal to drop the db:

```
dotnet ef database drop
```

Update the `SeedData` class so that it provides a value for the new column. A sample change is shown below, but you'll want to make this change for each `new Movie`.

```
new Movie
{
    Title = "When Harry Met Sally",
    ReleaseDate = DateTime.Parse("1989-1-11"),
    Genre = "Romantic Comedy",
    Rating = "R",
    Price = 7.99M
},
```

Add the `Rating` field to the `Edit`, `Details`, and `Delete` view.

Run the app and verify you can create/edit/display movies with a `Rating` field. templates.

PREVIOUS - ADD  
SEARCH

NEXT - ADD  
VALIDATION

# Add validation to an ASP.NET Core MVC app

6/26/2018 • 10 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

In this section you'll add validation logic to the `Movie` model, and you'll ensure that the validation rules are enforced any time a user creates or edits a movie.

## Keeping things DRY

One of the design tenets of MVC is [DRY](#) ("Don't Repeat Yourself"). ASP.NET MVC encourages you to specify functionality or behavior only once, and then have it be reflected everywhere in an app. This reduces the amount of code you need to write and makes the code you do write less error prone, easier to test, and easier to maintain.

The validation support provided by MVC and Entity Framework Core Code First is a good example of the DRY principle in action. You can declaratively specify validation rules in one place (in the model class) and the rules are enforced everywhere in the app.

## Adding validation rules to the movie model

Open the `Movie.cs` file. DataAnnotations provides a built-in set of validation attributes that you apply declaratively to any class or property. (It also contains formatting attributes like `DataType` that help with formatting and don't provide any validation.)

Update the `Movie` class to take advantage of the built-in `Required`, `StringLength`, `RegularExpression`, and `Range` validation attributes.

```
public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3)]
    [Required]
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [Range(1, 100)]
    [DataType(DataType.Currency)]
    [Column(TypeName = "decimal(18, 2)")]
    public decimal Price { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z''"\s-]*$")]
    [Required]
    [StringLength(30)]
    public string Genre { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z0-9'''\s-]*$")]
    [StringLength(5)]
    [Required]
    public string Rating { get; set; }
}
```

```

public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3)]
    [Required]
    public string Title { get; set; }

    [Display(Name = "Release Date")]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [Range(1, 100)]
    [DataType(DataType.Currency)]
    public decimal Price { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z\s-]*$")]
    [Required]
    [StringLength(30)]
    public string Genre { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z0-9\s-]*$")]
    [StringLength(5)]
    [Required]
    public string Rating { get; set; }
}

```

The validation attributes specify behavior that you want to enforce on the model properties they're applied to. The `Required` and `MinimumLength` attributes indicate that a property must have a value; but nothing prevents a user from entering white space to satisfy this validation. The `RegularExpression` attribute is used to limit what characters can be input. In the code above, `Genre` and `Rating` must use only letters (First letter uppercase, white space, numbers and special characters are not allowed). The `Range` attribute constrains a value to within a specified range. The `StringLength` attribute lets you set the maximum length of a string property, and optionally its minimum length. Value types (such as `decimal`, `int`, `float`, `DateTime`) are inherently required and don't need the `[Required]` attribute.

Having validation rules automatically enforced by ASP.NET helps make your app more robust. It also ensures that you can't forget to validate something and inadvertently let bad data into the database.

## Validation Error UI in MVC

Run the app and navigate to the Movies controller.

Tap the **Create New** link to add a new movie. Fill out the form with some invalid values. As soon as jQuery client side validation detects the error, it displays an error message.

The screenshot shows a browser window titled "Create - Movie App" with the URL "localhost:5000/Movies/Create". The page is titled "Create Movie". It contains a form with the following fields and validation errors:

- Title**: An input field with a placeholder icon. Error message: "The field Title must be a string with a minimum length of 3 and a maximum length of 60."
- Release Date**: An input field with a placeholder "mm/dd/yyyy".
- Genre**: An input field. Error message: "The Genre field is required."
- Price**: An input field containing "z". Error message: "The field Price must be a number."
- Rating**: An input field. Error message: "The field Rating must match the regular expression '^([A-Z]+[a-zA-Z-\s]\*)\$'."

At the bottom of the form are two buttons: "Create" and "Back to List".

#### NOTE

You may not be able to enter decimal commas in the `Price` field. To support [jQuery validation](#) for non-US English locales that use a comma (",") for a decimal point, and non US-English date formats, you must take steps to globalize your app. This [GitHub issue 4076](#) for instructions on adding decimal comma.

Notice how the form has automatically rendered an appropriate validation error message in each field containing an invalid value. The errors are enforced both client-side (using JavaScript and jQuery) and server-side (in case a user has JavaScript disabled).

A significant benefit is that you didn't need to change a single line of code in the `MoviesController` class or in the `Create.cshtml` view in order to enable this validation UI. The controller and views you created earlier in this tutorial automatically picked up the validation rules that you specified by using validation attributes on the properties of the `Movie` model class. Test validation using the `Edit` action method, and the same validation is applied.

The form data isn't sent to the server until there are no client side validation errors. You can verify this by putting a break point in the `HTTP Post` method, by using the [Fiddler tool](#), or the [F12 Developer tools](#).

## How validation works

You might wonder how the validation UI was generated without any updates to the code in the controller or views. The following code shows the two `Create` methods.

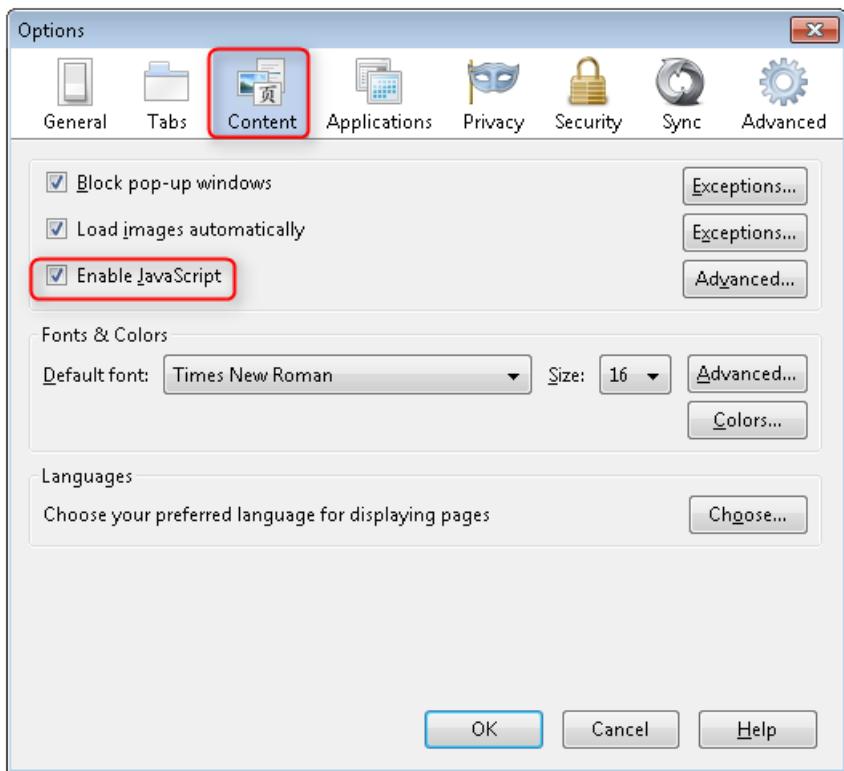
```
// GET: Movies/Create
public IActionResult Create()
{
    return View();
}

// POST: Movies/Create
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Create(
    [Bind("ID,Title,ReleaseDate,Genre,Price, Rating")] Movie movie)
{
    if (ModelState.IsValid)
    {
        _context.Add(movie);
        await _context.SaveChangesAsync();
        return RedirectToAction("Index");
    }
    return View(movie);
}
```

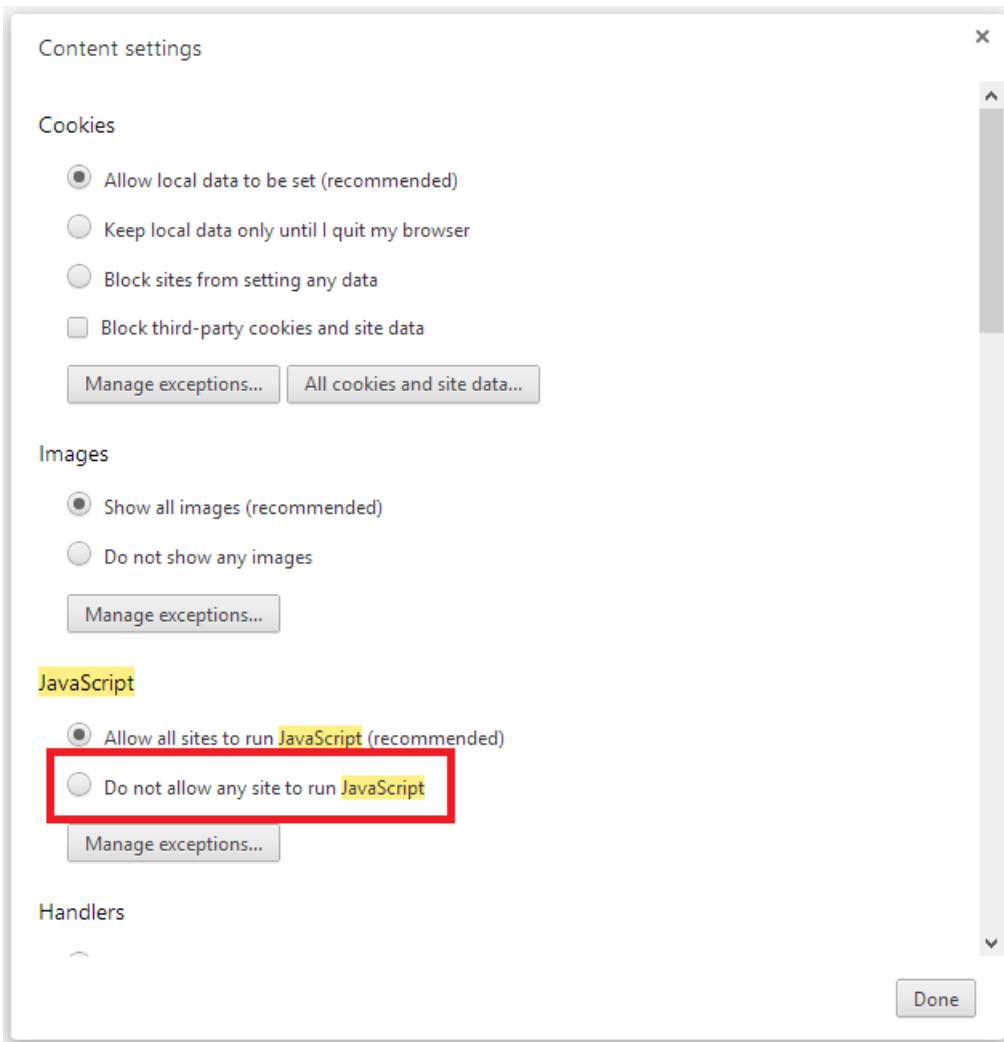
The first (HTTP GET) `Create` action method displays the initial Create form. The second (`[HttpPost]`) version handles the form post. The second `Create` method (The `[HttpPost]` version) calls `ModelState.IsValid` to check whether the movie has any validation errors. Calling this method evaluates any validation attributes that have been applied to the object. If the object has validation errors, the `Create` method re-displays the form. If there are no errors, the method saves the new movie in the database. In our movie example, the form isn't posted to the server when there are validation errors detected on the client side; the second `Create` method is never called when there are client side validation errors. If you disable JavaScript in your browser, client validation is disabled and you can test the HTTP POST `Create` method `ModelState.IsValid` detecting any validation errors.

You can set a break point in the `[HttpPost] Create` method and verify the method is never called, client side validation won't submit the form data when validation errors are detected. If you disable JavaScript in your browser, then submit the form with errors, the break point will be hit. You still get full validation without JavaScript.

The following image shows how to disable JavaScript in the FireFox browser.



The following image shows how to disable JavaScript in the Chrome browser.



After you disable JavaScript, post invalid data and step through the debugger.

```
74     // POST: Movies/Create
75     // To protect from overposting attacks, please enable t
76     // more details see http://go.microsoft.com/fwlink/?LinkID=142072
77     [HttpPost]
78     [ValidateAntiForgeryToken]
79     0 references
80     public async Task<IActionResult> Create([Bind("ID,Title")]
81     {
82         if (ModelState.IsValid)
83         {
84             _context.Add(movie);
85             await _context.SaveChangesAsync();
86             return RedirectToAction("Index");
87         }
88         return View(movie);
89     }

```

Below is portion of the `Create.cshtml` view template that you scaffolded earlier in the tutorial. It's used by the action methods shown above both to display the initial form and to redisplay it in the event of an error.

```
<form asp-action="Create">
    <div class="form-horizontal">
        <h4>Movie</h4>
        <hr />

        <div asp-validation-summary="ModelOnly" class="text-danger"></div>
        <div class="form-group">
            <label asp-for="Title" class="col-md-2 control-label"></label>
            <div class="col-md-10">
                <input asp-for="Title" class="form-control" />
                <span asp-validation-for="Title" class="text-danger"></span>
            </div>
        </div>

        @*Markup removed for brevity.*@
    </div>
</form>
```

The [Input Tag Helper](#) uses the [DataAnnotations](#) attributes and produces HTML attributes needed for jQuery Validation on the client side. The [Validation Tag Helper](#) displays validation errors. See [Validation](#) for more information.

What's really nice about this approach is that neither the controller nor the `Create` view template knows anything about the actual validation rules being enforced or about the specific error messages displayed. The validation rules and the error strings are specified only in the `Movie` class. These same validation rules are automatically applied to the `Edit` view and any other views templates you might create that edit your model.

When you need to change validation logic, you can do so in exactly one place by adding validation attributes to the model (in this example, the `Movie` class). You won't have to worry about different parts of the application being inconsistent with how the rules are enforced — all validation logic will be defined in one place and used everywhere. This keeps the code very clean, and makes it easy to maintain and evolve. And it means that you'll be fully honoring the DRY principle.

## Using DataType Attributes

Open the `Movie.cs` file and examine the `Movie` class. The `System.ComponentModel.DataAnnotations` namespace provides formatting attributes in addition to the built-in set of validation attributes. We've already applied a `DataType` enumeration value to the release date and to the price fields. The following code shows the `ReleaseDate` and `Price` properties with the appropriate `DataType` attribute.

```
[Display(Name = "Release Date")]
[DataType(DataType.Date)]
public DateTime ReleaseDate { get; set; }

[Range(1, 100)]
[DataType(DataType.Currency)]
public decimal Price { get; set; }
```

The `DataType` attributes only provide hints for the view engine to format the data (and supplies elements/attributes such as `<a>` for URL's and `<a href="mailto:EmailAddress.com">` for email). You can use the `RegularExpression` attribute to validate the format of the data. The `DataType` attribute is used to specify a data type that's more specific than the database intrinsic type, they're not validation attributes. In this case we only want to keep track of the date, not the time. The `DataType` Enumeration provides for many data types, such as Date, Time, PhoneNumber, Currency, EmailAddress and more. The `DataType` attribute can also enable the application to automatically provide type-specific features. For example, a `mailto:` link can be created for `DataType.EmailAddress`, and a date selector can be provided for `DataType.Date` in browsers that support HTML5. The `DataType` attributes emits HTML 5 `data-` (pronounced data dash) attributes that HTML 5 browsers can understand. The `DataType` attributes do **not** provide any validation.

`DataType.Date` doesn't specify the format of the date that's displayed. By default, the data field is displayed according to the default formats based on the server's `CultureInfo`.

The `DisplayFormat` attribute is used to explicitly specify the date format:

```
[DisplayFormat(DataFormatString = "{0:yyyy-MM-dd}", ApplyFormatInEditMode = true)]
public DateTime ReleaseDate { get; set; }
```

The `ApplyFormatInEditMode` setting specifies that the formatting should also be applied when the value is displayed in a text box for editing. (You might not want that for some fields — for example, for currency values, you probably don't want the currency symbol in the text box for editing.)

You can use the `DisplayFormat` attribute by itself, but it's generally a good idea to use the `DataType` attribute. The `DataType` attribute conveys the semantics of the data as opposed to how to render it on a screen, and provides the following benefits that you don't get with `DisplayFormat`:

- The browser can enable HTML5 features (for example to show a calendar control, the locale-appropriate currency symbol, email links, etc.)
- By default, the browser will render data using the correct format based on your locale.
- The `DataType` attribute can enable MVC to choose the right field template to render the data (the `DisplayFormat` if used by itself uses the string template).

#### NOTE

jQuery validation doesn't work with the `Range` attribute and `DateTime`. For example, the following code will always display a client side validation error, even when the date is in the specified range:

```
[Range(typeof(DateTime), "1/1/1966", "1/1/2020")]
```

You will need to disable jQuery date validation to use the `Range` attribute with `DateTime`. It's generally not a good practice to compile hard dates in your models, so using the `Range` attribute and `DateTime` is discouraged.

The following code shows combining attributes on one line:

```

public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3)]
    public string Title { get; set; }

    [Display(Name = "Release Date"), DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z\s-]*$"), Required, StringLength(30)]
    public string Genre { get; set; }

    [Range(1, 100), DataType(DataType.Currency)]
    [Column(TypeName = "decimal(18, 2)")]
    public decimal Price { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z0-9\s-]*$"), StringLength(5)]
    public string Rating { get; set; }
}

```

```

public class Movie
{
    public int ID { get; set; }

    [StringLength(60, MinimumLength = 3), Required]
    public string Title { get; set; }

    [Display(Name = "Release Date"), DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z\s-]*$"), Required, StringLength(30)]
    public string Genre { get; set; }

    [Range(1, 100), DataType(DataType.Currency)]
    public decimal Price { get; set; }

    [RegularExpression(@"^[A-Z]+[a-zA-Z0-9\s-]*$"), Required, StringLength(5)]
    public string Rating { get; set; }
}

```

In the next part of the series, we'll review the application and make some improvements to the automatically generated `Details` and `Delete` methods.

## Additional resources

- [Working with Forms](#)
- [Globalization and localization](#)
- [Introduction to Tag Helpers](#)
- [Author Tag Helpers](#)

PREVIOUS - ADD A  
FIELD

NEXT - EXAMINE THE DETAILS AND DELETE  
METHODS

# Examine the Details and Delete methods of an ASP.NET Core app

6/21/2018 • 3 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

Open the Movie controller and examine the `Details` method:

```
// GET: Movies/Details/5
public async Task<IActionResult> Details(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie
        .FirstOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }

    return View(movie);
}
```

```
// GET: Movies/Details/5
public async Task<IActionResult> Details(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie
        .SingleOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }

    return View(movie);
}
```

The MVC scaffolding engine that created this action method adds a comment showing an HTTP request that invokes the method. In this case it's a GET request with three URL segments, the `Movies` controller, the `Details` method and an `id` value. Recall these segments are defined in *Startup.cs*.

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

EF makes it easy to search for data using the `SingleOrDefaultAsync` method. An important security feature built into the method is that the code verifies that the search method has found a movie before it tries to do anything with it. For example, a hacker could introduce errors into the site by changing the URL created by the links from `http://localhost:xxxx/Movies/Details/1` to something like `http://localhost:xxxx/Movies/Details/12345` (or some other value that doesn't represent an actual movie). If you didn't check for a null movie, the app would throw an exception.

Examine the `Delete` and `DeleteConfirmed` methods.

```
// GET: Movies/Delete/5
public async Task<IActionResult> Delete(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie
        .FirstOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }

    return View(movie);
}

// POST: Movies/Delete/5
[HttpPost, ActionName("Delete")]
[ValidateAntiForgeryToken]
public async Task<IActionResult> DeleteConfirmed(int id)
{
    var movie = await _context.Movie.FindAsync(id);
    _context.Movie.Remove(movie);
    await _context.SaveChangesAsync();
    return RedirectToAction(nameof(Index));
}
```

```

// GET: Movies/Delete/5
public async Task<IActionResult> Delete(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    var movie = await _context.Movie
        .SingleOrDefaultAsync(m => m.ID == id);
    if (movie == null)
    {
        return NotFound();
    }

    return View(movie);
}

// POST: Movies/Delete/5
[HttpPost, ActionName("Delete")]
[ValidateAntiForgeryToken]
public async Task<IActionResult> DeleteConfirmed(int id)
{
    var movie = await _context.Movie.SingleOrDefaultAsync(m => m.ID == id);
    _context.Movie.Remove(movie);
    await _context.SaveChangesAsync();
    return RedirectToAction("Index");
}

```

Note that the `HTTP GET Delete` method doesn't delete the specified movie, it returns a view of the movie where you can submit (`HttpPost`) the deletion. Performing a delete operation in response to a GET request (or for that matter, performing an edit operation, create operation, or any other operation that changes data) opens up a security hole.

The `[HttpPost]` method that deletes the data is named `DeleteConfirmed` to give the HTTP POST method a unique signature or name. The two method signatures are shown below:

```

// GET: Movies/Delete/5
public async Task<IActionResult> Delete(int? id)
{
```

```

// POST: Movies/Delete/5
[HttpPost, ActionName("Delete")]
[ValidateAntiForgeryToken]
public async Task<IActionResult> DeleteConfirmed(int id)
{
```

The common language runtime (CLR) requires overloaded methods to have a unique parameter signature (same method name but different list of parameters). However, here you need two `Delete` methods -- one for GET and one for POST -- that both have the same parameter signature. (They both need to accept a single integer as a parameter.)

There are two approaches to this problem, one is to give the methods different names. That's what the scaffolding mechanism did in the preceding example. However, this introduces a small problem: ASP.NET maps segments of a URL to action methods by name, and if you rename a method, routing normally wouldn't be able to find that method. The solution is what you see in the example, which is to add the `ActionName("Delete")` attribute to the `DeleteConfirmed` method. That attribute performs mapping for the routing system so that a URL that includes `/Delete/` for a POST request will find the `DeleteConfirmed` method.

Another common work around for methods that have identical names and signatures is to artificially change the signature of the POST method to include an extra (unused) parameter. That's what we did in a previous post when we added the `notUsed` parameter. You could do the same thing here for the `[HttpPost] Delete` method:

```
// POST: Movies/Delete/6
[ValidateAntiForgeryToken]
public async Task<IActionResult> Delete(int id, bool notUsed)
```

## Publish to Azure

See [Publish an ASP.NET Core web app to Azure App Service using Visual Studio](#) for instructions on how to publish this app to Azure using Visual Studio. The app can also be published from the [command line](#).

[PREVIOUS](#)

# Create a Web API with ASP.NET Core and Visual Studio for Mac

6/21/2018 • 15 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Mike Wasson](#)

In this tutorial, build a web API for managing a list of "to-do" items. The UI isn't constructed.

There are three versions of this tutorial:

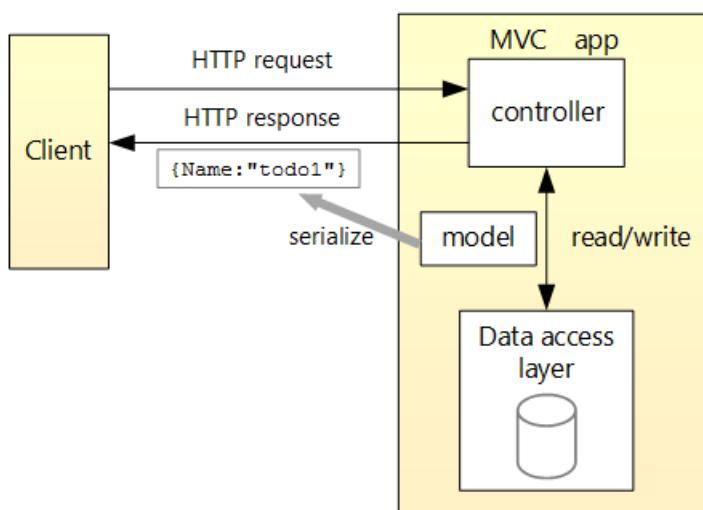
- macOS: Web API with Visual Studio for Mac (This tutorial)
- Windows: [Web API with Visual Studio for Windows](#)
- macOS, Linux, Windows: [Web API with Visual Studio Code](#)

## Overview

This tutorial creates the following API:

API	DESCRIPTION	REQUEST BODY	RESPONSE BODY
GET /api/todo	Get all to-do items	None	Array of to-do items
GET /api/todo/{id}	Get an item by ID	None	To-do item
POST /api/todo	Add a new item	To-do item	To-do item
PUT /api/todo/{id}	Update an existing item	To-do item	None
DELETE /api/todo/{id}	Delete an item	None	None

The following diagram shows the basic design of the app.



- The client is whatever consumes the web API (mobile app, browser, etc.). This tutorial doesn't create a client. [Postman](#) or [curl](#) is used as the client to test the app.
- A *model* is an object that represents the data in the app. In this case, the only model is a to-do item. Models are represented as C# classes, also known as **Plain Old ClR Object** (POCOs).

- A *controller* is an object that handles HTTP requests and creates the HTTP response. This app has a single controller.
- To keep the tutorial simple, the app doesn't use a persistent database. The sample app stores to-do items in an in-memory database.

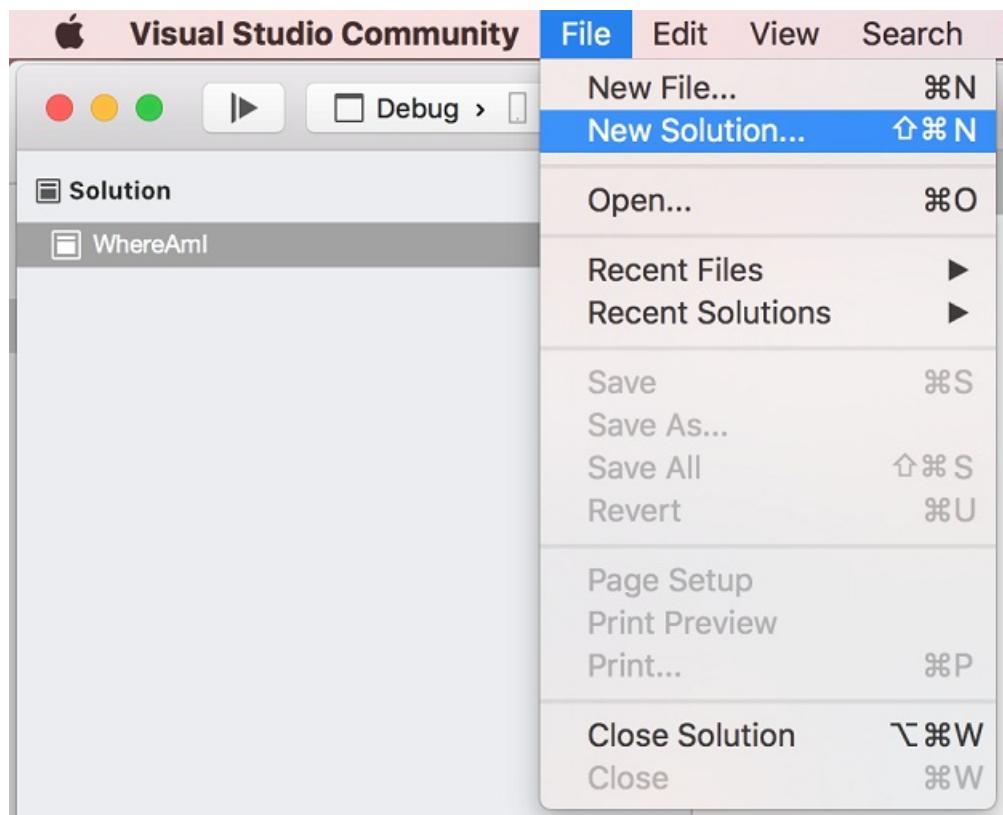
See [Introduction to ASP.NET Core MVC on macOS or Linux](#) for an example that uses a persistent database.

## Prerequisites

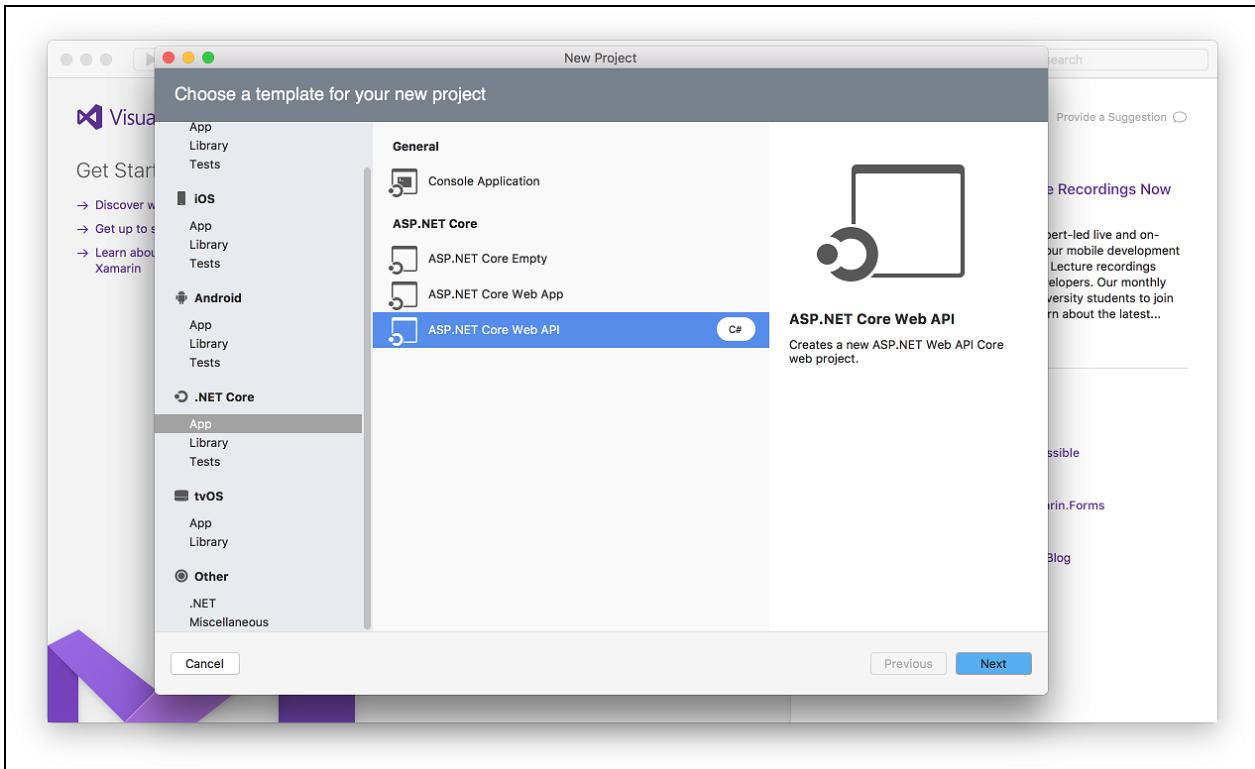
[Visual Studio for Mac](#)

## Create the project

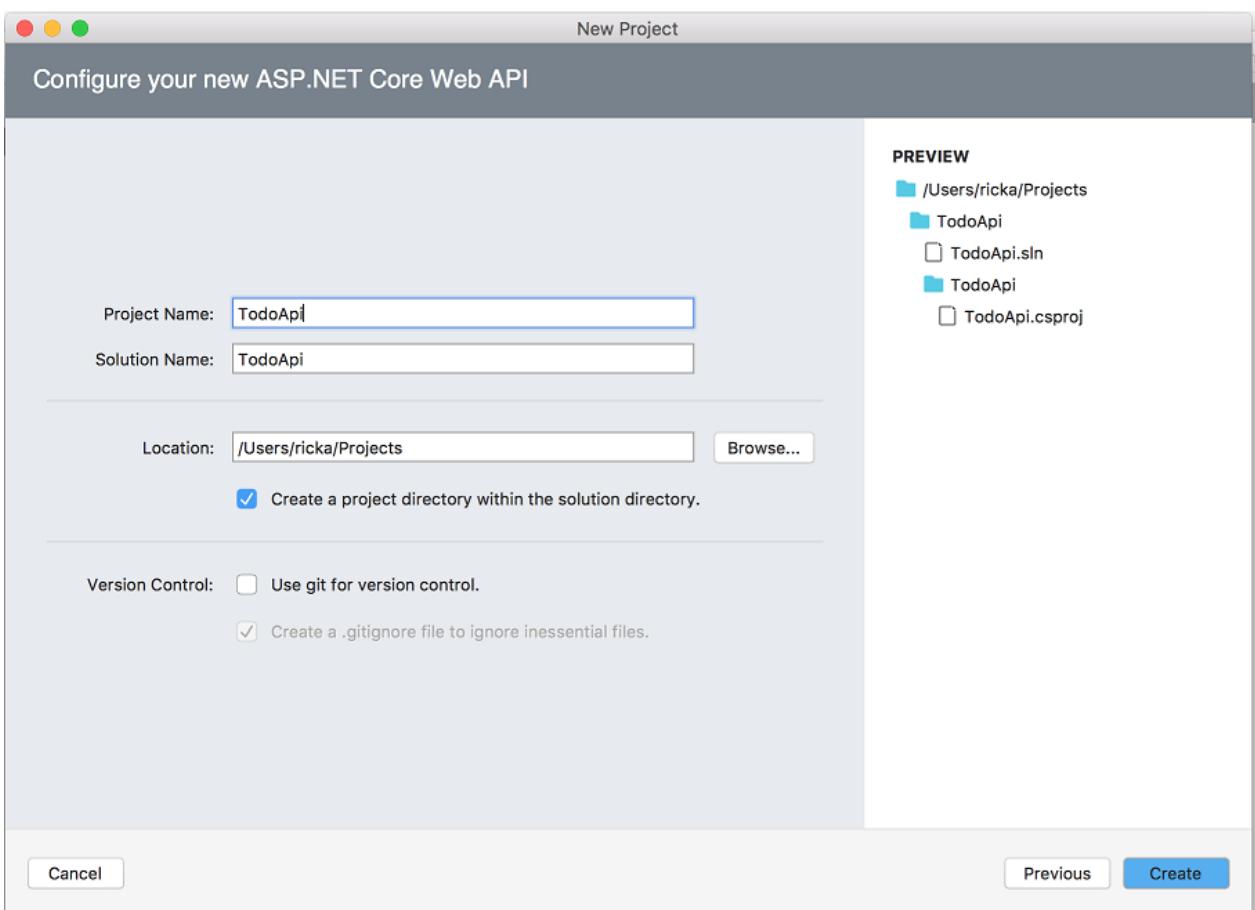
From Visual Studio, select **File > New Solution**.



Select **.NET Core App > ASP.NET Core Web API > Next**.



Enter `TodoApi` for the **Project Name**, and then click **Create**.



## Launch the app

In Visual Studio, select **Run > Start With Debugging** to launch the app. Visual Studio launches a browser and navigates to `http://localhost:5000`. You get an HTTP 404 (Not Found) error. Change the URL to `http://localhost:<port>/api/values`. The `ValuesController` data is displayed:

```
["value1","value2"]
```

## Add support for Entity Framework Core

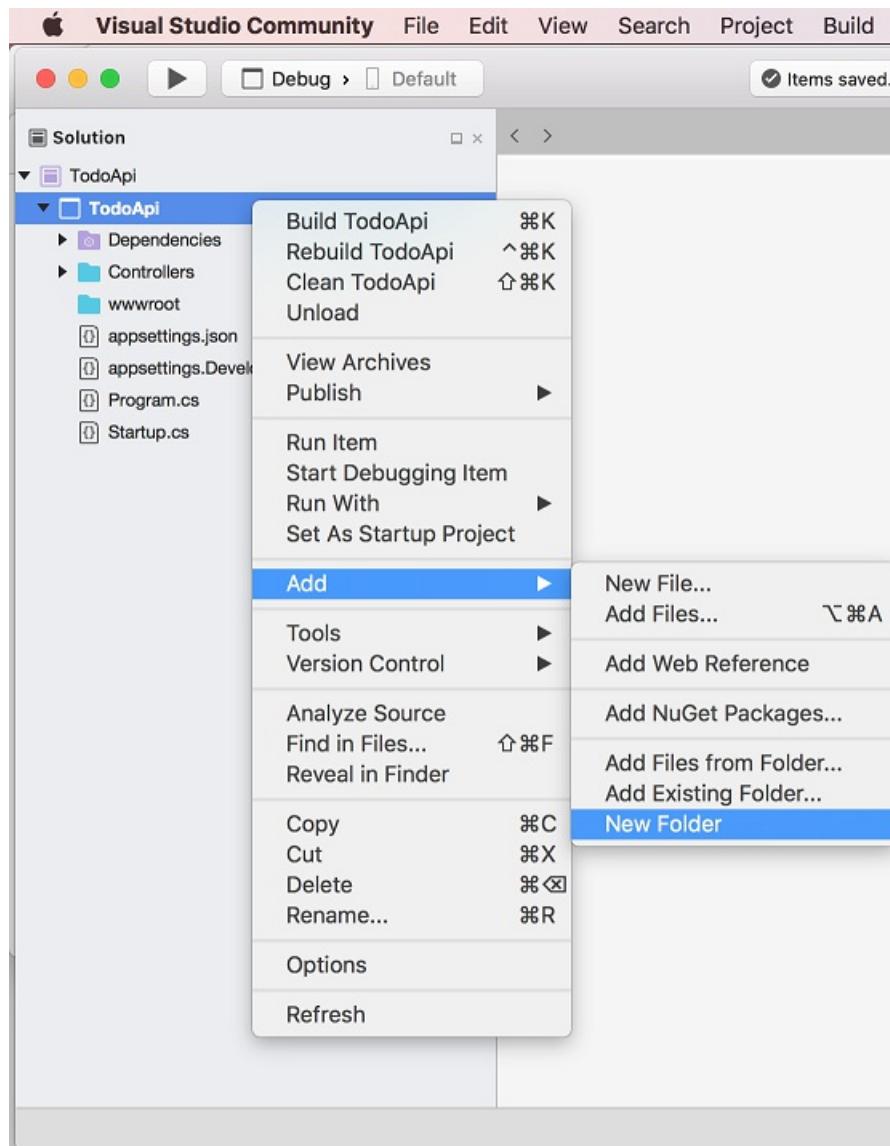
Install the [Entity Framework Core InMemory](#) database provider. This database provider allows Entity Framework Core to be used with an in-memory database.

- From the **Project** menu, select **Add NuGet Packages**.
  - Alternatively, you can right-click **Dependencies**, and then select **Add Packages**.
- Enter `EntityFrameworkCore.InMemory` in the search box.
- Select `Microsoft.EntityFrameworkCore.InMemory`, and then select **Add Package**.

## Add a model class

A model is an object representing the data in your app. In this case, the only model is a to-do item.

In Solution Explorer, right-click the project. Select **Add > New Folder**. Name the folder *Models*.



### NOTE

You can put model classes anywhere in your project, but the *Models* folder is used by convention.

Right-click the *Models* folder, and select **Add > New File > General > Empty Class**. Name the class *TodoItem*,

and then click **New**.

Replace the generated code with:

```
namespace TodoApi.Models
{
    public class TodoItem
    {
        public long Id { get; set; }
        public string Name { get; set; }
        public bool IsComplete { get; set; }
    }
}
```

The database generates the `Id` when a `TodoItem` is created.

### Create the database context

The *database context* is the main class that coordinates Entity Framework functionality for a given data model.

You create this class by deriving from the `Microsoft.EntityFrameworkCore.DbContext` class.

Add a `TodoContext` class to the *Models* folder.

```
using Microsoft.EntityFrameworkCore;

namespace TodoApi.Models
{
    public class TodoContext : DbContext
    {
        public TodoContext(DbContextOptions<TodoContext> options)
            : base(options)
        {

        }

        public DbSet<TodoItem> TodoItems { get; set; }
    }
}
```

## Register the database context

In this step, the database context is registered with the [dependency injection](#) container. Services (such as the DB context) that are registered with the dependency injection (DI) container are available to the controllers.

Register the DB context with the service container using the built-in support for [dependency injection](#). Replace the contents of the *Startup.cs* file with the following code:

```

using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Mvc;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using TodoApi.Models;

namespace TodoApi
{
    public class Startup
    {
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<TodoContext>(opt =>
                opt.UseInMemoryDatabase("TodoList"));
            services.AddMvc()
                .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
        }

        public void Configure(IApplicationBuilder app)
        {
            app.UseMvc();
        }
    }
}

```

```

using Microsoft.AspNetCore.Builder;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using TodoApi.Models;

namespace TodoApi
{
    public class Startup
    {
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<TodoContext>(opt =>
                opt.UseInMemoryDatabase("TodoList"));
            services.AddMvc();
        }

        public void Configure(IApplicationBuilder app)
        {
            app.UseMvc();
        }
    }
}

```

The preceding code:

- Removes the unused code.
- Specifies an in-memory database is injected into the service container.

## Add a controller

In Solution Explorer, in the *Controllers* folder, add the class `TodoController`.

Replace the generated code with the following:

```

using Microsoft.AspNetCore.Mvc;
using System.Collections.Generic;
using System.Linq;
using TodoApi.Models;

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

        public TodoController(TodoContext context)
        {
            _context = context;

            if (_context.TodoItems.Count() == 0)
            {
                _context.TodoItems.Add(new TodoItem { Name = "Item1" });
                _context.SaveChanges();
            }
        }
    }
}

```

The preceding code defines an API controller class without methods. In the next sections, methods are added to implement the API.

```

using Microsoft.AspNetCore.Mvc;
using System.Collections.Generic;
using System.Linq;
using TodoApi.Models;

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    [ApiController]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

        public TodoController(TodoContext context)
        {
            _context = context;

            if (_context.TodoItems.Count() == 0)
            {
                _context.TodoItems.Add(new TodoItem { Name = "Item1" });
                _context.SaveChanges();
            }
        }
    }
}

```

The preceding code defines an API controller class without methods. In the next sections, methods are added to implement the API. The class is annotated with an `[ApiController]` attribute to enable some convenient features. For information on features enabled by the attribute, see [Annotate class with ApiControllerAttribute](#).

The controller's constructor uses [Dependency Injection](#) to inject the database context (`TodoContext`) into the controller. The database context is used in each of the [CRUD](#) methods in the controller. The constructor adds an item to the in-memory database if one doesn't exist.

## Get to-do items

To get to-do items, add the following methods to the `TodoController` class:

```
[HttpGet]
public List<TodoItem> GetAll()
{
    return _context.TodoItems.ToList();
}

[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}
```

```
[HttpGet]
public ActionResult<List<TodoItem>> GetAll()
{
    return _context.TodoItems.ToList();
}

[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}
```

These methods implement the two GET methods:

- `GET /api/todo`
- `GET /api/todo/{id}`

Here's a sample HTTP response for the `GetAll` method:

```
[
{
    "id": 1,
    "name": "Item1",
    "isComplete": false
}]
```

Later in the tutorial, I'll show how the HTTP response can be viewed with [Postman](#) or [curl](#).

### Routing and URL paths

The `[HttpGet]` attribute denotes a method that responds to an HTTP GET request. The URL path for each method is constructed as follows:

- Take the template string in the controller's `Route` attribute:

```

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

```

```

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    [ApiController]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

```

- Replace `[controller]` with the name of the controller, which is the controller class name minus the "Controller" suffix. For this sample, the controller class name is **TodoController** and the root name is "todo". ASP.NET Core [routing](#) is case insensitive.
- If the `[HttpGet]` attribute has a route template (such as `[HttpGet("/products")]`), append that to the path. This sample doesn't use a template. For more information, see [Attribute routing with Http\[Verb\] attributes](#).

In the following  `GetById` method, `"{id}"` is a placeholder variable for the unique identifier of the to-do item. When  `GetById` is invoked, it assigns the value of `"{id}"` in the URL to the method's `id` parameter.

```

[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}

```

```

[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}

```

`Name = "GetTodo"` creates a named route. Named routes:

- Enable the app to create an HTTP link using the route name.
- Are explained later in the tutorial.

## Return values

The  `GetAll` method returns a collection of  `TodoItem` objects. MVC automatically serializes the object to [JSON](#) and writes the JSON into the body of the response message. The response code for this method is 200, assuming there are no unhandled exceptions. Unhandled exceptions are translated into 5xx errors.

In contrast, the  `GetById` method returns the more general [IActionResult type](#), which represents a wide range of

return types.  `GetById` has two different return types:

- If no item matches the requested ID, the method returns a 404 error. Returning `NotFound` returns an HTTP 404 response.
- Otherwise, the method returns 200 with a JSON response body. Returning `Ok` results in an HTTP 200 response.

In contrast, the  `GetById` method returns the `ActionResult<T>` type, which represents a wide range of return types.  `GetById` has two different return types:

- If no item matches the requested ID, the method returns a 404 error. Returning `NotFound` returns an HTTP 404 response.
- Otherwise, the method returns 200 with a JSON response body. Returning `item` results in an HTTP 200 response.

## Launch the app

In Visual Studio, select **Run > Start With Debugging** to launch the app. Visual Studio launches a browser and navigates to `http://localhost:<port>`, where `<port>` is a randomly chosen port number. You get an HTTP 404 (Not Found) error. Change the URL to `http://localhost:<port>/api/values`. The `ValuesController` data is displayed:

```
["value1","value2"]
```

Navigate to the  `Todo` controller at `http://localhost:<port>/api/todo`. The following JSON is returned:

```
[{"key":1,"name":"Item1","isComplete":false}]
```

## Implement the other CRUD operations

We'll add `Create`, `Update`, and `Delete` methods to the controller. These methods are variations on a theme, so I'll just show the code and highlight the main differences. Build the project after adding or changing code.

### Create

```
[HttpPost]
public IActionResult Create([FromBody] TodoItem item)
{
    if (item == null)
    {
        return BadRequest();
    }

    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}
```

The preceding method responds to an HTTP POST, as indicated by the `[HttpPost]` attribute. The `[FromBody]` attribute tells MVC to get the value of the to-do item from the body of the HTTP request.

```
[HttpPost]
public IActionResult Create(TodoItem item)
{
    _context.TodoItems.Add(item);
    _context.SaveChanges();

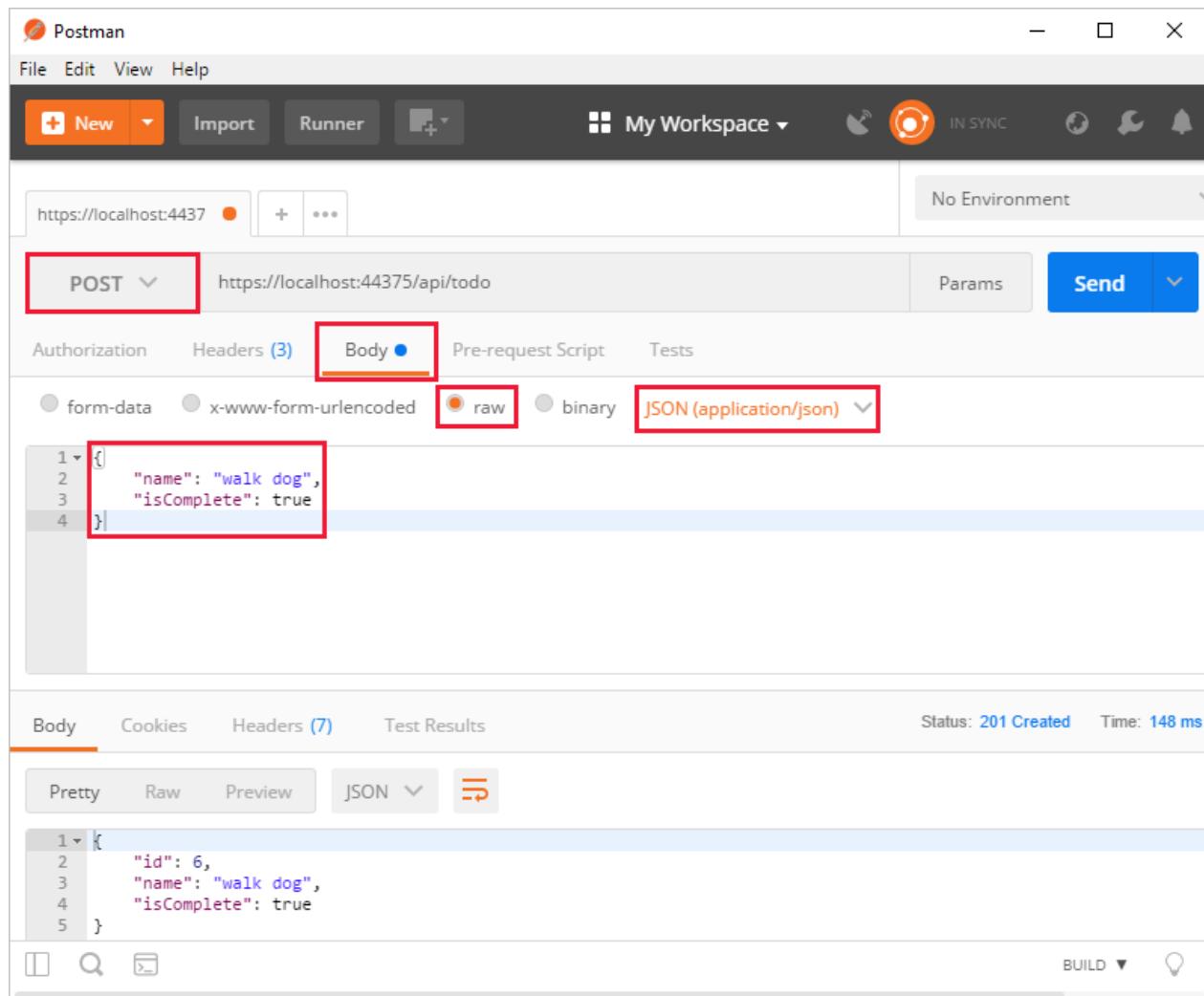
    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}
```

The preceding method responds to an HTTP POST, as indicated by the `[HttpPost]` attribute. MVC gets the value of the to-do item from the body of the HTTP request.

The `CreatedAtRoute` method returns a 201 response. It's the standard response for an HTTP POST method that creates a new resource on the server. `CreatedAtRoute` also adds a Location header to the response. The Location header specifies the URI of the newly created to-do item. See [10.2.2 201 Created](#).

### Use Postman to send a Create request

- Start the app (**Run > Start With Debugging**).
- Open Postman.



- Update the port number in the localhost URL.
- Set the HTTP method to *POST*.
- Click the **Body** tab.
- Select the **raw** radio button.
- Set the type to *JSON (application/json)*.
- Enter a request body with a to-do item resembling the following JSON:

```
{  
    "name": "walk dog",  
    "isComplete": true  
}
```

- Click the **Send** button.

#### TIP

If no response displays after clicking **Send**, disable the **SSL certification verification** option. This is found under **File > Settings**. Click the **Send** button again after disabling the setting.

Click the **Headers** tab in the **Response** pane and copy the **Location** header value:

The screenshot shows the Postman application interface. A POST request is being made to `https://localhost:44375/api/todo`. The request body is set to raw JSON, containing the object defined at the top of the page. The 'Headers' tab is selected in the response pane, which displays several headers, including the 'Location' header which is highlighted with a red box. The status of the request is 201 Created, and it took 148 ms.

You can use the Location header URI to access the resource you created. The `Create` method returns `CreatedAtRoute`. The first parameter passed to `CreatedAtRoute` represents the named route to use for generating the URL. Recall that the  `GetById` method created the `"GetTodo"` named route:

```
[HttpGet("{id}", Name = "GetTodo")]
```

## Update

```
[HttpPut("{id}")]
public IActionResult Update(long id, [FromBody] TodoItem item)
{
    if (item == null || item.Id != id)
    {
        return BadRequest();
    }

    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    todo.IsComplete = item.IsComplete;
    todo.Name = item.Name;

    _context.TodoItems.Update(todo);
    _context.SaveChanges();
    return NoContent();
}
```

```
[HttpPut("{id}")]
public IActionResult Update(long id, TodoItem item)
{
    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    todo.IsComplete = item.IsComplete;
    todo.Name = item.Name;

    _context.TodoItems.Update(todo);
    _context.SaveChanges();
    return NoContent();
}
```

`Update` is similar to `Create`, but uses HTTP PUT. The response is [204 \(No Content\)](#). According to the HTTP spec, a PUT request requires the client to send the entire updated entity, not just the deltas. To support partial updates, use HTTP PATCH.

```
{
    "key": 1,
    "name": "walk dog",
    "isComplete": true
}
```

The screenshot shows the Postman application interface. A red box highlights the 'PUT' method in the top left. The URL 'https://localhost:44375/api/todo/1' is entered in the main input field. To the right are buttons for 'Params' and a large blue 'Send' button. Below the URL, tabs for 'Authorization', 'Headers (3)', 'Body (●)', 'Pre-request Script', and 'Tests' are visible, with 'Body' being the active tab. A red box highlights the 'Body' tab. Under 'Body', there are four options: 'form-data', 'x-www-form-urlencoded', 'raw', and 'binary'. 'raw' is selected and highlighted with a red box. To its right is a dropdown set to 'JSON (application/json)'. The 'Body' content area contains the following JSON:

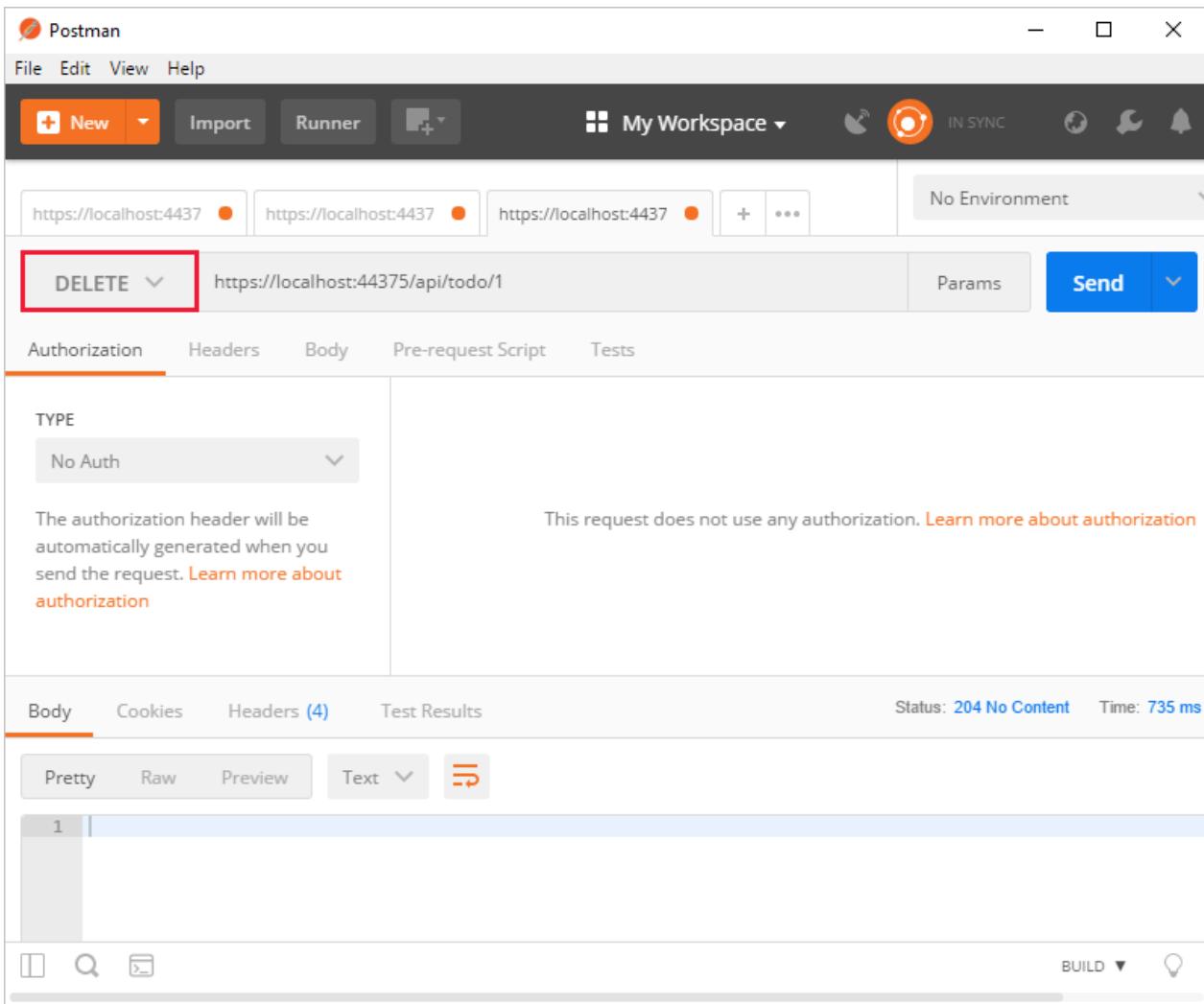
```
1 {  
2   "name": "walk cat",  
3   "isComplete": true  
4 }
```

## Delete

```
[HttpDelete("{id}")]
public IActionResult Delete(long id)
{
    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    _context.TodoItems.Remove(todo);
    _context.SaveChanges();
    return NoContent();
}
```

The response is 204 (No Content).



## Call the Web API with jQuery

In this section, an HTML page is added that uses jQuery to call the Web API. jQuery initiates the request and updates the page with the details from the API's response.

Configure the project to serve static files and to enable default file mapping. This is accomplished by invoking the [UseStaticFiles](#) and [UseDefaultFiles](#) extension methods in *Startup.Configure*. For more information, see [Static files](#).

```
public void Configure(IApplicationBuilder app)
{
    app.UseDefaultFiles();
    app.UseStaticFiles();
    app.UseMvc();
}
```

Add an HTML file, named *index.html*, to the project's *wwwroot* directory. Replace its contents with the following markup:

```
<!DOCTYPE html>
<html>
<head>
    <meta charset="UTF-8">
    <title>To-do CRUD</title>
    <style>
        input[type='submit'], button, [aria-label] {
            cursor: pointer;
        }
    </style>

```

```

    #spoiler {
        display: none;
    }

    table {
        font-family: Arial, sans-serif;
        border: 1px solid;
        border-collapse: collapse;
    }

    th {
        background-color: #0066CC;
        color: white;
    }

    td {
        border: 1px solid;
        padding: 5px;
    }

```

</style>

</head>

<body>

<h1>To-do CRUD</h1>

<h3>Add</h3>

<form action="javascript:void(0);" method="POST" onsubmit="addItem()">

<input type="text" id="add-name" placeholder="New to-do">

<input type="submit" value="Add">

</form>

<div id="spoiler">

<h3>Edit</h3>

<form class="my-form">

<input type="hidden" id="edit-id">

<input type="checkbox" id="edit-isComplete">

<input type="text" id="edit-name">

<input type="submit" value="Edit">

<a onclick="closeInput()" aria-label="Close" href="#">Close</a>

</form>

</div>

<p id="counter"></p>

<table>

<tr>

<th>Is Complete</th>

<th>Name</th>

<th></th>

<th></th>

</tr>

<tbody id="todos"></tbody>

</table>

<script src="https://code.jquery.com/jquery-3.3.1.min.js"
 integrity="sha256-FgpCb/KJQlLNfOu91ta32o/NMZxltwRo8QtmkMRdAu8="
 crossorigin="anonymous"></script>

<script src="site.js"></script>

</body>

</html>

Add a JavaScript file, named *site.js*, to the project's *wwwroot* directory. Replace its contents with the following code:

```

const uri = 'api/todo';
let todos = null;
function getCount(data) {
    const el = $('#counter');

```

```

let name = 'to-do';
if (data) {
    if (data > 1) {
        name = 'to-dos';
    }
    el.text(data + ' ' + name);
} else {
    el.html('No ' + name);
}

$(document).ready(function () {
    getData();
});

function getData() {
    $.ajax({
        type: 'GET',
        url: uri,
        success: function (data) {
            $('#todos').empty();
            getCount(data.length);
            $.each(data, function (key, item) {
                const checked = item.isComplete ? 'checked' : '';
                $(`<tr><td><input disabled="true" type="checkbox" ${checked}></td>' +
                    '<td>' + item.name + '</td>' +
                    '<td><button onclick="editItem(' + item.id + ')">Edit</button></td>' +
                    '<td><button onclick="deleteItem(' + item.id + ')">Delete</button></td>' +
                    '</tr>').appendTo($('#todos'));
            });
            todos = data;
        }
    });
}

function addItem() {
    const item = {
        'name': $('#add-name').val(),
        'isComplete': false
    };

    $.ajax({
        type: 'POST',
        accepts: 'application/json',
        url: uri,
        contentType: 'application/json',
        data: JSON.stringify(item),
        error: function (jqXHR, textStatus, errorThrown) {
            alert('here');
        },
        success: function (result) {
            getData();
            $('#add-name').val('');
        }
    });
}

function deleteItem(id) {
    $.ajax({
        url: uri + '/' + id,
        type: 'DELETE',
        success: function (result) {
            getData();
        }
    });
}

```

```

function editItem(id) {
    $.each(todos, function (key, item) {
        if (item.id === id) {
            $('#edit-name').val(item.name);
            $('#edit-id').val(item.id);
            $('#edit-isComplete').val(item.isComplete);
        }
    });
    $('#spoiler').css({ 'display': 'block' });
}

$('.my-form').on('submit', function () {
    const item = {
        'name': $('#edit-name').val(),
        'isComplete': $('#edit-isComplete').is(':checked'),
        'id': $('#edit-id').val()
    };

    $.ajax({
        url: uri + '/' + $('#edit-id').val(),
        type: 'PUT',
        accepts: 'application/json',
        contentType: 'application/json',
        data: JSON.stringify(item),
        success: function (result) {
            getData();
        }
    });
    closeInput();
    return false;
});

function closeInput() {
    $('#spoiler').css({ 'display': 'none' });
}

```

A change to the ASP.NET Core project's launch settings may be required to test the HTML page locally. Open `launchSettings.json` in the *Properties* directory of the project. Remove the `launchUrl` property to force the app to open at `index.html`—the project's default file.

There are several ways to get jQuery. In the preceding snippet, the library is loaded from a CDN. This sample is a complete CRUD example of calling the API with jQuery. There are additional features in this sample to make the experience richer. Below are explanations around the calls to the API.

### Get a list of to-do items

To get a list of to-do items, send an HTTP GET request to `/api/todo`.

The jQuery `ajax` function sends an AJAX request to the API, which returns JSON representing an object or array. This function can handle all forms of HTTP interaction, sending an HTTP request to the specified `url`. `GET` is used as the `type`. The `success` callback function is invoked if the request succeeds. In the callback, the DOM is updated with the to-do information.

```

$(document).ready(function () {
    getData();
});

function getData() {
    $.ajax({
        type: 'GET',
        url: uri,
        success: function (data) {
            $('#todos').empty();
            getCount(data.length);
            $.each(data, function (key, item) {
                const checked = item.isComplete ? 'checked' : '';
                $('<tr><td><input disabled="true" type="checkbox" ' + checked + '></td>' +
                    '<td>' + item.name + '</td>' +
                    '<td><button onclick="editItem(' + item.id + ')>Edit</button></td>' +
                    '<td><button onclick="deleteItem(' + item.id + ')>Delete</button></td>' +
                    '</tr>').appendTo($('#todos'));
            });
            todos = data;
        }
    });
}

```

## Add a to-do item

To add a to-do item, send an HTTP POST request to `/api/todo/`. The request body should contain a to-do object. The `ajax` function is using `POST` to call the API. For `POST` and `PUT` requests, the request body represents the data sent to the API. The API is expecting a JSON request body. The `accepts` and `contentType` options are set to `application/json` to classify the media type being received and sent, respectively. The data is converted to a JSON object using `JSON.stringify`. When the API returns a successful status code, the `getData` function is invoked to update the HTML table.

```

function addItem() {
    const item = {
        'name': $('#add-name').val(),
        'isComplete': false
    };

    $.ajax({
        type: 'POST',
        accepts: 'application/json',
        url: uri,
        contentType: 'application/json',
        data: JSON.stringify(item),
        error: function (jqXHR, textStatus, errorThrown) {
            alert('here');
        },
        success: function (result) {
            getData();
            $('#add-name').val('');
        }
    });
}

```

## Update a to-do item

Updating a to-do item is very similar to adding one, since both rely on a request body. The only real difference between the two in this case is that the `url` changes to add the unique identifier of the item, and the `type` is `PUT`.

```
$.ajax({
    url: uri + '/' + $('#edit-id').val(),
    type: 'PUT',
    accepts: 'application/json',
    contentType: 'application/json',
    data: JSON.stringify(item),
    success: function (result) {
        getData();
    }
});
```

## Delete a to-do item

Deleting a to-do item is accomplished by setting the `type` on the AJAX call to `DELETE` and specifying the item's unique identifier in the URL.

```
$.ajax({
    url: uri + '/' + id,
    type: 'DELETE',
    success: function (result) {
        getData();
    }
});
```

## Next steps

- For information on using a persistent database, see:
  - [Create a Razor Pages web app with ASP.NET Core](#)
  - [Work with data in ASP.NET Core](#)
- [ASP.NET Core Web API help pages using Swagger](#)
- [Routing to controller actions](#)
- [Build web APIs with ASP.NET Core](#)
- [Controller action return types](#)
- For information about deploying an API, including to Azure App Service, see [Host and deploy](#).
- [View or download sample code](#). See [how to download](#).

# Create a Web API with ASP.NET Core and Visual Studio Code

6/21/2018 • 15 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Mike Wasson](#)

In this tutorial, build a web API for managing a list of "to-do" items. A UI isn't constructed.

There are three versions of this tutorial:

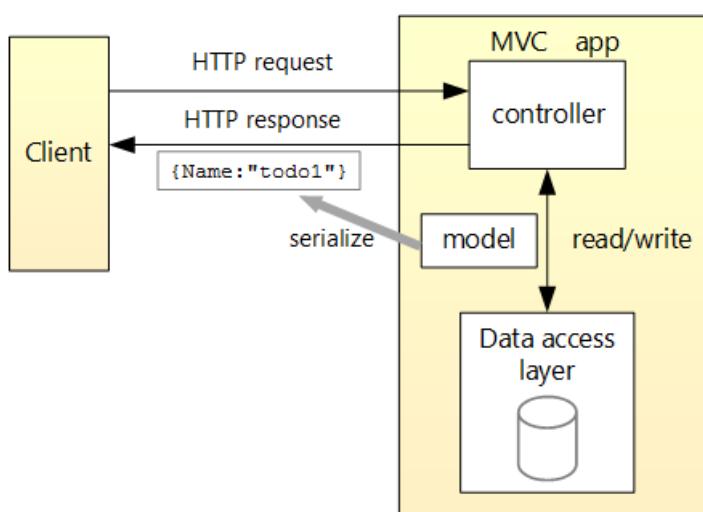
- macOS, Linux, Windows: Web API with Visual Studio Code (This tutorial)
- macOS: [Web API with Visual Studio for Mac](#)
- Windows: [Web API with Visual Studio for Windows](#)

## Overview

This tutorial creates the following API:

API	DESCRIPTION	REQUEST BODY	RESPONSE BODY
GET /api/todo	Get all to-do items	None	Array of to-do items
GET /api/todo/{id}	Get an item by ID	None	To-do item
POST /api/todo	Add a new item	To-do item	To-do item
PUT /api/todo/{id}	Update an existing item	To-do item	None
DELETE /api/todo/{id}	Delete an item	None	None

The following diagram shows the basic design of the app.



- The client is whatever consumes the web API (mobile app, browser, etc.). This tutorial doesn't create a client. [Postman](#) or [curl](#) is used as the client to test the app.
- A *model* is an object that represents the data in the app. In this case, the only model is a to-do item. Models are represented as C# classes, also known as **Plain Old CLR Object** (POCOs).

- A *controller* is an object that handles HTTP requests and creates the HTTP response. This app has a single controller.
- To keep the tutorial simple, the app doesn't use a persistent database. The sample app stores to-do items in an in-memory database.

## Prerequisites

Install the following:

- .NET Core SDK 2.0 or later
- Visual Studio Code
- C# for Visual Studio Code
- .NET Core 2.1 SDK or later
- Visual Studio Code
- C# for Visual Studio Code

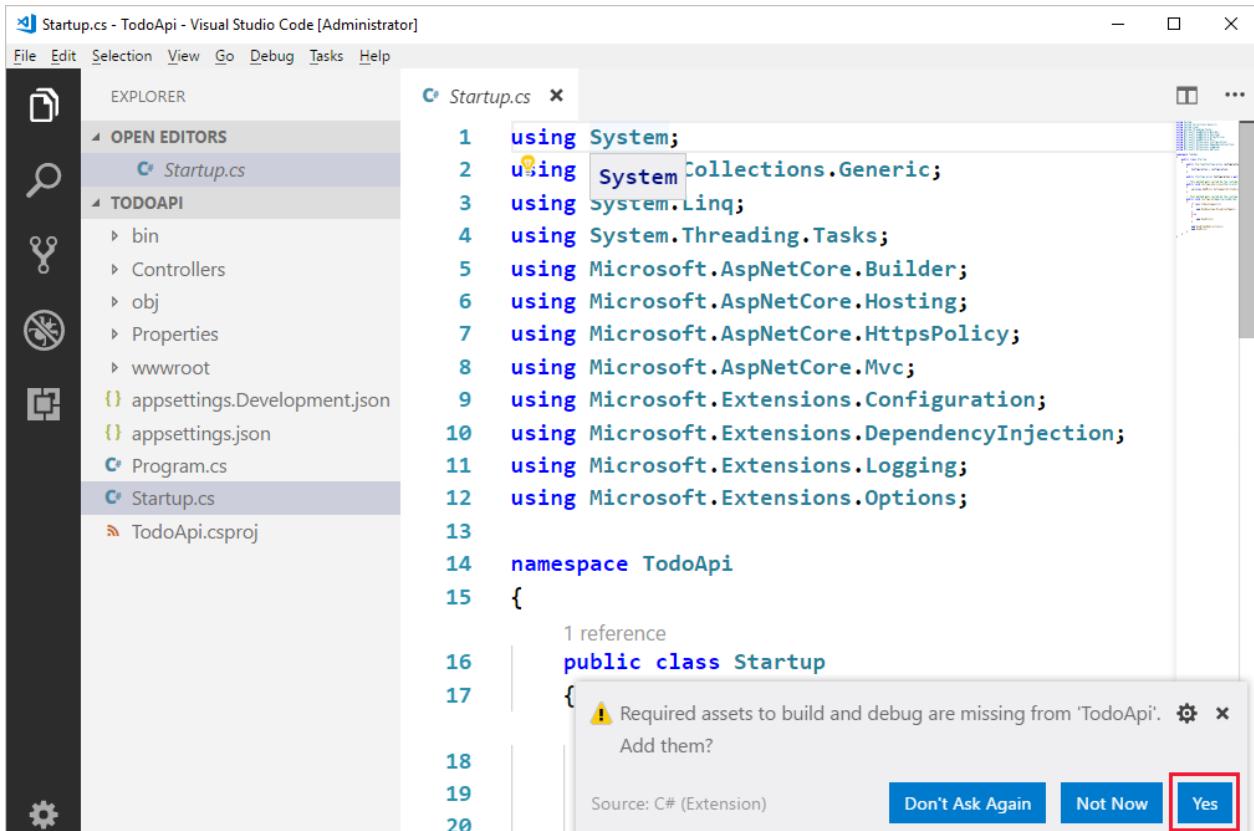
## Create the project

From a console, run the following commands:

```
dotnet new webapi -o TodoApi
code TodoApi
```

The *TodoApi* folder opens in Visual Studio Code (VS Code). Select the *Startup.cs* file.

- Select **Yes** to the **Warn** message "Required assets to build and debug are missing from 'TodoApi'. Add them?"
- Select **Restore** to the **Info** message "There are unresolved dependencies".



Press **Debug** (F5) to build and run the program. In a browser, navigate to <http://localhost:5000/api/values>. The

following output is displayed:

```
[ "value1", "value2" ]
```

See [Visual Studio Code help](#) for tips on using VS Code.

## Add support for Entity Framework Core

Creating a new project in ASP.NET Core 2.0 adds the [Microsoft.AspNetCore.All](#) package reference to the *TodoApi.csproj* file:

```
<ItemGroup>
  <PackageReference Include="Microsoft.AspNetCore.All" Version="2.0.3" />
</ItemGroup>
```

Creating a new project in ASP.NET Core 2.1 or later adds the [Microsoft.AspNetCore.App](#) package reference to the *TodoApi.csproj* file:

```
<ItemGroup>
  <PackageReference Include="Microsoft.AspNetCore.App" Version="2.1.1" />
</ItemGroup>
```

There's no need to install the [Entity Framework Core InMemory](#) database provider separately. This database provider allows Entity Framework Core to be used with an in-memory database.

## Add a model class

A model is an object representing the data in your app. In this case, the only model is a to-do item.

Add a folder named *Models*. You can put model classes anywhere in your project, but the *Models* folder is used by convention.

Add a `TodoItem` class with the following code:

```
namespace TodoApi.Models
{
    public class TodoItem
    {
        public long Id { get; set; }
        public string Name { get; set; }
        public bool IsComplete { get; set; }
    }
}
```

The database generates the `Id` when a `TodoItem` is created.

## Create the database context

The *database context* is the main class that coordinates Entity Framework functionality for a given data model. You create this class by deriving from the [Microsoft.EntityFrameworkCore.DbContext](#) class.

Add a `TodoContext` class in the *Models* folder:

```
using Microsoft.EntityFrameworkCore;

namespace TodoApi.Models
{
    public class TodoContext : DbContext
    {
        public TodoContext(DbContextOptions<TodoContext> options)
            : base(options)
        {
        }

        public DbSet<TodoItem> TodoItems { get; set; }
    }
}
```

## Register the database context

In this step, the database context is registered with the [dependency injection](#) container. Services (such as the DB context) that are registered with the dependency injection (DI) container are available to the controllers.

Register the DB context with the service container using the built-in support for [dependency injection](#). Replace the contents of the *Startup.cs* file with the following code:

```
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Mvc;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using TodoApi.Models;

namespace TodoApi
{
    public class Startup
    {
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<TodoContext>(opt =>
                opt.UseInMemoryDatabase("TodoList"));
            services.AddMvc()
                .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
        }

        public void Configure(IApplicationBuilder app)
        {
            app.UseMvc();
        }
    }
}
```

```

using Microsoft.AspNetCore.Builder;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using TodoApi.Models;

namespace TodoApi
{
    public class Startup
    {
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<TodoContext>(opt =>
                opt.UseInMemoryDatabase("TodoList"));
            services.AddMvc();
        }

        public void Configure(IApplicationBuilder app)
        {
            app.UseMvc();
        }
    }
}

```

The preceding code:

- Removes the unused code.
- Specifies an in-memory database is injected into the service container.

## Add a controller

In the *Controllers* folder, create a class named `| TodoController |`. Replace its contents with the following code:

```

using Microsoft.AspNetCore.Mvc;
using System.Collections.Generic;
using System.Linq;
using TodoApi.Models;

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

        public TodoController(TodoContext context)
        {
            _context = context;

            if (_context.TodoItems.Count() == 0)
            {
                _context.TodoItems.Add(new TodoItem { Name = "Item1" });
                _context.SaveChanges();
            }
        }
    }
}

```

The preceding code defines an API controller class without methods. In the next sections, methods are added to implement the API.

```

using Microsoft.AspNetCore.Mvc;
using System.Collections.Generic;
using System.Linq;
using TodoApi.Models;

namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    [ApiController]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;

        public TodoController(TodoContext context)
        {
            _context = context;

            if (_context.TodoItems.Count() == 0)
            {
                _context.TodoItems.Add(new TodoItem { Name = "Item1" });
                _context.SaveChanges();
            }
        }
    }
}

```

The preceding code defines an API controller class without methods. In the next sections, methods are added to implement the API. The class is annotated with an `[ApiController]` attribute to enable some convenient features. For information on features enabled by the attribute, see [Annotate class with ApiControllerAttribute](#).

The controller's constructor uses [Dependency Injection](#) to inject the database context (`TodoContext`) into the controller. The database context is used in each of the [CRUD](#) methods in the controller. The constructor adds an item to the in-memory database if one doesn't exist.

## Get to-do items

To get to-do items, add the following methods to the `TodoController` class:

```

[HttpGet]
public List<TodoItem> GetAll()
{
    return _context.TodoItems.ToList();
}

[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}

```

```
[HttpGet]
public ActionResult<List<TodoItem>> GetAll()
{
    return _context.TodoItems.ToList();
}

[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}
```

These methods implement the two GET methods:

- `GET /api/todo`
- `GET /api/todo/{id}`

Here's a sample HTTP response for the `GetAll` method:

```
[
{
    "id": 1,
    "name": "Item1",
    "isComplete": false
}]
```

Later in the tutorial, I'll show how the HTTP response can be viewed with [Postman](#) or [curl](#).

## Routing and URL paths

The `[HttpGet]` attribute denotes a method that responds to an HTTP GET request. The URL path for each method is constructed as follows:

- Take the template string in the controller's `Route` attribute:

```
namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;
```

```
namespace TodoApi.Controllers
{
    [Route("api/[controller]")]
    [ApiController]
    public class TodoController : ControllerBase
    {
        private readonly TodoContext _context;
```

- Replace `[controller]` with the name of the controller, which is the controller class name minus the "Controller" suffix. For this sample, the controller class name is **TodoController** and the root name is "todo". ASP.NET Core [routing](#) is case insensitive.

- If the `[HttpGet]` attribute has a route template (such as `[HttpGet("/products")]`), append that to the path. This sample doesn't use a template. For more information, see [Attribute routing with Http\[Verb\] attributes](#).

In the following  `GetById` method, `"{id}"` is a placeholder variable for the unique identifier of the to-do item. When  `GetById` is invoked, it assigns the value of `"{id}"` in the URL to the method's `id` parameter.

```
[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}
```

```
[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}
```

`Name = "GetTodo"` creates a named route. Named routes:

- Enable the app to create an HTTP link using the route name.
- Are explained later in the tutorial.

## Return values

The  `GetAll` method returns a collection of  `TodoItem` objects. MVC automatically serializes the object to  `JSON` and writes the JSON into the body of the response message. The response code for this method is 200, assuming there are no unhandled exceptions. Unhandled exceptions are translated into 5xx errors.

In contrast, the  `GetById` method returns the more general `IActionResult type`, which represents a wide range of return types.  `GetById` has two different return types:

- If no item matches the requested ID, the method returns a 404 error. Returning `NotFound` returns an HTTP 404 response.
- Otherwise, the method returns 200 with a JSON response body. Returning `Ok` results in an HTTP 200 response.

In contrast, the  `GetById` method returns the  `ActionResult<T> type`, which represents a wide range of return types.  `GetById` has two different return types:

- If no item matches the requested ID, the method returns a 404 error. Returning `NotFound` returns an HTTP 404 response.
- Otherwise, the method returns 200 with a JSON response body. Returning  `item` results in an HTTP 200 response.

## Launch the app

In VS Code, press F5 to launch the app. Navigate to `http://localhost:5000/api/todo` (the  `Todo` controller we created).

## Call the Web API with jQuery

In this section, an HTML page is added that uses jQuery to call the Web API. jQuery initiates the request and updates the page with the details from the API's response.

Configure the project to serve static files and to enable default file mapping. This is accomplished by invoking the [UseStaticFiles](#) and [UseDefaultFiles](#) extension methods in *Startup.Configure*. For more information, see [Static files](#).

```
public void Configure(IApplicationBuilder app)
{
    app.UseDefaultFiles();
    app.UseStaticFiles();
    app.UseMvc();
}
```

Add an HTML file, named *index.html*, to the project's *wwwroot* directory. Replace its contents with the following markup:

```
<!DOCTYPE html>
<html>
<head>
    <meta charset="UTF-8">
    <title>To-do CRUD</title>
    <style>
        input[type='submit'], button, [aria-label] {
            cursor: pointer;
        }

        #spoiler {
            display: none;
        }

        table {
            font-family: Arial, sans-serif;
            border: 1px solid;
            border-collapse: collapse;
        }

        th {
            background-color: #0066CC;
            color: white;
        }

        td {
            border: 1px solid;
            padding: 5px;
        }
    </style>
</head>
<body>
    <h1>To-do CRUD</h1>
    <h3>Add</h3>
    <form action="javascript:void(0);" method="POST" onsubmit="addItem()">
        <input type="text" id="add-name" placeholder="New to-do">
        <input type="submit" value="Add">
    </form>

    <div id="spoiler">
        <h3>Edit</h3>
        <form class="my-form">
            <input type="hidden" id="edit-id">
            <input type="checkbox" id="edit-isComplete">
            <input type="text" id="edit-name">
        </form>
    </div>
</body>
```

```

        <input type="submit" value="Edit">
        <a onclick="closeInput()" aria-label="Close">✖</a>
    </form>
</div>

<p id="counter"></p>

<table>
    <tr>
        <th>Is Complete</th>
        <th>Name</th>
        <th></th>
        <th></th>
    </tr>
    <tbody id="todos"></tbody>
</table>

<script src="https://code.jquery.com/jquery-3.3.1.min.js"
    integrity="sha256-FgpCb/KJQlLNfOu91ta32o/NMZxltwRo8QtmkMRdAu8="
    crossorigin="anonymous"></script>
<script src="site.js"></script>
</body>
</html>

```

Add a JavaScript file, named *site.js*, to the project's *wwwroot* directory. Replace its contents with the following code:

```

const uri = 'api/todo';
let todos = null;
function getCount(data) {
    const el = $('#counter');
    let name = 'to-do';
    if (data) {
        if (data > 1) {
            name = 'to-dos';
        }
        el.text(data + ' ' + name);
    } else {
        el.html('No ' + name);
    }
}

$(document).ready(function () {
    getData();
});

function getData() {
    $.ajax({
        type: 'GET',
        url: uri,
        success: function (data) {
            $('#todos').empty();
            getCount(data.length);
            $.each(data, function (key, item) {
                const checked = item.isComplete ? 'checked' : '';
                $('<tr><td><input disabled="true" type="checkbox" ' + checked + '></td>' +
                    '<td>' + item.name + '</td>' +
                    '<td><button onclick="editItem(' + item.id + ')">Edit</button></td>' +
                    '<td><button onclick="deleteItem(' + item.id + ')">Delete</button></td>' +
                    '</tr>').appendTo($('#todos'));
            });
            todos = data;
        }
    });
}

```

```

function addItem() {
  const item = {
    'name': $('#add-name').val(),
    'isComplete': false
  };

  $.ajax({
    type: 'POST',
    accepts: 'application/json',
    url: uri,
    contentType: 'application/json',
    data: JSON.stringify(item),
    error: function (jqXHR, textStatus, errorThrown) {
      alert('here');
    },
    success: function (result) {
      getData();
      $('#add-name').val('');
    }
  });
}

function deleteItem(id) {
  $.ajax({
    url: uri + '/' + id,
    type: 'DELETE',
    success: function (result) {
      getData();
    }
  });
}

function editItem(id) {
  $.each(todos, function (key, item) {
    if (item.id === id) {
      $('#edit-name').val(item.name);
      $('#edit-id').val(item.id);
      $('#edit-isComplete').val(item.isComplete);
    }
  });
  $('#spoiler').css({ 'display': 'block' });
}

$('.my-form').on('submit', function () {
  const item = {
    'name': $('#edit-name').val(),
    'isComplete': $('#edit-isComplete').is(':checked'),
    'id': $('#edit-id').val()
  };

  $.ajax({
    url: uri + '/' + $('#edit-id').val(),
    type: 'PUT',
    accepts: 'application/json',
    contentType: 'application/json',
    data: JSON.stringify(item),
    success: function (result) {
      getData();
    }
  });

  closeInput();
  return false;
});

function closeInput() {
  $('#spoiler').css({ 'display': 'none' });
}

```

A change to the ASP.NET Core project's launch settings may be required to test the HTML page locally. Open `launchSettings.json` in the `Properties` directory of the project. Remove the `launchUrl` property to force the app to open at `index.html`—the project's default file.

There are several ways to get jQuery. In the preceding snippet, the library is loaded from a CDN. This sample is a complete CRUD example of calling the API with jQuery. There are additional features in this sample to make the experience richer. Below are explanations around the calls to the API.

### Get a list of to-do items

To get a list of to-do items, send an HTTP GET request to `/api/todo`.

The jQuery `ajax` function sends an AJAX request to the API, which returns JSON representing an object or array. This function can handle all forms of HTTP interaction, sending an HTTP request to the specified `url`. `GET` is used as the `type`. The `success` callback function is invoked if the request succeeds. In the callback, the DOM is updated with the to-do information.

```
$(document).ready(function () {
    getData();
});

function getData() {
    $.ajax({
        type: 'GET',
        url: uri,
        success: function (data) {
            $('#todos').empty();
            getCount(data.length);
            $.each(data, function (key, item) {
                const checked = item.isComplete ? 'checked' : '';

                $('<tr><td><input disabled="true" type="checkbox" ' + checked + '></td>' +
                    '<td>' + item.name + '</td>' +
                    '<td><button onclick="editItem(' + item.id + ')">Edit</button></td>' +
                    '<td><button onclick="deleteItem(' + item.id + ')">Delete</button></td>' +
                    '</tr>').appendTo($('#todos'));
            });
            todos = data;
        }
    });
}
```

### Add a to-do item

To add a to-do item, send an HTTP POST request to `/api/todo/`. The request body should contain a to-do object. The `ajax` function is using `POST` to call the API. For `POST` and `PUT` requests, the request body represents the data sent to the API. The API is expecting a JSON request body. The `accepts` and `contentType` options are set to `application/json` to classify the media type being received and sent, respectively. The data is converted to a JSON object using `JSON.stringify`. When the API returns a successful status code, the `getData` function is invoked to update the HTML table.

```

function addItem() {
  const item = {
    'name': $('#add-name').val(),
    'isComplete': false
  };

  $.ajax({
    type: 'POST',
    accepts: 'application/json',
    url: uri,
    contentType: 'application/json',
    data: JSON.stringify(item),
    error: function (jqXHR, textStatus, errorThrown) {
      alert('here');
    },
    success: function (result) {
      getData();
      $('#add-name').val('');
    }
  });
}

```

## Update a to-do item

Updating a to-do item is very similar to adding one, since both rely on a request body. The only real difference between the two in this case is that the `url` changes to add the unique identifier of the item, and the `type` is `PUT`.

```

$.ajax({
  url: uri + '/' + $('#edit-id').val(),
  type: 'PUT',
  accepts: 'application/json',
  contentType: 'application/json',
  data: JSON.stringify(item),
  success: function (result) {
    getData();
  }
});

```

## Delete a to-do item

Deleting a to-do item is accomplished by setting the `type` on the AJAX call to `DELETE` and specifying the item's unique identifier in the URL.

```

$.ajax({
  url: uri + '/' + id,
  type: 'DELETE',
  success: function (result) {
    getData();
  }
});

```

# Implement the other CRUD operations

In the following sections, `Create`, `Update`, and `Delete` methods are added to the controller.

## Create

Add the following `Create` method:

```
[HttpPost]
public IActionResult Create([FromBody] TodoItem item)
{
    if (item == null)
    {
        return BadRequest();
    }

    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}
```

The preceding code is an HTTP POST method, as indicated by the `[HttpPost]` attribute. The `[FromBody]` attribute tells MVC to get the value of the to-do item from the body of the HTTP request.

```
[HttpPost]
public IActionResult Create(TodoItem item)
{
    _context.TodoItems.Add(item);
    _context.SaveChanges();

    return CreatedAtRoute("GetTodo", new { id = item.Id }, item);
}
```

The preceding code is an HTTP POST method, as indicated by the `[HttpPost]` attribute. MVC gets the value of the to-do item from the body of the HTTP request.

The `CreatedAtRoute` method:

- Returns a 201 response. HTTP 201 is the standard response for an HTTP POST method that creates a new resource on the server.
- Adds a Location header to the response. The Location header specifies the URI of the newly created to-do item. See [10.2.2 201 Created](#).
- Uses the "GetTodo" named route to create the URL. The "GetTodo" named route is defined in  `GetById`:

```
[HttpGet("{id}", Name = "GetTodo")]
public IActionResult GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return Ok(item);
}
```

```
[HttpGet("{id}", Name = "GetTodo")]
public ActionResult<TodoItem> GetById(long id)
{
    var item = _context.TodoItems.Find(id);
    if (item == null)
    {
        return NotFound();
    }
    return item;
}
```

## Use Postman to send a Create request

- Start the app.
- Open Postman.

The screenshot shows the Postman application window. At the top, the URL is set to `https://localhost:44375/api/todo`. The **Body** tab is selected, and the **raw** radio button is chosen. The JSON input field contains the following code:

```
1 {  
2   "name": "walk dog",  
3   "isComplete": true  
4 }
```

The response pane shows the result of the POST request:

```
1 {  
2   "id": 6,  
3   "name": "walk dog",  
4   "isComplete": true  
5 }
```

- Update the port number in the localhost URL.
- Set the HTTP method to *POST*.
- Click the **Body** tab.
- Select the **raw** radio button.
- Set the type to *JSON (application/json)*.
- Enter a request body with a to-do item resembling the following JSON:

```
{  
  "name": "walk dog",  
  "isComplete": true  
}
```

- Click the **Send** button.

### TIP

If no response displays after clicking **Send**, disable the **SSL certification verification** option. This is found under **File > Settings**. Click the **Send** button again after disabling the setting.

Click the **Headers** tab in the **Response** pane and copy the **Location** header value:

The screenshot shows the Postman application interface. At the top, there's a navigation bar with File, Edit, View, Help, and workspace-related buttons like New, Import, Runner, and My Workspace (IN SYNC). Below the bar, the URL is set to https://localhost:4437 and the method is POST. The target endpoint is https://localhost:44375/api/todo. The Headers tab is selected, showing a red box around it. The Body tab is also visible. The JSON body is defined as follows:

```
1 {  
2     "name": "walk dog",  
3     "isComplete": true  
4 }
```

Below the request details, the response section is shown with a red box around the Headers tab. It displays the following headers:

- Content-Type → application/json; charset=utf-8
- Date → Fri, 27 Apr 2018 18:32:32 GMT
- Location → https://localhost/api/Todo/6

The status is 201 Created and the time taken was 148 ms.

The Location header URI can be used to access the new item.

## Update

Add the following `Update` method:

```
[HttpPut("{id}")]
public IActionResult Update(long id, [FromBody] TodoItem item)
{
    if (item == null || item.Id != id)
    {
        return BadRequest();
    }

    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    todo.IsComplete = item.IsComplete;
    todo.Name = item.Name;

    _context.TodoItems.Update(todo);
    _context.SaveChanges();
    return NoContent();
}
```

```
[HttpPut("{id}")]
public IActionResult Update(long id, TodoItem item)
{
    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    todo.IsComplete = item.IsComplete;
    todo.Name = item.Name;

    _context.TodoItems.Update(todo);
    _context.SaveChanges();
    return NoContent();
}
```

`Update` is similar to `Create`, except it uses HTTP PUT. The response is [204 \(No Content\)](#). According to the HTTP specification, a PUT request requires the client to send the entire updated entity, not just the deltas. To support partial updates, use HTTP PATCH.

Use Postman to update the to-do item's name to "walk cat":

The screenshot shows the Postman application interface. The request method is set to `PUT` and the URL is `https://localhost:44375/api/todo/1`. The `Body` tab is selected, showing the raw JSON payload:

```
{
  "name": "walk cat",
  "isComplete": true
}
```

The `Content-Type` is set to `JSON (application/json)`. The response status is `204 No Content` with a response time of `70 ms`.

## Delete

Add the following `Delete` method:

```
[HttpDelete("{id}")]
public IActionResult Delete(long id)
{
    var todo = _context.TodoItems.Find(id);
    if (todo == null)
    {
        return NotFound();
    }

    _context.TodoItems.Remove(todo);
    _context.SaveChanges();
    return NoContent();
}
```

The `Delete` response is [204 \(No Content\)](#).

Use Postman to delete the to-do item:

The screenshot shows the Postman application window. At the top, there's a menu bar with File, Edit, View, Help, and a toolbar with New, Import, Runner, and a search bar labeled "My Workspace". Below the toolbar, there are three tabs for environments: "https://localhost:4437" (selected), "https://localhost:4437" (disabled), and "https://localhost:4437" (disabled). To the right of the tabs, it says "No Environment".

In the main area, a red box highlights the "DELETE" dropdown menu. Next to it is the URL "https://localhost:44375/api/todo/1". To the right of the URL are "Params" and a "Send" button. Below the URL, there are tabs for Authorization, Headers, Body, Pre-request Script, and Tests. The "Authorization" tab is selected, showing "No Auth" selected in a dropdown. A note below says: "The authorization header will be automatically generated when you send the request. [Learn more about authorization](#)". To the right of this note, another note says: "This request does not use any authorization. [Learn more about authorization](#)".

At the bottom of the main area, there are tabs for Body, Cookies, Headers (4), and Test Results. The "Body" tab is selected. It has sub-options for Pretty, Raw, Preview, and Text (which is currently selected). Below these options is a large text input area containing the number "1".

At the very bottom of the window, there are icons for refresh, search, and file operations, along with a "BUILD" dropdown.

## Visual Studio Code help

- [Getting started](#)
- [Debugging](#)
- [Integrated terminal](#)
- [Keyboard shortcuts](#)
  - [macOS keyboard shortcuts](#)

- Linux keyboard shortcuts
- Windows keyboard shortcuts

## Next steps

- For information on using a persistent database, see:
  - [Create a Razor Pages web app with ASP.NET Core](#)
  - [Work with data in ASP.NET Core](#)
- [ASP.NET Core Web API help pages using Swagger](#)
- [Routing to controller actions](#)
- [Build web APIs with ASP.NET Core](#)
- [Controller action return types](#)
- For information about deploying an API, including to Azure App Service, see [Host and deploy](#).
- [View or download sample code](#). See [how to download](#).

# Develop ASP.NET Core apps using a file watcher

7/14/2018 • 3 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Victor Hurdugaci](#)

`dotnet watch` is a tool that runs a [.NET Core CLI](#) command when source files change. For example, a file change can trigger compilation, test execution, or deployment.

This tutorial uses an existing web API with two endpoints: one that returns a sum and one that returns a product. The product method has a bug, which is fixed in this tutorial.

Download the [sample app](#). It consists of two projects: *WebApp* (an ASP.NET Core web API) and *WebAppTests* (unit tests for the web API).

In a command shell, navigate to the *WebApp* folder. Run the following command:

```
dotnet run
```

The console output shows messages similar to the following (indicating that the app is running and awaiting requests):

```
$ dotnet run
Hosting environment: Development
Content root path: C:/Docs/aspnetcore/tutorials/dotnet-watch/sample/WebApp
Now listening on: http://localhost:5000
Application started. Press Ctrl+C to shut down.
```

In a web browser, navigate to `http://localhost:<port number>/api/math/sum?a=4&b=5`. You should see the result of 9.

Navigate to the product API (`http://localhost:<port number>/api/math/product?a=4&b=5`). It returns 9, not 20 as you'd expect. That problem is fixed later in the tutorial.

## Add `dotnet watch` to a project

The `dotnet watch` file watcher tool is included with version 2.1.300 of the .NET Core SDK. The following steps are required when using an earlier version of the .NET Core SDK.

1. Add a `Microsoft.DotNet.Watcher.Tools` package reference to the `.csproj` file:

```
<ItemGroup>
<DotNetCliToolReference Include="Microsoft.DotNet.Watcher.Tools" Version="2.0.0" />
</ItemGroup>
```

1. Install the `Microsoft.DotNet.Watcher.Tools` package by running the following command:

```
dotnet restore
```

## Run .NET Core CLI commands using `dotnet watch`

Any .NET Core CLI command can be run with `dotnet watch`. For example:

COMMAND	COMMAND WITH WATCH
<code>dotnet run</code>	<code>dotnet watch run</code>
<code>dotnet run -f netcoreapp2.0</code>	<code>dotnet watch run -f netcoreapp2.0</code>
<code>dotnet run -f netcoreapp2.0 -- --arg1</code>	<code>dotnet watch run -f netcoreapp2.0 -- --arg1</code>
<code>dotnet test</code>	<code>dotnet watch test</code>

Run `dotnet watch run` in the *WebApp* folder. The console output indicates `watch` has started.

## Make changes with `dotnet watch`

Make sure `dotnet watch` is running.

Fix the bug in the `Product` method of *MathController.cs* so it returns the product and not the sum:

```
public static int Product(int a, int b)
{
    return a * b;
}
```

Save the file. The console output indicates that `dotnet watch` detected a file change and restarted the app.

Verify `http://localhost:<port number>/api/math/product?a=4&b=5` returns the correct result.

## Run tests using `dotnet watch`

1. Change the `Product` method of *MathController.cs* back to returning the sum. Save the file.
2. In a command shell, navigate to the *WebAppTests* folder.
3. Run `dotnet restore`.
4. Run `dotnet watch test`. Its output indicates that a test failed and that the watcher is awaiting file changes:

```
Total tests: 2. Passed: 1. Failed: 1. Skipped: 0.
Test Run Failed.
```

5. Fix the `Product` method code so it returns the product. Save the file.

`dotnet watch` detects the file change and reruns the tests. The console output indicates the tests passed.

## Customize files list to watch

By default, `dotnet-watch` tracks all files matching the following glob patterns:

- `**/*.cs`
- `*.csproj`
- `**/*.resx`

More items can be added to the watch list by editing the *.csproj* file. Items can be specified individually or by using

glob patterns.

```
<ItemGroup>
    <!-- extends watching group to include *.js files -->
    <Watch Include="**\*.js" Exclude="node_modules\**\*;**\*.js.map;obj\**\*;bin\**\*" />
</ItemGroup>
```

## Opt-out of files to be watched

`dotnet-watch` can be configured to ignore its default settings. To ignore specific files, add the `Watch="false"` attribute to an item's definition in the `.csproj` file:

```
<ItemGroup>
    <!-- exclude Generated.cs from dotnet-watch -->
    <Compile Include="Generated.cs" Watch="false" />

    <!-- exclude Strings.resx from dotnet-watch -->
    <EmbeddedResource Include="Strings.resx" Watch="false" />

    <!-- exclude changes in this referenced project -->
    <ProjectReference Include=".\\ClassLibrary1\\ClassLibrary1.csproj" Watch="false" />
</ItemGroup>
```

## Custom watch projects

`dotnet-watch` isn't restricted to C# projects. Custom watch projects can be created to handle different scenarios. Consider the following project layout:

- **test**
  - *UnitTests/UnitTests.csproj*
  - *IntegrationTests/IntegrationTests.csproj*

If the goal is to watch both projects, create a custom project file configured to watch both projects:

```
<Project>
    <ItemGroup>
        <TestProjects Include="**\*.csproj" />
        <Watch Include="**\*.cs" />
    </ItemGroup>

    <Target Name="Test">
        <MSBuild Targets="VSTest" Projects="@({TestProjects})" />
    </Target>

    <Import Project="$(MSBuildExtensionsPath)\\Microsoft.Common.targets" />
</Project>
```

To start file watching on both projects, change to the `test` folder. Execute the following command:

```
dotnet watch msbuild /t:Test
```

VSTest executes when any file changes in either test project.

`dotnet-watch` in GitHub

`dotnet-watch` is part of the GitHub [DotNetTools repository](#).



# Create backend services for native mobile apps with ASP.NET Core

6/21/2018 • 7 minutes to read • [Edit Online](#)

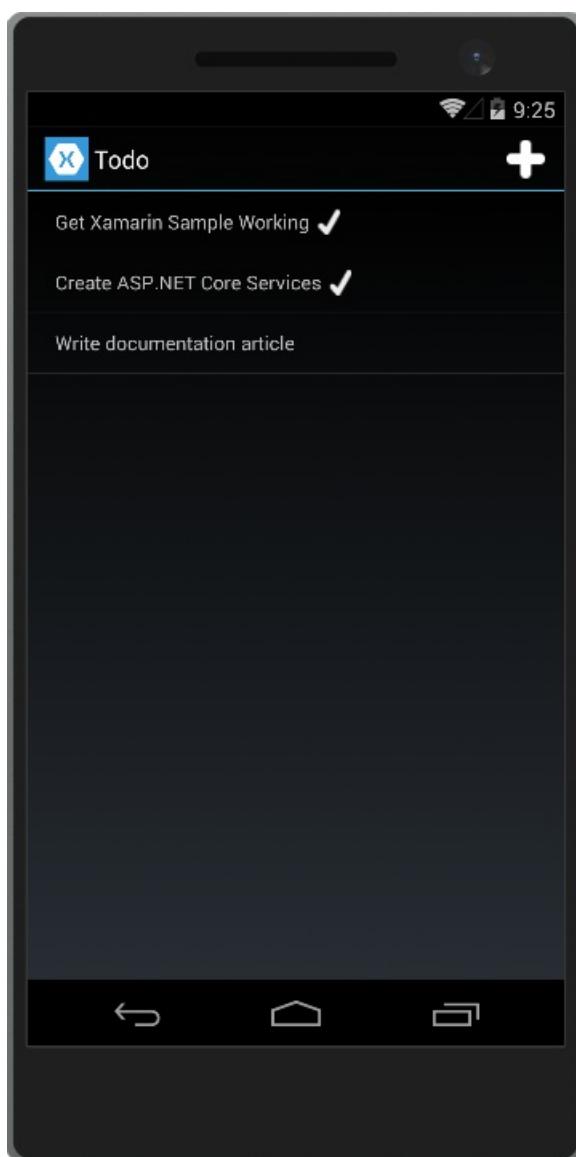
By [Steve Smith](#)

Mobile apps can easily communicate with ASP.NET Core backend services.

[View or download sample backend services code](#)

## The Sample Native Mobile App

This tutorial demonstrates how to create backend services using ASP.NET Core MVC to support native mobile apps. It uses the [Xamarin Forms ToDoRest app](#) as its native client, which includes separate native clients for Android, iOS, Windows Universal, and Window Phone devices. You can follow the linked tutorial to create the native app (and install the necessary free Xamarin tools), as well as download the Xamarin sample solution. The Xamarin sample includes an ASP.NET Web API 2 services project, which this article's ASP.NET Core app replaces (with no changes required by the client).

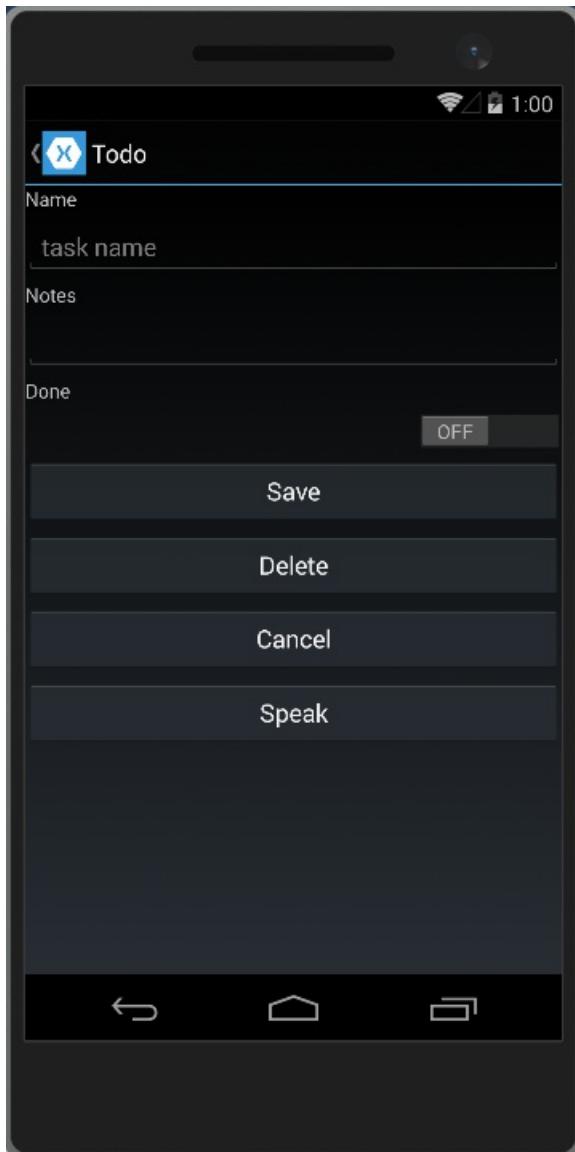


### Features

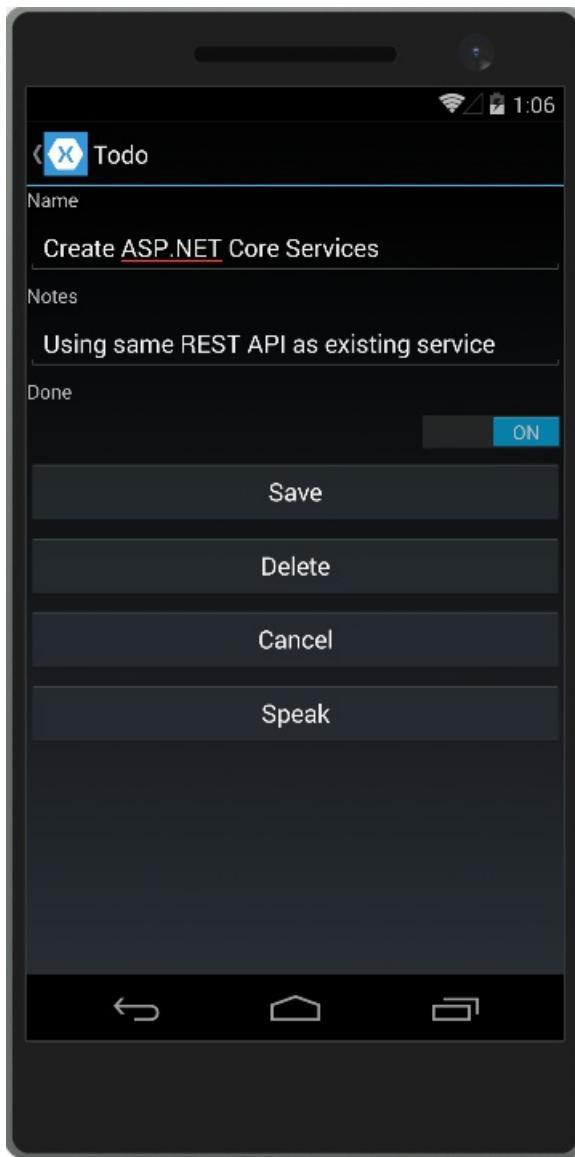
The ToDoRest app supports listing, adding, deleting, and updating To-Do items. Each item has an ID, a Name, Notes, and a property indicating whether it's been Done yet.

The main view of the items, as shown above, lists each item's name and indicates if it's done with a checkmark.

Tapping the  icon opens an add item dialog:



Tapping an item on the main list screen opens up an edit dialog where the item's Name, Notes, and Done settings can be modified, or the item can be deleted:



This sample is configured by default to use backend services hosted at developer.xamarin.com, which allow read-only operations. To test it out yourself against the ASP.NET Core app created in the next section running on your computer, you'll need to update the app's `RestUrl` constant. Navigate to the `ToDoREST` project and open the `Constants.cs` file. Replace the `RestUrl` with a URL that includes your machine's IP address (not localhost or 127.0.0.1, since this address is used from the device emulator, not from your machine). Include the port number as well (5000). In order to test that your services work with a device, ensure you don't have an active firewall blocking access to this port.

```
// URL of REST service (Xamarin ReadOnly Service)
//public static string RestUrl = "http://developer.xamarin.com:8081/api/todoitems{0}";

// use your machine's IP address
public static string RestUrl = "http://192.168.1.207:5000/api/todoitems/{0}";
```

## Creating the ASP.NET Core Project

Create a new ASP.NET Core Web Application in Visual Studio. Choose the Web API template and No Authentication. Name the project `ToDoApi`.

Select a template:

**ASP.NET Core Templates**

Empty



Web API



Web Application

A project template for creating an ASP.NET Core application with an example Controller for a RESTful HTTP service. This template can also be used for ASP.NET MVC Views and Controllers.

[Learn more](#)[Change Authentication](#)Authentication: **No Authentication**

Microsoft Azure

 Host in the cloud

App Service

[OK](#)[Cancel](#)

The application should respond to all requests made to port 5000. Update *Program.cs* to include

```
.UseUrls("http://*:5000")
```

 to achieve this:

```
var host = new WebHostBuilder()
    .UseKestrel()
    .UseUrls("http://*:5000")
    .UseContentRoot(Directory.GetCurrentDirectory())
    .UseIISIntegration()
    .UseStartup<Startup>()
    .Build();
```

**NOTE**

Make sure you run the application directly, rather than behind IIS Express, which ignores non-local requests by default. Run [dotnet run](#) from a command prompt, or choose the application name profile from the Debug Target dropdown in the Visual Studio toolbar.

Add a model class to represent To-Do items. Mark required fields using the `[Required]` attribute:

```

using System.ComponentModel.DataAnnotations;

namespace ToDoApi.Models
{
    public class ToDoItem
    {
        [Required]
        public string ID { get; set; }

        [Required]
        public string Name { get; set; }

        [Required]
        public string Notes { get; set; }

        public bool Done { get; set; }
    }
}

```

The API methods require some way to work with data. Use the same `IToDoRepository` interface the original Xamarin sample uses:

```

using System.Collections.Generic;
using ToDoApi.Models;

namespace ToDoApi.Interfaces
{
    public interface IToDoRepository
    {
        bool DoesItemExist(string id);
        IEnumerable<ToDoItem> All { get; }
        ToDoItem Find(string id);
        void Insert(ToDoItem item);
        void Update(ToDoItem item);
        void Delete(string id);
    }
}

```

For this sample, the implementation just uses a private collection of items:

```

using System.Collections.Generic;
using System.Linq;
using ToDoApi.Interfaces;
using ToDoApi.Models;

namespace ToDoApi.Services
{
    public class ToDoRepository : IToDoRepository
    {
        private List<ToDoItem> _ToDoList;

        public ToDoRepository()
        {
            InitializeData();
        }

        public IEnumerable<ToDoItem> All
        {
            get { return _ToDoList; }
        }

        public bool DoesItemExist(string id)
        {
            return _ToDoList.Any(item => item.ID == id);
        }
    }
}

```

```

        }

        public ToDoItem Find(string id)
        {
            return _toDoList.FirstOrDefault(item => item.ID == id);
        }

        public void Insert(ToDoItem item)
        {
            _toDoList.Add(item);
        }

        public void Update(ToDoItem item)
        {
            var todoItem = this.Find(item.ID);
            var index = _toDoList.IndexOf(todoItem);
            _toDoList.RemoveAt(index);
            _toDoList.Insert(index, item);
        }

        public void Delete(string id)
        {
            _toDoList.Remove(this.Find(id));
        }

        private void InitializeData()
        {
            _toDoList = new List<ToDoItem>();

            var todoItem1 = new ToDoItem
            {
                ID = "6bb8a868-dba1-4f1a-93b7-24ebce87e243",
                Name = "Learn app development",
                Notes = "Attend Xamarin University",
                Done = true
            };

            var todoItem2 = new ToDoItem
            {
                ID = "b94afb54-a1cb-4313-8af3-b7511551b33b",
                Name = "Develop apps",
                Notes = "Use Xamarin Studio/Visual Studio",
                Done = false
            };

            var todoItem3 = new ToDoItem
            {
                ID = "ecfa6f80-3671-4911-aabe-63cc442c1ecf",
                Name = "Publish apps",
                Notes = "All app stores",
                Done = false,
            };

            _toDoList.Add(todoItem1);
            _toDoList.Add(todoItem2);
            _toDoList.Add(todoItem3);
        }
    }
}

```

Configure the implementation in *Startup.cs*:

```
public void ConfigureServices(IServiceCollection services)
{
    // Add framework services.
    services.AddMvc();

    services.AddSingleton<IToDoRepository, ToDoRepository>();
}
```

At this point, you're ready to create the *ToDoItemsController*.

**TIP**

Learn more about creating web APIs in [Build your first Web API with ASP.NET Core MVC and Visual Studio](#).

## Creating the Controller

Add a new controller to the project, *ToDoItemsController*. It should inherit from `Microsoft.AspNetCore.Mvc.Controller`. Add a `[Route]` attribute to indicate that the controller will handle requests made to paths starting with `api/todoitems`. The `[controller]` token in the route is replaced by the name of the controller (omitting the `Controller` suffix), and is especially helpful for global routes. Learn more about [routing](#).

The controller requires an `IToDoRepository` to function; request an instance of this type through the controller's constructor. At runtime, this instance will be provided using the framework's support for [dependency injection](#).

```
using System;
using Microsoft.AspNetCore.Http;
using Microsoft.AspNetCore.Mvc;
using ToDoApi.Interfaces;
using ToDoApi.Models;

namespace ToDoApi.Controllers
{
    [Route("api/[controller]")]
    public class ToDoItemsController : Controller
    {
        private readonly IToDoRepository _ToDoRepository;

        public ToDoItemsController(IToDoRepository ToDoRepository)
        {
            _ToDoRepository = ToDoRepository;
        }
    }
}
```

This API supports four different HTTP verbs to perform CRUD (Create, Read, Update, Delete) operations on the data source. The simplest of these is the Read operation, which corresponds to an HTTP GET request.

### Reading Items

Requesting a list of items is done with a GET request to the `List` method. The `[HttpGet]` attribute on the `List` method indicates that this action should only handle GET requests. The route for this action is the route specified on the controller. You don't necessarily need to use the action name as part of the route. You just need to ensure each action has a unique and unambiguous route. Routing attributes can be applied at both the controller and method levels to build up specific routes.

```
[HttpGet]
public IActionResult List()
{
    return Ok(_todoRepository.All);
}
```

The `List` method returns a 200 OK response code and all of the ToDo items, serialized as JSON.

You can test your new API method using a variety of tools, such as [Postman](#), shown here:

The screenshot shows the Postman application interface. At the top, there are tabs for 'Runner', 'Import', 'Builder', 'Team Library', and status indicators for 'SYNC OFF' and notifications. Below the header, the URL is set to `http://192.168.1.207:5000/api/todoitems`. The main interface shows a 'GET' request selected, with the URL again displayed. Below the request type are tabs for 'Authorization', 'Headers', 'Body', 'Pre-request Script', 'Tests', and 'Generate Code'. The 'Headers' tab is currently active. In the 'Body' section, there are tabs for 'Pretty', 'Raw', 'Preview', and 'JSON'. The 'Pretty' tab is selected, displaying a JSON array of three todo items. Each item has an ID, name, notes, and a 'done' status. The 'Status' field indicates a '200 OK' response, and the 'Time' taken is 69 ms.

id	name	notes	done
6bb8a868-dba1-4f1a-93b7-24ebce87e243	Learn app development	Attend Xamarin University	true
b94afb54-a1cb-4313-8af3-b7511551b33b	Develop apps	Use Xamarin Studio/Visual Studio	false
ecfa6f80-3671-4911-aabe-63cc442c1ecf	Publish apps	All app stores	false

## Creating Items

By convention, creating new data items is mapped to the HTTP POST verb. The `Create` method has an `[HttpPost]` attribute applied to it, and accepts a `ToDoItem` instance. Since the `item` argument will be passed in the body of the POST, this parameter is decorated with the `[FromBody]` attribute.

Inside the method, the item is checked for validity and prior existence in the data store, and if no issues occur, it's added using the repository. Checking `ModelState.IsValid` performs [model validation](#), and should be done in every API method that accepts user input.

```
[HttpPost]
public IActionResult Create([FromBody] ToDoItem item)
{
    try
    {
        if (item == null || !ModelState.IsValid)
        {
            return BadRequest(ErrorCode.TodoItemNameAndNotesRequired.ToString());
        }
        bool itemExists = _ToDoRepository.DoesItemExist(item.ID);
        if (itemExists)
        {
            return StatusCode(StatusCodes.Status409Conflict, ErrorCode.TodoItemIDInUse.ToString());
        }
        _ToDoRepository.Insert(item);
    }
    catch (Exception)
    {
        return BadRequest(ErrorCode.CouldNotCreateItem.ToString());
    }
    return Ok(item);
}
```

The sample uses an enum containing error codes that are passed to the mobile client:

```
public enum ErrorCode
{
    TodoItemNameAndNotesRequired,
    TodoItemIDInUse,
    RecordNotFound,
    CouldNotCreateItem,
    CouldNotUpdateItem,
    CouldNotDeleteItem
}
```

Test adding new items using Postman by choosing the POST verb providing the new object in JSON format in the Body of the request. You should also add a request header specifying a Content-Type of application/json.

The method returns the newly created item in the response.

## Updating Items

Modifying records is done using HTTP PUT requests. Other than this change, the `Edit` method is almost identical to `Create`. Note that if the record isn't found, the `Edit` action will return a `NotFound` (404) response.

```
[HttpPut]
public IActionResult Edit([FromBody] ToDoItem item)
{
    try
    {
        if (item == null || !ModelState.IsValid)
        {
            return BadRequest(ErrorCode.TodoItemNameAndNotesRequired.ToString());
        }
        var existingItem = _todoRepository.Find(item.ID);
        if (existingItem == null)
        {
            return NotFound(ErrorCode.RecordNotFound.ToString());
        }
        _todoRepository.Update(item);
    }
    catch (Exception)
    {
        return BadRequest(ErrorCode.CouldNotUpdateItem.ToString());
    }
    return NoContent();
}
```

To test with Postman, change the verb to PUT. Specify the updated object data in the Body of the request.

The screenshot shows the Postman application interface. The top navigation bar includes 'Runner', 'Import', 'Builder' (which is selected), 'Team Library', and various status indicators like 'SYNC OFF'. Below the header, the URL is set to `http://192.168.1.207:5000/a`. The main area shows a 'PUT' request to `http://192.168.1.207:5000/api/todoitems`. The 'Body' tab is active, showing a raw JSON payload:

```
1 {  
2     "ID": "6bb8b868-dba1-4f1a-93b7-24ebce87243",  
3     "Name": "An UPDATED Test Item",  
4     "Notes": "Some updated notes",  
5     "Done": true  
6 }
```

The 'Headers' section contains two entries: 'Content-Type: application/json' and 'Accept: application/json'. The 'Body' section is set to 'raw' and 'JSON (application/json)'. The response section shows a successful `204 No Content` response with a time of `91 ms`.

This method returns a `NoContent` (204) response when successful, for consistency with the pre-existing API.

## Deleting Items

Deleting records is accomplished by making DELETE requests to the service, and passing the ID of the item to be deleted. As with updates, requests for items that don't exist will receive `NotFound` responses. Otherwise, a successful request will get a `NoContent` (204) response.

```
[HttpDelete("{id}")]
public IActionResult Delete(string id)
{
    try
    {
        var item = _todoRepository.Find(id);
        if (item == null)
        {
            return NotFound(ErrorCode.RecordNotFound.ToString());
        }
        _todoRepository.Delete(id);
    }
    catch (Exception)
    {
        return BadRequest(ErrorCode.CouldNotDeleteItem.ToString());
    }
    return NoContent();
}
```

Note that when testing the delete functionality, nothing is required in the Body of the request.

The screenshot shows the Postman application interface. At the top, there are tabs for Runner, Import, Builder (which is selected), and Team Library. On the right side of the header, there are icons for a gear (Sync Off), a bell, and a dropdown menu. Below the header, the URL `http://192.168.1.207:5000/a` is entered in the address bar, along with a plus sign icon for creating new requests. To the right of the URL, it says "No environment" with a dropdown arrow and an eye icon. The main workspace shows a **DELETE** request to `http://192.168.1.207:5000/api/todoitems/6bb8b8`. The "Body" tab is selected, showing options for form-data, x-www-form-urlencoded, raw, and binary, with "raw" selected and "JSON (application/json)" chosen. A large text area for the request body is present but empty. Other tabs include Headers (2), Pre-request Script, Tests, and Generate Code. Below the request area, the response section is shown with "Body" selected. It displays the status `204 No Content` and time `91 ms`. It includes Pretty, Raw, Preview, and HTML buttons, and a search icon. A large text area for the response body is also empty.

## Common Web API Conventions

As you develop the backend services for your app, you will want to come up with a consistent set of conventions or policies for handling cross-cutting concerns. For example, in the service shown above, requests for specific records that weren't found received a `NotFound` response, rather than a `BadRequest` response. Similarly, commands made to this service that passed in model bound types always checked `ModelState.IsValid` and returned a `BadRequest` for invalid model types.

Once you've identified a common policy for your APIs, you can usually encapsulate it in a [filter](#). Learn more about [how to encapsulate common API policies in ASP.NET Core MVC applications](#).

# ASP.NET Core fundamentals

7/2/2018 • 7 minutes to read • [Edit Online](#)

An ASP.NET Core application is a console app that creates a web server in its `Main` method:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;

namespace aspnetcoreapp
{
    public class Program
    {
        public static void Main(string[] args)
        {
            BuildWebHost(args).Run();
        }

        public static IWebHost BuildWebHost(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>()
                .Build();
    }
}
```

The `Main` method invokes `WebHost.CreateDefaultBuilder`, which follows the builder pattern to create a web application host. The builder has methods that define the web server (for example, `UseKestrel`) and the startup class (`UseStartup`). In the preceding example, the `Kestrel` web server is automatically allocated. ASP.NET Core's web host attempts to run on IIS, if available. Other web servers, such as `HTTP.sys`, can be used by invoking the appropriate extension method. `UseStartup` is explained further in the next section.

`IWebHostBuilder`, the return type of the `WebHost.CreateDefaultBuilder` invocation, provides many optional methods. Some of these methods include `UseHttpSys` for hosting the app in `HTTP.sys` and `UseContentRoot` for specifying the root content directory. The `Build` and `Run` methods build the `IWebHost` object that hosts the app and begins listening for HTTP requests.

## Startup

The `UseStartup` method on `WebHostBuilder` specifies the `Startup` class for your app:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
public class Program
{
    public static void Main(string[] args)
    {
        BuildWebHost(args).Run();
    }

    public static IWebHost BuildWebHost(string[] args) =>
        WebHost.CreateDefaultBuilder(args)
            .UseStartup<Startup>()
            .Build();
}
```

The `Startup` class is where you define the request handling pipeline and where any services needed by the app are configured. The `Startup` class must be public and contain the following methods:

```
public class Startup
{
    // This method gets called by the runtime. Use this method
    // to add services to the container.
    public void ConfigureServices(IServiceCollection services)
    {

        // This method gets called by the runtime. Use this method
        // to configure the HTTP request pipeline.
        public void Configure(IApplicationBuilder app)
        {
        }
}
```

`ConfigureServices` defines the [Services](#) used by your app (for example, ASP.NET Core MVC, Entity Framework Core, Identity). `Configure` defines the [middleware](#) for the request pipeline.

For more information, see [Application startup](#).

## Content root

The content root is the base path to any content used by the app, such as views, [Razor Pages](#), and static assets. By default, the content root is the same as application base path for the executable hosting the app.

## Web root

The web root of an app is the directory in the project containing public, static resources, such as CSS, JavaScript, and image files.

## Dependency injection (services)

A service is a component that's intended for common consumption in an app. Services are made available through [dependency injection \(DI\)](#). ASP.NET Core includes a native [Inversion of Control](#) (IoC) container that supports [constructor injection](#) by default. You can replace the default native container if you wish. In addition to its loose coupling benefit, DI makes services available throughout your app (for example, [logging](#)).

For more information, see [Dependency injection](#).

## Middleware

In ASP.NET Core, you compose your request pipeline using [middleware](#). ASP.NET Core middleware performs

asynchronous logic on an `HttpContext` and then either invokes the next middleware in the sequence or terminates the request directly. A middleware component called "XYZ" is added by invoking an `UseXYZ` extension method in the `Configure` method.

ASP.NET Core includes a rich set of built-in middleware:

- [Static files](#)
- [Routing](#)
- [Authentication](#)
- [Response Compression Middleware](#)
- [URL Rewriting Middleware](#)

OWIN-based middleware is available for ASP.NET Core apps, and you can write your own custom middleware.

For more information, see [Middleware](#) and [Open Web Interface for .NET \(OWIN\)](#).

## Initiate HTTP requests

For information about using `IHttpClientFactory` to access `HttpClient` instances to make HTTP requests, see [Initiate HTTP requests](#).

## Environments

Environments, such as "Development" and "Production", are a first-class notion in ASP.NET Core and can be set using environment variables.

For more information, see [Use multiple environments](#).

## Configuration

ASP.NET Core uses a configuration model based on name-value pairs. The configuration model isn't based on `System.Configuration` or `web.config`. Configuration obtains settings from an ordered set of configuration providers. The built-in configuration providers support a variety of file formats (XML, JSON, INI) and environment variables to enable environment-based configuration. You can also write your own custom configuration providers.

For more information, see [Configuration](#).

## Logging

ASP.NET Core supports a logging API that works with a variety of logging providers. Built-in providers support sending logs to one or more destinations. Third-party logging frameworks can be used.

For more information, see [Logging](#)

## Error handling

ASP.NET Core has built-in features for handling errors in apps, including a developer exception page, custom error pages, static status code pages, and startup exception handling.

For more information, see [how to handle errors](#).

## Routing

ASP.NET Core offers features for routing of app requests to route handlers.

For more information, see [Routing](#).

## File providers

ASP.NET Core abstracts file system access through the use of File Providers, which offers a common interface for working with files across platforms.

For more information, see [File Providers](#).

## Static files

Static files middleware serves static files, such as HTML, CSS, image, and JavaScript.

For more information, see [Static files](#).

## Hosting

ASP.NET Core apps configure and launch a *host*, which is responsible for app startup and lifetime management.

For more information, see [Host in ASP.NET Core](#).

## Session and app state

ASP.NET Core offers several approaches to preserve session and app state while the user browses a web app.

For more information, see [Session and app state](#).

## Servers

The ASP.NET Core hosting model doesn't directly listen for requests. The hosting model relies on an HTTP server implementation to forward the request to the app. The forwarded request is wrapped as a set of feature objects that can be accessed through interfaces. ASP.NET Core includes a managed, cross-platform web server, called **Kestrel**. Kestrel is often run behind a production web server, such as [IIS](#) or [Nginx](#). Kestrel can be run as an edge server.

For more information, see [Servers](#) and the following topics:

- [Kestrel](#)
- [ASP.NET Core Module](#)
- [HTTP.sys](#) (formerly called [WebListener](#))

## Globalization and localization

Creating a multilingual website with ASP.NET Core allows your site to reach a wider audience. ASP.NET Core provides services and middleware for localizing into different languages and cultures.

For more information, see [Globalization and localization](#).

## Request features

Web server implementation details related to HTTP requests and responses are defined in interfaces. These interfaces are used by server implementations and middleware to create and modify the app's hosting pipeline.

For more information, see [Request Features](#).

## Background tasks

Background tasks are implemented as *hosted services*. A hosted service is a class with background task logic that implements the [IHostedService](#) interface.

For more information, see [Background tasks with hosted services](#).

## Open Web Interface for .NET (OWIN)

ASP.NET Core supports the Open Web Interface for .NET (OWIN). OWIN allows web apps to be decoupled from web servers.

For more information, see [Open Web Interface for .NET \(OWIN\)](#).

## WebSockets

[WebSocket](#) is a protocol that enables two-way persistent communication channels over TCP connections. It's used for apps such as chat, stock tickers, games, and anywhere you desire real-time functionality in a web app. ASP.NET Core supports web socket features.

For more information, see [WebSockets](#).

## Microsoft.AspNetCore.App metapackage

The [Microsoft.AspNetCore.App](#) metapackage simplifies package management. For more information, see [Microsoft.AspNetCore.App metapackage](#).

## Microsoft.AspNetCore.All metapackage

The [Microsoft.AspNetCore.All](#) metapackage for ASP.NET Core includes:

- All supported packages by the ASP.NET Core team.
- All supported packages by Entity Framework Core.
- Internal and 3rd-party dependencies used by ASP.NET Core and Entity Framework Core.

For more information, see [Microsoft.AspNetCore.All metapackage](#).

## .NET Core vs. .NET Framework runtime

An ASP.NET Core app can target the .NET Core or .NET Framework runtime.

For more information, see [Choosing between .NET Core and .NET Framework](#).

## Choose between ASP.NET Core and ASP.NET

For more information on choosing between ASP.NET Core and ASP.NET, see [Choose between ASP.NET Core and ASP.NET](#).

# Application startup in ASP.NET Core

7/14/2018 • 8 minutes to read • [Edit Online](#)

By [Steve Smith](#), [Tom Dykstra](#), and [Luke Latham](#)

The `Startup` class configures services and the app's request pipeline.

## The Startup class

ASP.NET Core apps use a `Startup` class, which is named `Startup` by convention. The `Startup` class:

- Can optionally include a `ConfigureServices` method to configure the app's services.
- Must include a `Configure` method to create the app's request processing pipeline.

`ConfigureServices` and `Configure` are called by the runtime when the app starts:

```
public class Startup
{
    // Use this method to add services to the container.
    public void ConfigureServices(IServiceCollection services)
    {
        ...
    }

    // Use this method to configure the HTTP request pipeline.
    public void Configure(IApplicationBuilder app)
    {
        ...
    }
}
```

Specify the `Startup` class with the `WebHostBuilderExtensions.UseStartup<TStartup>` method:

```
public class Program
{
    public static void Main(string[] args)
    {
        BuildWebHost(args).Run();
    }

    public static IWebHost BuildWebHost(string[] args) =>
        WebHost.CreateDefaultBuilder(args)
            .UseStartup<Startup>()
            .Build();
}
```

The `Startup` class constructor accepts dependencies defined by the host. A common use of [dependency injection](#) into the `Startup` class is to inject:

- [IHostingEnvironment](#) to configure services by environment.
- [IConfiguration](#) to configure the app during startup.

```

public class Startup
{
    public Startup(IHostingEnvironment env, IConfiguration config)
    {
        HostingEnvironment = env;
        Configuration = config;
    }

    public IHostingEnvironment HostingEnvironment { get; }
    public IConfiguration Configuration { get; }

    public void ConfigureServices(IServiceCollection services)
    {
        if (HostingEnvironment.IsDevelopment())
        {
            // Development configuration
        }
        else
        {
            // Staging/Production configuration
        }

        // Configuration is available during startup. Examples:
        // Configuration["key"]
        // Configuration["subsection:suboption1"]
    }
}

```

An alternative to injecting `IHostingEnvironment` is to use a conventions-based approach. The app can define separate `Startup` classes for different environments (for example, `StartupDevelopment`), and the appropriate `Startup` class is selected at runtime. The class whose name suffix matches the current environment is prioritized. If the app is run in the Development environment and includes both a `Startup` class and a `StartupDevelopment` class, the `StartupDevelopment` class is used. For more information, see [Use multiple environments](#).

To learn more about `WebHostBuilder`, see the [Hosting](#) topic. For information on handling errors during startup, see [Startup exception handling](#).

## The ConfigureServices method

The `ConfigureServices` method is:

- Optional
- Called by the web host before the `Configure` method to configure the app's services.
- Where [configuration options](#) are set by convention.

Adding services to the service container makes them available within the app and in the `Configure` method. The services are resolved via [dependency injection](#) or from `IApplicationBuilder.ApplicationServices`.

The web host may configure some services before `Startup` methods are called. Details are available in the [Host in ASP.NET Core](#) topic.

For features that require substantial setup, there are `Add[Service]` extension methods on `IServiceCollection`. A typical web app registers services for Entity Framework, Identity, and MVC:

```

public void ConfigureServices(IServiceCollection services)
{
    // Add framework services.
    services.AddDbContext<ApplicationDbContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("DefaultConnection")));

    services.AddIdentity< ApplicationUser, IdentityRole>()
        .AddEntityFrameworkStores<ApplicationDbContext>()
        .AddDefaultTokenProviders();

    services.AddMvc();

    // Add application services.
    services.AddTransient< IEmailSender, AuthMessageSender>();
    services.AddTransient< ISmsSender, AuthMessageSender>();
}

```

## SetCompatibilityVersion for ASP.NET Core MVC

The `SetCompatibilityVersion` method allows an app to opt-in or opt-out of potentially breaking behavior changes introduced in ASP.NET MVC Core 2.1+. These potentially breaking behavior changes are generally in how the MVC subsystem behaves and how **your code** is called by the runtime. By opting in, you get the latest behavior, and the long-term behavior of ASP.NET Core.

The following code sets the compatibility mode to ASP.NET Core 2.1:

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc()
        .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
}

```

We recommend you test your application using the latest version (`CompatibilityVersion.Version_2_1`). We anticipate that most applications will not have breaking behavior changes using the latest version.

Applications that call `SetCompatibilityVersion(CompatibilityVersion.Version_2_0)` are protected from potentially breaking behavior changes introduced in the ASP.NET Core 2.1 MVC and later 2.x versions. This protection:

- Does not apply to all 2.1 and later changes, it's targeted to potentially breaking ASP.NET Core runtime behavior changes in the MVC subsystem.
- Does not extend to the next major version.

The default compatibility for ASP.NET Core 2.1 and later 2.x applications that do **not** call `SetCompatibilityVersion` is 2.0 compatibility. That is, not calling `SetCompatibilityVersion` is the same as calling `SetCompatibilityVersion(CompatibilityVersion.Version_2_0)`.

The following code sets the compatibility mode to ASP.NET Core 2.1, except for the following behaviors:

- [AllowCombiningAuthorizeFilters](#)
- [InputFormatterExceptionPolicy](#)

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc()
        // Include the 2.1 behaviors
        .SetCompatibilityVersion(CompatibilityVersion.Version_2_1)
        // Except for the following.
        .AddMvcOptions(options =>
    {
        // Don't combine authorize filters (keep 2.0 behavior).
        options.AllowCombiningAuthorizeFilters = false;
        // All exceptions thrown by an IInputFormatter will be treated
        // as model state errors (keep 2.0 behavior).
        options.InputFormatterExceptionPolicy =
            InputFormatterExceptionPolicy.AllExceptions;
    });
}

```

For apps that encounter breaking behavior changes, using the appropriate compatibility switches:

- Allows you to use the latest release and opt out of specific breaking behavior changes.
- Gives you time to update your app so it works with the latest changes.

The [MvcOptions](#) class source comments have a good explanation of what changed and why the changes are an improvement for most users.

At some future date, there will be an [ASP.NET Core 3.0 version](#). Old behaviors supported by compatibility switches will be removed in the 3.0 version. We feel these are positive changes benefitting nearly all users. By introducing these changes now, most apps can benefit now, and the others will have time to update their applications.

## Services available in Startup

The web host provides some services that are available to the `Startup` class constructor. The app adds additional services via `ConfigureServices`. Both the host and app services are then available in `Configure` and throughout the application.

## The Configure method

The `Configure` method is used to specify how the app responds to HTTP requests. The request pipeline is configured by adding [middleware](#) components to an `IApplicationBuilder` instance. `IApplicationBuilder` is available to the `Configure` method, but it isn't registered in the service container. Hosting creates an `IApplicationBuilder` and passes it directly to `Configure` ([reference source](#)).

The [ASP.NET Core templates](#) configure the pipeline with support for a developer exception page, [BrowserLink](#), error pages, static files, and ASP.NET MVC:

```
public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
        app.UseBrowserLink();
    }
    else
    {
        app.UseExceptionHandler("/Error");
    }

    app.UseStaticFiles();

    app.UseMvc(routes =>
    {
        routes.MapRoute(
            name: "default",
            template: "{controller}/{action=Index}/{id?}");
    });
}
```

Each `use` extension method adds a middleware component to the request pipeline. For instance, the `useMvc` extension method adds the [Routing Middleware](#) to the request pipeline and configures [MVC](#) as the default handler.

Each middleware component in the request pipeline is responsible for invoking the next component in the pipeline or short-circuiting the chain, if appropriate. If short-circuiting doesn't occur along the middleware chain, each middleware has a second chance to process the request before it's sent to the client.

Additional services, such as `IHostingEnvironment` and `ILoggerFactory`, may also be specified in the method signature. When specified, additional services are injected if they're available.

For more information on how to use `IApplicationBuilder` and the order of middleware processing, see [Middleware](#).

## Convenience methods

`ConfigureServices` and `Configure` convenience methods can be used instead of specifying a `Startup` class. Multiple calls to `ConfigureServices` append to one another. Multiple calls to `Configure` use the last method call.

```

public class Program
{
    public static IHostingEnvironment HostingEnvironment { get; set; }
    public static IConfiguration Configuration { get; set; }

    public static void Main(string[] args)
    {
        BuildWebHost(args).Run();
    }

    public static IWebHost BuildWebHost(string[] args) =>
        WebHost.CreateDefaultBuilder(args)
            .ConfigureAppConfiguration((hostingContext, config) =>
            {
                HostingEnvironment = hostingContext.HostingEnvironment;
                Configuration = config.Build();
            })
            .ConfigureServices(services =>
            {
                services.AddMvc();
            })
            .Configure(app =>
            {
                if (HostingEnvironment.IsDevelopment())
                {
                    app.UseDeveloperExceptionPage();
                }
                else
                {
                    app.UseExceptionHandler("/Error");
                }

                // Configuration is available during startup. Examples:
                // Configuration["key"]
                // Configuration["subsection:suboption1"]

                app.UseMvcWithDefaultRoute();
                app.UseStaticFiles();
            })
            .Build();
    }
}

```

## Startup filters

Use [IStartupFilter](#) to configure middleware at the beginning or end of an app's [Configure](#) middleware pipeline. [IStartupFilter](#) is useful to ensure that a middleware runs before or after middleware added by libraries at the start or end of the app's request processing pipeline.

[IStartupFilter](#) implements a single method, [Configure](#), which receives and returns an [Action<IApplicationBuilder>](#). An [IApplicationBuilder](#) defines a class to configure an app's request pipeline. For more information, see [Create a middleware pipeline with IApplicationBuilder](#).

Each [IStartupFilter](#) implements one or more middlewares in the request pipeline. The filters are invoked in the order they were added to the service container. Filters may add middleware before or after passing control to the next filter, thus they append to the beginning or end of the app pipeline.

The [sample app \(how to download\)](#) demonstrates how to register a middleware with [IStartupFilter](#). The sample app includes a middleware that sets an options value from a query string parameter:

```

public class RequestSetOptionsMiddleware
{
    private readonly RequestDelegate _next;
    private IOptions<AppOptions> _injectedOptions;

    public RequestSetOptionsMiddleware(
        RequestDelegate next, IOptions<AppOptions> injectedOptions)
    {
        _next = next;
        _injectedOptions = injectedOptions;
    }

    public async Task Invoke(HttpContext httpContext)
    {
        Console.WriteLine("RequestSetOptionsMiddleware.Invoke");

        var option = httpContext.Request.Query["option"];

        if (!string.IsNullOrWhiteSpace(option))
        {
            _injectedOptions.Value.Option = WebUtility.HtmlEncode(option);
        }

        await _next(httpContext);
    }
}

```

The `RequestSetOptionsMiddleware` is configured in the `RequestSetOptionsStartupFilter` class:

```

public class RequestSetOptionsStartupFilter : IStartupFilter
{
    public Action<IApplicationBuilder> Configure(Action<IApplicationBuilder> next)
    {
        return builder =>
        {
            builder.UseMiddleware<RequestSetOptionsMiddleware>();
            next(builder);
        };
    }
}

```

The `IStartupFilter` is registered in the service container in `ConfigureServices`:

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddTransient<IStartupFilter, RequestSetOptionsStartupFilter>();
    services.AddMvc();
}

```

When a query string parameter for `option` is provided, the middleware processes the value assignment before the MVC middleware renders the response:



Middleware execution order is set by the order of `IStartupFilter` registrations:

- Multiple `IStartupFilter` implementations may interact with the same objects. If ordering is important, order their `IStartupFilter` service registrations to match the order that their middlewares should run.
- Libraries may add middleware with one or more `IStartupFilter` implementations that run before or after other app middleware registered with `IStartupFilter`. To invoke an `IStartupFilter` middleware before a middleware added by a library's `IStartupFilter`, position the service registration before the library is added to the service container. To invoke it afterward, position the service registration after the library is added.

## Adding configuration at startup from an external assembly

An `IHostingStartup` implementation allows adding enhancements to an app at startup from an external assembly outside of the app's `Startup` class. For more information, see [Enhance an app from an external assembly](#).

## Additional resources

- [Hosting](#)
- [Use multiple environments](#)
- [Middleware](#)
- [Logging](#)
- [Configuration](#)
- [StartupLoader class: FindStartupType method \(reference source\)](#)

# Dependency injection in ASP.NET Core

6/21/2018 • 17 minutes to read • [Edit Online](#)

By [Steve Smith](#) and [Scott Addie](#)

ASP.NET Core is designed from the ground up to support and leverage dependency injection. ASP.NET Core applications can leverage built-in framework services by having them injected into methods in the Startup class, and application services can be configured for injection as well. The default services container provided by ASP.NET Core provides a minimal feature set and isn't intended to replace other containers.

[View or download sample code \(how to download\)](#)

## What is dependency injection?

Dependency injection (DI) is a technique for achieving loose coupling between objects and their collaborators, or dependencies. Rather than directly instantiating collaborators, or using static references, the objects a class needs in order to perform its actions are provided to the class in some fashion. Most often, classes will declare their dependencies via their constructor, allowing them to follow the [Explicit Dependencies Principle](#). This approach is known as "constructor injection".

When classes are designed with DI in mind, they're more loosely coupled because they don't have direct, hard-coded dependencies on their collaborators. This follows the [Dependency Inversion Principle](#), which states that "*high level modules shouldn't depend on low level modules; both should depend on abstractions.*" Instead of referencing specific implementations, classes request abstractions (typically `interfaces`) which are provided to them when the class is constructed. Extracting dependencies into interfaces and providing implementations of these interfaces as parameters is also an example of the [Strategy design pattern](#).

When a system is designed to use DI, with many classes requesting their dependencies via their constructor (or properties), it's helpful to have a class dedicated to creating these classes with their associated dependencies. These classes are referred to as *containers*, or more specifically, [Inversion of Control \(IoC\)](#) containers or Dependency Injection (DI) containers. A container is essentially a factory that's responsible for providing instances of types that are requested from it. If a given type has declared that it has dependencies, and the container has been configured to provide the dependency types, it will create the dependencies as part of creating the requested instance. In this way, complex dependency graphs can be provided to classes without the need for any hard-coded object construction. In addition to creating objects with their dependencies, containers typically manage object lifetimes within the application.

ASP.NET Core includes a simple built-in container (represented by the `IServiceProvider` interface) that supports constructor injection by default, and ASP.NET makes certain services available through DI. ASP.NET's container refers to the types it manages as *services*. Throughout the rest of this article, *services* will refer to types that are managed by ASP.NET Core's IoC container. You configure the built-in container's services in the `ConfigureServices` method in your application's `Startup` class.

#### NOTE

Martin Fowler has written an extensive article on [Inversion of Control Containers and the Dependency Injection Pattern](#). Microsoft Patterns and Practices also has a great description of [Dependency Injection](#).

#### NOTE

This article covers Dependency Injection as it applies to all ASP.NET applications. Dependency Injection within MVC controllers is covered in [Dependency Injection and Controllers](#).

### Constructor injection behavior

Constructor injection requires that the constructor in question be *public*. Otherwise, your app will throw an `InvalidOperationException`:

A suitable constructor for type 'YourType' couldn't be located. Ensure the type is concrete and services are registered for all parameters of a public constructor.

Constructor injection requires that only one applicable constructor exist. Constructor overloads are supported, but only one overload can exist whose arguments can all be fulfilled by dependency injection. If more than one exists, your app will throw an `InvalidOperationException`:

Multiple constructors accepting all given argument types have been found in type 'YourType'. There should only be one applicable constructor.

Constructors can accept arguments that are not provided by dependency injection, but these must support default values. For example:

```
// throws InvalidOperationException: Unable to resolve service for type 'System.String'...
public CharactersController(ICharacterRepository characterRepository, string title)
{
    _characterRepository = characterRepository;
    _title = title;
}

// runs without error
public CharactersController(ICharacterRepository characterRepository, string title =
"Characters")
{
    _characterRepository = characterRepository;
    _title = title;
}
```

## Using framework-provided services

The `ConfigureServices` method in the `Startup` class is responsible for defining the services the application will use, including platform features like Entity Framework Core and ASP.NET Core MVC. Initially, the `IServiceCollection` provided to `ConfigureServices` has the following services defined (depending on [how the host was configured](#)):

SERVICE TYPE	LIFETIME
<code>Microsoft.AspNetCore.Hosting.IHostingEnvironment</code>	Singleton

Service Type	Lifetime
Microsoft.Extensions.Logging.ILoggerFactory	Singleton
Microsoft.Extensions.Logging.ILogger<T>	Singleton
Microsoft.AspNetCore.Hosting.Builder.IApplicationBuilderFactory	Transient
Microsoft.AspNetCore.Http.IHttpContextFactory	Transient
Microsoft.Extensions.Options.IOptions<T>	Singleton
System.Diagnostics.DiagnosticSource	Singleton
System.Diagnostics.DiagnosticListener	Singleton
Microsoft.AspNetCore.Hosting.IStartupFilter	Transient
Microsoft.Extensions.ObjectPool.ObjectPoolProvider	Singleton
Microsoft.Extensions.Options.IConfigureOptions<T>	Transient
Microsoft.AspNetCore.Hosting.Server.IServer	Singleton
Microsoft.AspNetCore.Hosting.IStartup	Singleton
Microsoft.AspNetCore.Hosting.IApplicationLifetime	Singleton

Below is an example of how to add additional services to the container using a number of extension methods like `AddDbContext`, `AddIdentity`, and `AddMvc`.

```
// This method gets called by the runtime. Use this method to add services to the container.
public void ConfigureServices(IServiceCollection services)
{
    // Add framework services.
    services.AddDbContext<ApplicationContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("DefaultConnection")));

    services.AddIdentity< ApplicationUser, IdentityRole >()
        .AddEntityFrameworkStores< ApplicationContext >()
        .AddDefaultTokenProviders();

    services.AddMvc();

    // Add application services.
    services.AddTransient< IEmailSender, AuthMessageSender >();
    services.AddTransient< ISmsSender, AuthMessageSender >();
}
```

The features and middleware provided by ASP.NET, such as MVC, follow a convention of using a single `AddServiceName` extension method to register all of the services required by that feature.

#### TIP

You can request certain framework-provided services within `Startup` methods through their parameter lists - see [Application Startup](#) for more details.

## Registering services

You can register your own application services as follows. The first generic type represents the type (typically an interface) that will be requested from the container. The second generic type represents the concrete type that will be instantiated by the container and used to fulfill such requests.

```
services.AddTransient<IEmailSender, AuthMessageSender>();
services.AddTransient<ISmsSender, AuthMessageSender>();
```

#### NOTE

Each `services.Add<ServiceName>` extension method adds (and potentially configures) services. For example, `services.AddMvc()` adds the services MVC requires. It's recommended that you follow this convention, placing extension methods in the `Microsoft.Extensions.DependencyInjection` namespace, to encapsulate groups of service registrations.

The `AddTransient` method is used to map abstract types to concrete services that are instantiated separately for every object that requires it. This is known as the service's *lifetime*, and additional lifetime options are described below. It's important to choose an appropriate lifetime for each of the services you register. Should a new instance of the service be provided to each class that requests it? Should one instance be used throughout a given web request? Or should a single instance be used for the lifetime of the application?

In the sample for this article, there's a simple controller that displays character names, called `CharactersController`. Its `Index` method displays the current list of characters that have been stored in the application, and initializes the collection with a handful of characters if none exist. Note that although this application uses Entity Framework Core and the `ApplicationDbContext` class for its persistence, none of that's apparent in the controller. Instead, the specific data access mechanism has been abstracted behind an interface, `ICharacterRepository`, which follows the [repository pattern](#). An instance of `ICharacterRepository` is requested via the constructor and assigned to a private field, which is then used to access characters as necessary.

```

public class CharactersController : Controller
{
    private readonly ICharacterRepository _characterRepository;

    public CharactersController(ICharacterRepository characterRepository)
    {
        _characterRepository = characterRepository;
    }

    // GET: /characters/
    public IActionResult Index()
    {
        PopulateCharactersIfNoneExist();
        var characters = _characterRepository.ListAll();

        return View(characters);
    }

    private void PopulateCharactersIfNoneExist()
    {
        if (!_characterRepository.ListAll().Any())
        {
            _characterRepository.Add(new Character("Darth Maul"));
            _characterRepository.Add(new Character("Darth Vader"));
            _characterRepository.Add(new Character("Yoda"));
            _characterRepository.Add(new Character("Mace Windu"));
        }
    }
}

```

The `ICharacterRepository` defines the two methods the controller needs to work with `Character` instances.

```

using System.Collections.Generic;
using DependencyInjectionSample.Models;

namespace DependencyInjectionSample.Interfaces
{
    public interface ICharacterRepository
    {
        IEnumerable<Character> ListAll();
        void Add(Character character);
    }
}

```

This interface is in turn implemented by a concrete type, `CharacterRepository`, that's used at runtime.

#### NOTE

The way DI is used with the `CharacterRepository` class is a general model you can follow for all of your application services, not just in "repositories" or data access classes.

```

using System.Collections.Generic;
using System.Linq;
using DependencyInjectionSample.Interfaces;

namespace DependencyInjectionSample.Models
{
    public class CharacterRepository : ICharacterRepository
    {
        private readonly ApplicationDbContext _dbContext;

        public CharacterRepository(ApplicationDbContext dbContext)
        {
            _dbContext = dbContext;
        }

        public IEnumerable<Character> ListAll()
        {
            return _dbContext.Characters.AsEnumerable();
        }

        public void Add(Character character)
        {
            _dbContext.Characters.Add(character);
            _dbContext.SaveChanges();
        }
    }
}

```

Note that `CharacterRepository` requests an `ApplicationDbContext` in its constructor. It's not unusual for dependency injection to be used in a chained fashion like this, with each requested dependency in turn requesting its own dependencies. The container is responsible for resolving all of the dependencies in the graph and returning the fully resolved service.

#### **NOTE**

Creating the requested object, and all of the objects it requires, and all of the objects those require, is sometimes referred to as an *object graph*. Likewise, the collective set of dependencies that must be resolved is typically referred to as a *dependency tree* or *dependency graph*.

In this case, both `ICharacterRepository` and in turn `ApplicationDbContext` must be registered with the services container in `ConfigureServices` in `Startup`. `ApplicationDbContext` is configured with the call to the extension method `AddDbContext<T>`. The following code shows the registration of the `CharacterRepository` type.

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<ApplicationContext>(options =>
        options.UseInMemoryDatabase()
    );

    // Add framework services.
    services.AddMvc();

    // Register application services.
    services.AddScoped<ICharacterRepository, CharacterRepository>();
    services.AddTransient<IOperationTransient, Operation>();
    services.AddScoped<IOperationScoped, Operation>();
    services.AddSingleton<IOperationSingleton, Operation>();
    services.AddSingleton<IOperationSingletonInstance>(new Operation(Guid.Empty));
    services.AddTransient<OperationService, OperationService>();
}
```

Entity Framework contexts should be added to the services container using the `Scoped` lifetime. This is taken care of automatically if you use the helper methods as shown above. Repositories that will make use of Entity Framework should use the same lifetime.

#### **WARNING**

The main danger to be wary of is resolving a `Scoped` service from a singleton. It's likely in such a case that the service will have incorrect state when processing subsequent requests.

Services that have dependencies should register them in the container. If a service's constructor requires a primitive, such as a `string`, this can be injected by using [configuration](#) and the [options pattern](#).

## Service lifetimes and registration options

ASP.NET services can be configured with the following lifetimes:

### **Transient**

Transient lifetime services are created each time they're requested. This lifetime works best for lightweight, stateless services.

### **Scoped**

Scoped lifetime services are created once per request.

#### **WARNING**

If you're using a scoped service in a middleware, inject the service into the `Invoke` or `InvokeAsync` method. Don't inject via constructor injection because it forces the service to behave like a singleton.

### **Singleton**

Singleton lifetime services are created the first time they're requested (or when `ConfigureServices` is run if you specify an instance there) and then every subsequent request will use the same instance. If your application requires singleton behavior, allowing the services container to manage the service's lifetime is recommended instead of implementing the singleton design pattern and managing your object's lifetime in the class yourself.

Services can be registered with the container in several ways. We have already seen how to register a service implementation with a given type by specifying the concrete type to use. In addition, a factory can be specified, which will then be used to create the instance on demand. The third approach is to directly specify the instance of the type to use, in which case the container will never attempt to create an instance (nor will it dispose of the instance).

To demonstrate the difference between these lifetime and registration options, consider a simple interface that represents one or more tasks as an *operation* with a unique identifier, `OperationId`. Depending on how we configure the lifetime for this service, the container will provide either the same or different instances of the service to the requesting class. To make it clear which lifetime is being requested, we will create one type per lifetime option:

```
using System;

namespace DependencyInjectionSample.Interfaces
{
    public interface IOperation
    {
        Guid OperationId { get; }
    }

    public interface IOperationTransient : IOperation
    {
    }

    public interface IOperationScoped : IOperation
    {
    }

    public interface IOperationSingleton : IOperation
    {
    }

    public interface IOperationSingletonInstance : IOperation
    {
    }
}
```

We implement these interfaces using a single class, `Operation`, that accepts a `Guid` in its constructor, or uses a new `Guid` if none is provided.

Next, in `ConfigureServices`, each type is added to the container according to its named lifetime:

```
services.AddScoped<ICharacterRepository, CharacterRepository>();
services.AddTransient<IOperationTransient, Operation>();
services.AddScoped<IOperationScoped, Operation>();
services.AddSingleton<IOperationSingleton, Operation>();
services.AddSingleton<IOperationSingletonInstance>(new Operation(Guid.Empty));
services.AddTransient<OperationService, OperationService>();
}
```

Note that the `IOperationSingletonInstance` service is using a specific instance with a known ID of `Guid.Empty` so it will be clear when this type is in use (its `Guid` will be all zeroes). We have also registered an `OperationService` that depends on each of the other `Operation` types, so that it will be clear within a request whether this service is getting the same instance as the controller, or a new one, for each operation type. All this service does is expose its dependencies as properties, so they can be displayed in the view.

```
using DependencyInjectionSample.Interfaces;

namespace DependencyInjectionSample.Services
{
    public class OperationService
    {
        public IOperationTransient TransientOperation { get; }
        public IOperationScoped ScopedOperation { get; }
        public IOperationSingleton SingletonOperation { get; }
        public IOperationSingletonInstance SingletonInstanceOperation { get; }

        public OperationService(IOperationTransient transientOperation,
            IOperationScoped scopedOperation,
            IOperationSingleton singletonOperation,
            IOperationSingletonInstance instanceOperation)
        {
            TransientOperation = transientOperation;
            ScopedOperation = scopedOperation;
            SingletonOperation = singletonOperation;
            SingletonInstanceOperation = instanceOperation;
        }
    }
}
```

To demonstrate the object lifetimes within and between separate individual requests to the application, the sample includes an `OperationsController` that requests each kind of `IOperation` type as well as an `OperationService`. The `Index` action then displays all of the controller's and service's `OperationId` values.

```

using DependencyInjectionSample.Interfaces;
using DependencyInjectionSample.Services;
using Microsoft.AspNetCore.Mvc;

namespace DependencyInjectionSample.Controllers
{
    public class OperationsController : Controller
    {
        private readonly OperationService _operationService;
        private readonly IOperationTransient _transientOperation;
        private readonly IOperationScoped _scopedOperation;
        private readonly IOperationSingleton _singletonOperation;
        private readonly IOperationSingletonInstance _singletonInstanceOperation;

        public OperationsController(OperationService operationService,
            IOperationTransient transientOperation,
            IOperationScoped scopedOperation,
            IOperationSingleton singletonOperation,
            IOperationSingletonInstance singletonInstanceOperation)
        {
            _operationService = operationService;
            _transientOperation = transientOperation;
            _scopedOperation = scopedOperation;
            _singletonOperation = singletonOperation;
            _singletonInstanceOperation = singletonInstanceOperation;
        }

        public IActionResult Index()
        {
            // ViewBag contains controller-requested services
            ViewBag.Transient = _transientOperation;
            ViewBag.Scoped = _scopedOperation;
            ViewBag.Singleton = _singletonOperation;
            ViewBag.SingletonInstance = _singletonInstanceOperation;

            // operation service has its own requested services
            ViewBag.Service = _operationService;
            return View();
        }
    }
}

```

Now two separate requests are made to this controller action:

Lifetimes - Dependency × +

localhost:40931/operations

DependencyInjectionSample Home Characters Register Log in

## Lifetimes

Request One

Controller Operations

<b>Transient</b>	e6fee2c8-2122-4d10-aa05-cb376042e2c7
<b>Scoped</b>	661bff78-5ecb-4758-ae43-ec22a3e0babe
<b>Singleton</b>	93c52d5b-4c51-4907-a4d2-6a336a797ce6
<b>Instance</b>	00000000-0000-0000-0000-000000000000

OperationService Operations

<b>Transient</b>	a379336b-3fd0-49ac-b176-bae7c27c5de5
<b>Scoped</b>	661bff78-5ecb-4758-ae43-ec22a3e0babe
<b>Singleton</b>	93c52d5b-4c51-4907-a4d2-6a336a797ce6
<b>Instance</b>	00000000-0000-0000-0000-000000000000

Observe which of the `OperationId` values vary within a request, and between requests.

- *Transient* objects are always different; a new instance is provided to every controller and every service.
- *Scoped* objects are the same within a request, but different across different requests
- *Singleton* objects are the same for every object and every request (regardless of whether an instance is provided in `ConfigureServices`)

## Resolve a scoped service within the application scope

Create an `IServiceScope` with `IServiceScopeFactory.CreateScope()` to resolve a scoped service within the app's scope. This approach is useful to access a scoped service at startup to run initialization tasks. The following example shows how to obtain a context for the `MyScopedService` in `Program.Main`:

```
public static void Main(string[] args)
{
    var host = BuildWebHost(args);

    using (var serviceScope = host.Services.CreateScope())
    {
        var services = serviceScope.ServiceProvider;

        try
        {
            var serviceContext = services.GetRequiredService<MyScopedService>();
            // Use the context here
        }
        catch (Exception ex)
        {
            var logger = services.GetRequiredService<ILogger<Program>>();
            logger.LogError(ex, "An error occurred.");
        }
    }

    host.Run();
}
```

## Scope validation

When the app is running in the Development environment on ASP.NET Core 2.0 or later, the default service provider performs checks to verify that:

- Scoped services aren't directly or indirectly resolved from the root service provider.
- Scoped services aren't directly or indirectly injected into singletons.

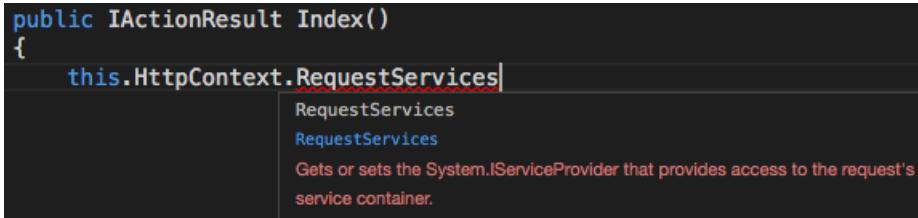
The root service provider is created when `BuildServiceProvider` is called. The root service provider's lifetime corresponds to the app/server's lifetime when the provider starts with the app and is disposed when the app shuts down.

Scoped services are disposed by the container that created them. If a scoped service is created in the root container, the service's lifetime is effectively promoted to singleton because it's only disposed by the root container when app/server is shut down. Validating service scopes catches these situations when `BuildServiceProvider` is called.

For more information, see [Scope validation in the Web Host topic](#).

## Request Services

The services available within an ASP.NET request from `HttpContext` are exposed through the `RequestServices` collection.



Request Services represent the services you configure and request as part of your application.

When your objects specify dependencies, these are satisfied by the types found in

`RequestServices`, not `ApplicationServices`.

Generally, you shouldn't use these properties directly, preferring instead to request the types your classes you require via your class's constructor, and letting the framework inject these dependencies. This yields classes that are easier to test (see [Test and debug](#)) and are more loosely coupled.

### NOTE

Prefer requesting dependencies as constructor parameters to accessing the `RequestServices` collection.

## Designing services for dependency injection

You should design your services to use dependency injection to get their collaborators. This means avoiding the use of stateful static method calls (which result in a code smell known as [static cling](#)) and the direct instantiation of dependent classes within your services. It may help to remember the phrase, [New is Glue](#), when choosing whether to instantiate a type or to request it via dependency injection. By following the [SOLID Principles of Object Oriented Design](#), your classes will naturally tend to be small, well-factored, and easily tested.

What if you find that your classes tend to have way too many dependencies being injected? This is generally a sign that your class is trying to do too much, and is probably violating SRP - the

[Single Responsibility Principle](#). See if you can refactor the class by moving some of its responsibilities into a new class. Keep in mind that your `Controller` classes should be focused on UI concerns, so business rules and data access implementation details should be kept in classes appropriate to these [separate concerns](#).

With regards to data access specifically, you can inject the `DbContext` into your controllers (assuming you've added EF to the services container in `ConfigureServices`). Some developers prefer to use a repository interface to the database rather than injecting the `DbContext` directly. Using an interface to encapsulate the data access logic in one place can minimize how many places you will have to change when your database changes.

### Disposing of services

The container will call `Dispose` for `IDisposable` types it creates. However, if you add an instance to the container yourself, it will not be disposed.

Example:

```
// Services implement IDisposable:  
public class Service1 : IDisposable {}  
public class Service2 : IDisposable {}  
public class Service3 : IDisposable {}  
  
public interface ISomeService {}  
public class SomeServiceImplementation : ISomeService, IDisposable {}  
  
public void ConfigureServices(IServiceCollection services)  
{  
    // container will create the instance(s) of these types and will dispose them  
    services.AddScoped<Service1>();  
    services.AddSingleton<Service2>();  
    services.AddSingleton<ISomeService>(sp => new SomeServiceImplementation());  
  
    // container didn't create instance so it will NOT dispose it  
    services.AddSingleton<Service3>(new Service3());  
    services.AddSingleton(new Service3());  
}
```

#### NOTE

In version 1.0, the container called dispose on *all* `IDisposable` objects, including those it didn't create.

## Replacing the default services container

The built-in services container is meant to serve the basic needs of the framework and most consumer applications built on it. However, developers can replace the built-in container with their preferred container. The `ConfigureServices` method typically returns `void`, but if its signature is changed to return `IServiceProvider`, a different container can be configured and returned. There are many IOC containers available for .NET. In this example, the [Autofac](#) package is used.

First, install the appropriate container package(s):

- `Autofac`
- `Autofac.Extensions.DependencyInjection`

Next, configure the container in `ConfigureServices` and return an `IServiceProvider`:

```
public IServiceProvider ConfigureServices(IServiceCollection services)
{
    services.AddMvc();
    // Add other framework services

    // Add Autofac
    var containerBuilder = new ContainerBuilder();
    containerBuilder.RegisterModule<DefaultModule>();
    containerBuilder.Populate(services);
    var container = containerBuilder.Build();
    return new AutofacServiceProvider(container);
}
```

#### NOTE

When using a third-party DI container, you must change `ConfigureServices` so that it returns `IServiceProvider` instead of `void`.

Finally, configure Autofac as normal in `DefaultModule`:

```
public class DefaultModule : Module
{
    protected override void Load(ContainerBuilder builder)
    {
        builder.RegisterType<CharacterRepository>().As<ICharacterRepository>();
    }
}
```

At runtime, Autofac will be used to resolve types and inject dependencies. [Learn more about using Autofac and ASP.NET Core](#).

#### Thread safety

Singleton services need to be thread safe. If a singleton service has a dependency on a transient service, the transient service may also need to be thread safe depending how it's used by the singleton.

## Recommendations

When working with dependency injection, keep the following recommendations in mind:

- DI is for objects that have complex dependencies. Controllers, services, adapters, and repositories are all examples of objects that might be added to DI.
- Avoid storing data and configuration directly in DI. For example, a user's shopping cart shouldn't typically be added to the services container. Configuration should use the [options pattern](#). Similarly, avoid "data holder" objects that only exist to allow access to some other object. It's better to request the actual item needed via DI, if possible.
- Avoid static access to services.
- Avoid service location in your application code.
- Avoid static access to `HttpContext`.

Like all sets of recommendations, you may encounter situations where ignoring one is required. We have found exceptions to be rare -- mostly very special cases within the framework itself.

Dependency injection is an *alternative* to static/global object access patterns. You may not be able

to realize the benefits of DI if you mix it with static object access.

## Additional resources

- [Dependency injection into views](#)
- [Dependency injection into controllers](#)
- [Dependency injection in requirement handlers](#)
- [Application Startup](#)
- [Test and debug](#)
- [Factory-based middleware activation](#)
- [Writing Clean Code in ASP.NET Core with Dependency Injection \(MSDN\)](#)
- [Container-Managed Application Design, Prelude: Where does the Container Belong?](#)
- [Explicit Dependencies Principle](#)
- [Inversion of Control Containers and the Dependency Injection Pattern \(Fowler\)](#)

# ASP.NET Core Middleware

6/21/2018 • 9 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Steve Smith](#)

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## What is middleware?

Middleware is software that's assembled into an application pipeline to handle requests and responses. Each component:

- Chooses whether to pass the request to the next component in the pipeline.
- Can perform work before and after the next component in the pipeline is invoked.

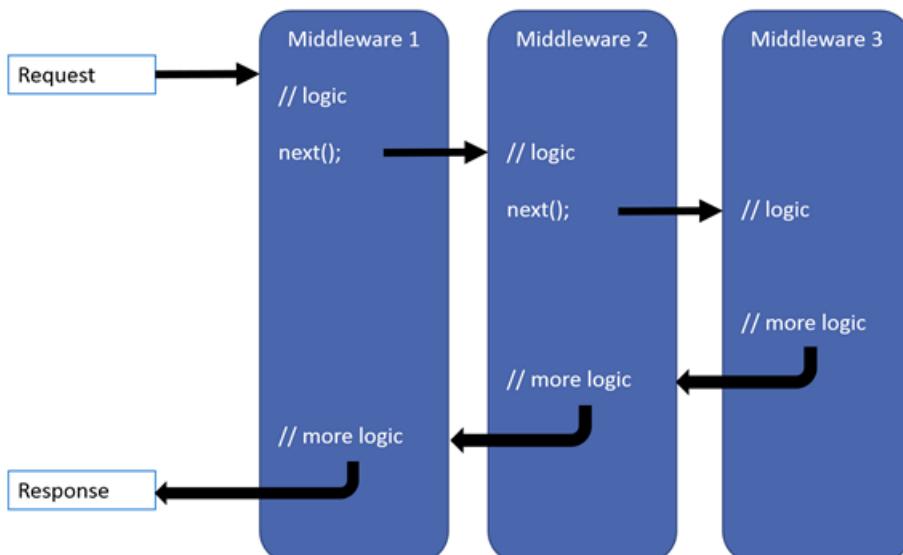
Request delegates are used to build the request pipeline. The request delegates handle each HTTP request.

Request delegates are configured using [Run](#), [Map](#), and [Use](#) extension methods. An individual request delegate can be specified in-line as an anonymous method (called in-line middleware), or it can be defined in a reusable class. These reusable classes and in-line anonymous methods are *middleware*, or *middleware components*. Each middleware component in the request pipeline is responsible for invoking the next component in the pipeline, or short-circuiting the chain if appropriate.

[Migrate HTTP Modules to Middleware](#) explains the difference between request pipelines in ASP.NET Core and ASP.NET 4.x and provides more middleware samples.

## Creating a middleware pipeline with `IApplicationBuilder`

The ASP.NET Core request pipeline consists of a sequence of request delegates, called one after the other, as this diagram shows (the thread of execution follows the black arrows):



Each delegate can perform operations before and after the next delegate. A delegate can also decide to not pass a request to the next delegate, which is called short-circuiting the request pipeline. Short-circuiting is often desirable because it avoids unnecessary work. For example, the static file middleware can return a request for a static file and short-circuit the rest of the pipeline. Exception-handling delegates need to be called early in the pipeline, so they

can catch exceptions that occur in later stages of the pipeline.

The simplest possible ASP.NET Core app sets up a single request delegate that handles all requests. This case doesn't include an actual request pipeline. Instead, a single anonymous function is called in response to every HTTP request.

```
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.AspNetCore.Http;

public class Startup
{
    public void Configure(IApplicationBuilder app)
    {
        app.Run(async context =>
        {
            await context.Response.WriteAsync("Hello, World!");
        });
    }
}
```

The first `app.Run` delegate terminates the pipeline.

You can chain multiple request delegates together with `app.Use`. The `next` parameter represents the next delegate in the pipeline. (Remember that you can short-circuit the pipeline by *not* calling the `next` parameter.) You can typically perform actions both before and after the next delegate, as this example demonstrates:

```
public class Startup
{
    public void Configure(IApplicationBuilder app)
    {
        app.Use(async (context, next) =>
        {
            // Do work that doesn't write to the Response.
            await next.Invoke();
            // Do logging or other work that doesn't write to the Response.
        });

        app.Run(async context =>
        {
            await context.Response.WriteAsync("Hello from 2nd delegate.");
        });
    }
}
```

### WARNING

Don't call `next.Invoke` after the response has been sent to the client. Changes to `HttpResponse` after the response has started will throw an exception. For example, changes such as setting headers, status code, etc, will throw an exception.

Writing to the response body after calling `next`:

- May cause a protocol violation. For example, writing more than the stated `content-length`.
- May corrupt the body format. For example, writing an HTML footer to a CSS file.

`HttpResponse.HasStarted` is a useful hint to indicate if headers have been sent and/or the body has been written to.

## Ordering

The order that middleware components are added in the `Configure` method defines the order in which they're

invoked on requests, and the reverse order for the response. This ordering is critical for security, performance, and functionality.

The Configure method (shown below) adds the following middleware components:

1. Exception/error handling
2. Static file server
3. Authentication
4. MVC

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
public void Configure(IApplicationBuilder app)
{
    app.UseExceptionHandler("/Home/Error"); // Call first to catch exceptions
                                                // thrown in the following middleware.

    app.UseStaticFiles();                      // Return static files and end pipeline.

    app.UseAuthentication();                  // Authenticate before you access
                                                // secure resources.

    app.UseMvcWithDefaultRoute();            // Add MVC to the request pipeline.
}
```

In the code above, `UseExceptionHandler` is the first middleware component added to the pipeline—therefore, it catches any exceptions that occur in later calls.

The static file middleware is called early in the pipeline so it can handle requests and short-circuit without going through the remaining components. The static file middleware provides **no** authorization checks. Any files served by it, including those under `wwwroot`, are publicly available. See [Static files](#) for an approach to secure static files.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

If the request isn't handled by the static file middleware, it's passed on to the Identity middleware (`app.UseAuthentication`), which performs authentication. Identity doesn't short-circuit unauthenticated requests. Although Identity authenticates requests, authorization (and rejection) occurs only after MVC selects a specific Razor Page or controller and action.

The following example demonstrates a middleware ordering where requests for static files are handled by the static file middleware before the response compression middleware. Static files are not compressed with this ordering of the middleware. The MVC responses from `UseMvcWithDefaultRoute` can be compressed.

```
public void Configure(IApplicationBuilder app)
{
    app.UseStaticFiles();          // Static files not compressed
                                  // by middleware.

    app.UseResponseCompression();
    app.UseMvcWithDefaultRoute();
}
```

## Use, Run, and Map

You configure the HTTP pipeline using `Use`, `Run`, and `Map`. The `Use` method can short-circuit the pipeline (that is, if it doesn't call a `next` request delegate). `Run` is a convention, and some middleware components may expose `Run[Middleware]` methods that run at the end of the pipeline.

`Map*` extensions are used as a convention for branching the pipeline. `Map` branches the request pipeline based on matches of the given request path. If the request path starts with the given path, the branch is executed.

```
public class Startup
{
    private static void HandleMapTest1(IApplicationBuilder app)
    {
        app.Run(async context =>
        {
            await context.Response.WriteAsync("Map Test 1");
        });
    }

    private static void HandleMapTest2(IApplicationBuilder app)
    {
        app.Run(async context =>
        {
            await context.Response.WriteAsync("Map Test 2");
        });
    }

    public void Configure(IApplicationBuilder app)
    {
        app.Map("/map1", HandleMapTest1);

        app.Map("/map2", HandleMapTest2);

        app.Run(async context =>
        {
            await context.Response.WriteAsync("Hello from non-Map delegate. <p>");
        });
    }
}
```

The following table shows the requests and responses from `http://localhost:1234` using the previous code:

REQUEST	RESPONSE
localhost:1234	Hello from non-Map delegate.
localhost:1234/map1	Map Test 1
localhost:1234/map2	Map Test 2
localhost:1234/map3	Hello from non-Map delegate.

When `Map` is used, the matched path segment(s) are removed from `HttpRequest.Path` and appended to `HttpRequest.PathBase` for each request.

`MapWhen` branches the request pipeline based on the result of the given predicate. Any predicate of type `Func<HttpContext, bool>` can be used to map requests to a new branch of the pipeline. In the following example, a predicate is used to detect the presence of a query string variable `branch`:

```

public class Startup
{
    private static void HandleBranch(IApplicationBuilder app)
    {
        app.Run(async context =>
        {
            var branchVer = context.Request.Query["branch"];
            await context.Response.WriteAsync($"Branch used = {branchVer}");
        });
    }

    public void Configure(IApplicationBuilder app)
    {
        app.MapWhen(context => context.Request.Query.ContainsKey("branch"),
                    HandleBranch);

        app.Run(async context =>
        {
            await context.Response.WriteAsync("Hello from non-Map delegate. <p>");
        });
    }
}

```

The following table shows the requests and responses from `http://localhost:1234` using the previous code:

REQUEST	RESPONSE
localhost:1234	Hello from non-Map delegate.
localhost:1234/?branch=master	Branch used = master

`Map` supports nesting, for example:

```

app.Map("/level1", level1App => {
    level1App.Map("/level2a", level2AApp => {
        // "/level1/level2a"
        //...
    });
    level1App.Map("/level2b", level2BApp => {
        // "/level1/level2b"
        //...
    });
});

```

`Map` can also match multiple segments at once, for example:

```
app.Map("/level1/level2", HandleMultiSeg);
```

## Built-in middleware

ASP.NET Core ships with the following middleware components, as well as a description of the order in which they should be added:

MIDDLEWARE	DESCRIPTION	ORDER
<a href="#">Authentication</a>	Provides authentication support.	Before <code>HttpContext.User</code> is needed. Terminal for OAuth callbacks.

MIDDLEWARE	DESCRIPTION	ORDER
<a href="#">CORS</a>	Configures Cross-Origin Resource Sharing.	Before components that use CORS.
<a href="#">Diagnostics</a>	Configures diagnostics.	Before components that generate errors.
<a href="#">Forwarded Headers</a>	Forwards proxied headers onto the current request.	Before components that consume the updated fields (examples: scheme, host, client IP, method).
<a href="#">HTTP Method Override</a>	Allows an incoming POST request to override the method.	Before components that consume the updated method.
<a href="#">HTTPS Redirection</a>	Redirect all HTTP requests to HTTPS (ASP.NET Core 2.1 or later).	Before components that consume the URL.
<a href="#">HTTP Strict Transport Security (HSTS)</a>	Security enhancement middleware that adds a special response header (ASP.NET Core 2.1 or later).	Before responses are sent and after components that modify requests (for example, Forwarded Headers, URL Rewriting).
<a href="#">Response Caching</a>	Provides support for caching responses.	Before components that require caching.
<a href="#">Response Compression</a>	Provides support for compressing responses.	Before components that require compression.
<a href="#">Request Localization</a>	Provides localization support.	Before localization sensitive components.
<a href="#">Routing</a>	Defines and constrains request routes.	Terminal for matching routes.
<a href="#">Session</a>	Provides support for managing user sessions.	Before components that require Session.
<a href="#">Static Files</a>	Provides support for serving static files and directory browsing.	Terminal if a request matches files.
<a href="#">URL Rewriting</a>	Provides support for rewriting URLs and redirecting requests.	Before components that consume the URL.
<a href="#">WebSockets</a>	Enables the WebSockets protocol.	Before components that are required to accept WebSocket requests.

## Writing middleware

Middleware is generally encapsulated in a class and exposed with an extension method. Consider the following middleware, which sets the culture for the current request from the query string:

```
public class Startup
{
    public void Configure(IApplicationBuilder app)
    {
        app.Use((context, next) =>
        {
            var cultureQuery = context.Request.Query["culture"];
            if (!string.IsNullOrWhiteSpace(cultureQuery))
            {
                var culture = new CultureInfo(cultureQuery);

                CultureInfo.CurrentCulture = culture;
                CultureInfo.CurrentUICulture = culture;
            }

            // Call the next delegate/middleware in the pipeline
            return next();
        });

        app.Run(async (context) =>
        {
            await context.Response.WriteAsync(
                $"Hello {CultureInfo.CurrentCulture.DisplayName}");
        });
    }
}
```

Note: The sample code above is used to demonstrate creating a middleware component. See [Globalization and localization](#) for ASP.NET Core's built-in localization support.

You can test the middleware by passing in the culture, for example `http://localhost:7997/?culture=no`.

The following code moves the middleware delegate to a class:

```

using Microsoft.AspNetCore.Http;
using System.Globalization;
using System.Threading.Tasks;

namespace Culture
{
    public class RequestCultureMiddleware
    {
        private readonly RequestDelegate _next;

        public RequestCultureMiddleware(RequestDelegate next)
        {
            _next = next;
        }

        public async Task InvokeAsync(HttpContext context)
        {
            var cultureQuery = context.Request.Query["culture"];
            if (!string.IsNullOrWhiteSpace(cultureQuery))
            {
                var culture = new CultureInfo(cultureQuery);

                CultureInfo.CurrentCulture = culture;
                CultureInfo.CurrentUICulture = culture;
            }

            // Call the next delegate/middleware in the pipeline
            await _next(context);
        }
    }
}

```

#### NOTE

In ASP.NET Core 1.x, the middleware `Task` method's name must be `Invoke`. In ASP.NET Core 2.0 or later, the name can be either `Invoke` or `InvokeAsync`.

The following extension method exposes the middleware through [IApplicationBuilder](#):

```

using Microsoft.AspNetCore.Builder;

namespace Culture
{
    public static class RequestCultureMiddlewareExtensions
    {
        public static IApplicationBuilder UseRequestCulture(
            this IApplicationBuilder builder)
        {
            return builder.UseMiddleware<RequestCultureMiddleware>();
        }
    }
}

```

The following code calls the middleware from `Configure`:

```

public class Startup
{
    public void Configure(IApplicationBuilder app)
    {
        app.UseRequestCulture();

        app.Run(async (context) =>
        {
            await context.Response.WriteAsync(
                $"Hello {CultureInfo.CurrentCulture.DisplayName}");
        });
    }
}

```

Middleware should follow the [Explicit Dependencies Principle](#) by exposing its dependencies in its constructor. Middleware is constructed once per *application lifetime*. See [Per-request dependencies](#) below if you need to share services with middleware within a request.

Middleware components can resolve their dependencies from dependency injection through constructor parameters. `UseMiddleware<T>` can also accept additional parameters directly.

### Per-request dependencies

Because middleware is constructed at app startup, not per-request, *scoped* lifetime services used by middleware constructors are not shared with other dependency-injected types during each request. If you must share a *scoped* service between your middleware and other types, add these services to the `Invoke` method's signature. The `Invoke` method can accept additional parameters that are populated by dependency injection. For example:

```

public class MyMiddleware
{
    private readonly RequestDelegate _next;

    public MyMiddleware(RequestDelegate next)
    {
        _next = next;
    }

    public async Task Invoke(HttpContext httpContext, IMyScopedService svc)
    {
        svc.MyProperty = 1000;
        await _next(httpContext);
    }
}

```

## Additional resources

- [Migrate HTTP Modules to Middleware](#)
- [Application Startup](#)
- [Request Features](#)
- [Factory-based middleware activation](#)
- [Middleware activation with a third-party container](#)

# ASP.NET Core Middleware

6/21/2018 • 9 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Steve Smith](#)

[View or download sample code \(how to download\)](#)

## What is middleware?

Middleware is software that's assembled into an application pipeline to handle requests and responses. Each component:

- Chooses whether to pass the request to the next component in the pipeline.
- Can perform work before and after the next component in the pipeline is invoked.

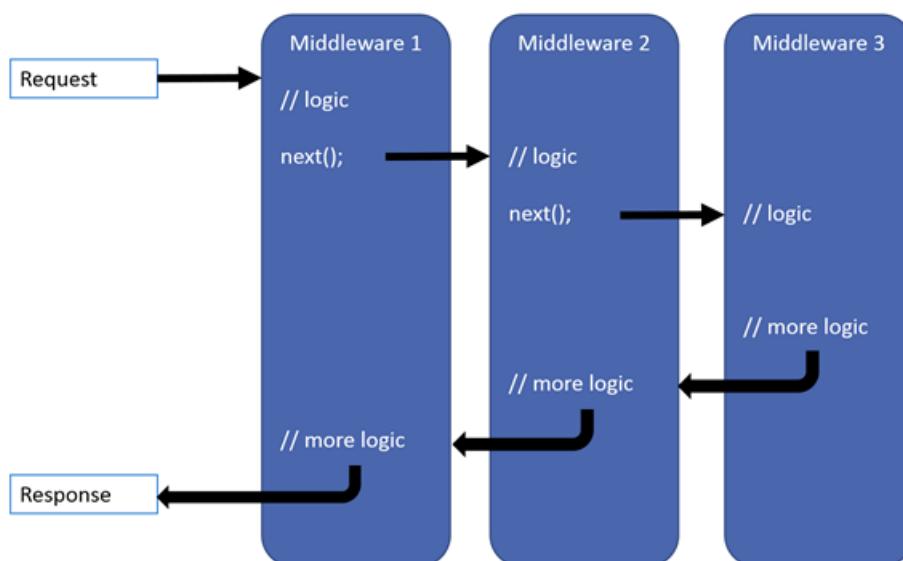
Request delegates are used to build the request pipeline. The request delegates handle each HTTP request.

Request delegates are configured using [Run](#), [Map](#), and [Use](#) extension methods. An individual request delegate can be specified in-line as an anonymous method (called in-line middleware), or it can be defined in a reusable class. These reusable classes and in-line anonymous methods are *middleware*, or *middleware components*. Each middleware component in the request pipeline is responsible for invoking the next component in the pipeline, or short-circuiting the chain if appropriate.

[Migrate HTTP Modules to Middleware](#) explains the difference between request pipelines in ASP.NET Core and ASP.NET 4.x and provides more middleware samples.

## Creating a middleware pipeline with `IApplicationBuilder`

The ASP.NET Core request pipeline consists of a sequence of request delegates, called one after the other, as this diagram shows (the thread of execution follows the black arrows):



Each delegate can perform operations before and after the next delegate. A delegate can also decide to not pass a request to the next delegate, which is called short-circuiting the request pipeline. Short-circuiting is often desirable because it avoids unnecessary work. For example, the static file middleware can return a request for a static file and short-circuit the rest of the pipeline. Exception-handling delegates need to be

called early in the pipeline, so they can catch exceptions that occur in later stages of the pipeline.

The simplest possible ASP.NET Core app sets up a single request delegate that handles all requests. This case doesn't include an actual request pipeline. Instead, a single anonymous function is called in response to every HTTP request.

```
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.AspNetCore.Http;

public class Startup
{
    public void Configure(IApplicationBuilder app)
    {
        app.Run(async context =>
        {
            await context.Response.WriteAsync("Hello, World!");
        });
    }
}
```

The first `app.Run` delegate terminates the pipeline.

You can chain multiple request delegates together with `app.Use`. The `next` parameter represents the next delegate in the pipeline. (Remember that you can short-circuit the pipeline by *not* calling the `next` parameter.) You can typically perform actions both before and after the next delegate, as this example demonstrates:

```
public class Startup
{
    public void Configure(IApplicationBuilder app)
    {
        app.Use(async (context, next) =>
        {
            // Do work that doesn't write to the Response.
            await next.Invoke();
            // Do logging or other work that doesn't write to the Response.
        });

        app.Run(async context =>
        {
            await context.Response.WriteAsync("Hello from 2nd delegate.");
        });
    }
}
```

#### WARNING

Don't call `next.Invoke` after the response has been sent to the client. Changes to `HttpResponse` after the response has started will throw an exception. For example, changes such as setting headers, status code, etc, will throw an exception. Writing to the response body after calling `next`:

- May cause a protocol violation. For example, writing more than the stated `content-length`.
- May corrupt the body format. For example, writing an HTML footer to a CSS file.

`HttpResponse.HasStarted` is a useful hint to indicate if headers have been sent and/or the body has been written to.

## Ordering

The order that middleware components are added in the `Configure` method defines the order in which

they're invoked on requests, and the reverse order for the response. This ordering is critical for security, performance, and functionality.

The Configure method (shown below) adds the following middleware components:

1. Exception/error handling

2. Static file server

3. Authentication

4. MVC

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
public void Configure(IApplicationBuilder app)
{
    app.UseExceptionHandler("/Home/Error"); // Call first to catch exceptions
                                                // thrown in the following middleware.

    app.UseStaticFiles();                      // Return static files and end pipeline.

    app.UseAuthentication();                  // Authenticate before you access
                                                // secure resources.

    app.UseMvcWithDefaultRoute();            // Add MVC to the request pipeline.
}
```

In the code above, `UseExceptionHandler` is the first middleware component added to the pipeline—therefore, it catches any exceptions that occur in later calls.

The static file middleware is called early in the pipeline so it can handle requests and short-circuit without going through the remaining components. The static file middleware provides **no** authorization checks. Any files served by it, including those under `wwwroot`, are publicly available. See [Static files](#) for an approach to secure static files.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

If the request isn't handled by the static file middleware, it's passed on to the Identity middleware (`app.UseAuthentication`), which performs authentication. Identity doesn't short-circuit unauthenticated requests. Although Identity authenticates requests, authorization (and rejection) occurs only after MVC selects a specific Razor Page or controller and action.

The following example demonstrates a middleware ordering where requests for static files are handled by the static file middleware before the response compression middleware. Static files are not compressed with this ordering of the middleware. The MVC responses from `UseMvcWithDefaultRoute` can be compressed.

```
public void Configure(IApplicationBuilder app)
{
    app.UseStaticFiles();          // Static files not compressed
                                  // by middleware.

    app.UseResponseCompression();
    app.UseMvcWithDefaultRoute();
}
```

## Use, Run, and Map

You configure the HTTP pipeline using `use`, `Run`, and `Map`. The `use` method can short-circuit the pipeline (that is, if it doesn't call a `next` request delegate). `Run` is a convention, and some middleware components

may expose `Run[Middleware]` methods that run at the end of the pipeline.

`Map*` extensions are used as a convention for branching the pipeline. `Map` branches the request pipeline based on matches of the given request path. If the request path starts with the given path, the branch is executed.

```
public class Startup
{
    private static void HandleMapTest1(IApplicationBuilder app)
    {
        app.Run(async context =>
        {
            await context.Response.WriteAsync("Map Test 1");
        });
    }

    private static void HandleMapTest2(IApplicationBuilder app)
    {
        app.Run(async context =>
        {
            await context.Response.WriteAsync("Map Test 2");
        });
    }

    public void Configure(IApplicationBuilder app)
    {
        app.Map("/map1", HandleMapTest1);

        app.Map("/map2", HandleMapTest2);

        app.Run(async context =>
        {
            await context.Response.WriteAsync("Hello from non-Map delegate. <p>");
        });
    }
}
```

The following table shows the requests and responses from `http://localhost:1234` using the previous code:

REQUEST	RESPONSE
localhost:1234	Hello from non-Map delegate.
localhost:1234/map1	Map Test 1
localhost:1234/map2	Map Test 2
localhost:1234/map3	Hello from non-Map delegate.

When `Map` is used, the matched path segment(s) are removed from `HttpRequest.Path` and appended to `HttpRequest.PathBase` for each request.

`MapWhen` branches the request pipeline based on the result of the given predicate. Any predicate of type `Func<HttpContext, bool>` can be used to map requests to a new branch of the pipeline. In the following example, a predicate is used to detect the presence of a query string variable `branch`:

```

public class Startup
{
    private static void HandleBranch(IApplicationBuilder app)
    {
        app.Run(async context =>
        {
            var branchVer = context.Request.Query["branch"];
            await context.Response.WriteAsync($"Branch used = {branchVer}");
        });
    }

    public void Configure(IApplicationBuilder app)
    {
        app.MapWhen(context => context.Request.Query.ContainsKey("branch"),
                    HandleBranch);

        app.Run(async context =>
        {
            await context.Response.WriteAsync("Hello from non-Map delegate. <p>");
        });
    }
}

```

The following table shows the requests and responses from `http://localhost:1234` using the previous code:

REQUEST	RESPONSE
localhost:1234	Hello from non-Map delegate.
localhost:1234/?branch=master	Branch used = master

`Map` supports nesting, for example:

```

app.Map("/level1", level1App => {
    level1App.Map("/level2a", level2AApp => {
        // "/level1/level2a"
        //...
    });
    level1App.Map("/level2b", level2BApp => {
        // "/level1/level2b"
        //...
    });
});

```

`Map` can also match multiple segments at once, for example:

```
app.Map("/level1/level2", HandleMultiSeg);
```

## Built-in middleware

ASP.NET Core ships with the following middleware components, as well as a description of the order in which they should be added:

MIDDLEWARE	DESCRIPTION	ORDER
<a href="#">Authentication</a>	Provides authentication support.	Before <code>HttpContext.User</code> is needed. Terminal for OAuth callbacks.

MIDDLEWARE	DESCRIPTION	ORDER
CORS	Configures Cross-Origin Resource Sharing.	Before components that use CORS.
Diagnostics	Configures diagnostics.	Before components that generate errors.
Forwarded Headers	Forwards proxied headers onto the current request.	Before components that consume the updated fields (examples: scheme, host, client IP, method).
HTTP Method Override	Allows an incoming POST request to override the method.	Before components that consume the updated method.
HTTPS Redirection	Redirect all HTTP requests to HTTPS (ASP.NET Core 2.1 or later).	Before components that consume the URL.
HTTP Strict Transport Security (HSTS)	Security enhancement middleware that adds a special response header (ASP.NET Core 2.1 or later).	Before responses are sent and after components that modify requests (for example, Forwarded Headers, URL Rewriting).
Response Caching	Provides support for caching responses.	Before components that require caching.
Response Compression	Provides support for compressing responses.	Before components that require compression.
Request Localization	Provides localization support.	Before localization sensitive components.
Routing	Defines and constrains request routes.	Terminal for matching routes.
Session	Provides support for managing user sessions.	Before components that require Session.
Static Files	Provides support for serving static files and directory browsing.	Terminal if a request matches files.
URL Rewriting	Provides support for rewriting URLs and redirecting requests.	Before components that consume the URL.
WebSockets	Enables the WebSockets protocol.	Before components that are required to accept WebSocket requests.

## Writing middleware

Middleware is generally encapsulated in a class and exposed with an extension method. Consider the following middleware, which sets the culture for the current request from the query string:

```
public class Startup
{
    public void Configure(IApplicationBuilder app)
    {
        app.Use((context, next) =>
        {
            var cultureQuery = context.Request.Query["culture"];
            if (!string.IsNullOrWhiteSpace(cultureQuery))
            {
                var culture = new CultureInfo(cultureQuery);

                CultureInfo.CurrentCulture = culture;
                CultureInfo.CurrentUICulture = culture;
            }

            // Call the next delegate/middleware in the pipeline
            return next();
        });

        app.Run(async (context) =>
        {
            await context.Response.WriteAsync(
                $"Hello {CultureInfo.CurrentCulture.DisplayName}");
        });
    }
}
```

Note: The sample code above is used to demonstrate creating a middleware component. See [Globalization and localization](#) for ASP.NET Core's built-in localization support.

You can test the middleware by passing in the culture, for example `http://localhost:7997/?culture=no`.

The following code moves the middleware delegate to a class:

```

using Microsoft.AspNetCore.Http;
using System.Globalization;
using System.Threading.Tasks;

namespace Culture
{
    public class RequestCultureMiddleware
    {
        private readonly RequestDelegate _next;

        public RequestCultureMiddleware(RequestDelegate next)
        {
            _next = next;
        }

        public async Task InvokeAsync(HttpContext context)
        {
            var cultureQuery = context.Request.Query["culture"];
            if (!string.IsNullOrWhiteSpace(cultureQuery))
            {
                var culture = new CultureInfo(cultureQuery);

                CultureInfo.CurrentCulture = culture;
                CultureInfo.CurrentUICulture = culture;
            }

            // Call the next delegate/middleware in the pipeline
            await _next(context);
        }
    }
}

```

#### NOTE

In ASP.NET Core 1.x, the middleware `Task` method's name must be `Invoke`. In ASP.NET Core 2.0 or later, the name can be either `Invoke` or `InvokeAsync`.

The following extension method exposes the middleware through [IApplicationBuilder](#):

```

using Microsoft.AspNetCore.Builder;

namespace Culture
{
    public static class RequestCultureMiddlewareExtensions
    {
        public static IApplicationBuilder UseRequestCulture(
            this IApplicationBuilder builder)
        {
            return builder.UseMiddleware<RequestCultureMiddleware>();
        }
    }
}

```

The following code calls the middleware from `Configure`:

```

public class Startup
{
    public void Configure(IApplicationBuilder app)
    {
        app.UseRequestCulture();

        app.Run(async (context) =>
        {
            await context.Response.WriteAsync(
                $"Hello {CultureInfo.CurrentCulture.DisplayName}");
        });
    }
}

```

Middleware should follow the [Explicit Dependencies Principle](#) by exposing its dependencies in its constructor. Middleware is constructed once per *application lifetime*. See *Per-request dependencies* below if you need to share services with middleware within a request.

Middleware components can resolve their dependencies from dependency injection through constructor parameters. `UseMiddleware<T>` can also accept additional parameters directly.

### Per-request dependencies

Because middleware is constructed at app startup, not per-request, *scoped* lifetime services used by middleware constructors are not shared with other dependency-injected types during each request. If you must share a *scoped* service between your middleware and other types, add these services to the `Invoke` method's signature. The `Invoke` method can accept additional parameters that are populated by dependency injection. For example:

```

public class MyMiddleware
{
    private readonly RequestDelegate _next;

    public MyMiddleware(RequestDelegate next)
    {
        _next = next;
    }

    public async Task Invoke(HttpContext httpContext, IMyScopedService svc)
    {
        svc.MyProperty = 1000;
        await _next(httpContext);
    }
}

```

## Additional resources

- [Migrate HTTP Modules to Middleware](#)
- [Application Startup](#)
- [Request Features](#)
- [Factory-based middleware activation](#)
- [Middleware activation with a third-party container](#)

# Factory-based middleware activation in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Luke Latham](#)

[IMiddlewareFactory](#)/[IMiddleware](#) is an extensibility point for [middleware](#) activation.

`UseMiddleware` extension methods check if a middleware's registered type implements `IMiddleware`. If it does, the `IMiddlewareFactory` instance registered in the container is used to resolve the `IMiddleware` implementation instead of using the convention-based middleware activation logic. The middleware is registered as a scoped or transient service in the app's service container.

Benefits:

- Activation per request (injection of scoped services)
- Strong typing of middleware

`IMiddleware` is activated per request, so scoped services can be injected into the middleware's constructor.

[View or download sample code](#) ([how to download](#))

The sample app demonstrates middleware activated by:

- Convention. For more information on conventional middleware activation, see the [Middleware](#) topic.
- An `IMiddleware` implementation. The default [MiddlewareFactory class](#) activates the middleware.

The middleware implementations function identically and record the value provided by a query string parameter (`key`). The middlewares use an injected database context (a scoped service) to record the query string value in an in-memory database.

## IMiddleware

[IMiddleware](#) defines middleware for the app's request pipeline. The `InvokeAsync(HttpContext, RequestDelegate)` method handles requests and returns a `Task` that represents the execution of the middleware.

Middleware activated by convention:

```

public class ConventionalMiddleware
{
    private readonly RequestDelegate _next;

    public ConventionalMiddleware(RequestDelegate next)
    {
        _next = next;
    }

    public async Task InvokeAsync(HttpContext context, AppDbContext db)
    {
        var keyValue = context.Request.Query["key"];

        if (!string.IsNullOrWhiteSpace(keyValue))
        {
            db.Add(new Request()
            {
                DT = DateTime.UtcNow,
                MiddlewareActivation = "ConventionalMiddleware",
                Value = keyValue
            });
        }

        await db.SaveChangesAsync();
    }

    await _next(context);
}

```

Middleware activated by `MiddlewareFactory` :

```

public class IMiddlewareMiddleware : IMiddleware
{
    private readonly AppDbContext _db;

    public IMiddlewareMiddleware(AppDbContext db)
    {
        _db = db;
    }

    public async Task InvokeAsync(HttpContext context, RequestDelegate next)
    {
        var keyValue = context.Request.Query["key"];

        if (!string.IsNullOrWhiteSpace(keyValue))
        {
            _db.Add(new Request()
            {
                DT = DateTime.UtcNow,
                MiddlewareActivation = "IMiddlewareMiddleware",
                Value = keyValue
            });
        }

        await _db.SaveChangesAsync();
    }

    await next(context);
}

```

Extensions are created for the middlewares:

```

public static class MiddlewareExtensions
{
    public static IApplicationBuilder UseConventionalMiddleware(
        this IApplicationBuilder builder)
    {
        return builder.UseMiddleware<ConventionalMiddleware>();
    }

    public static IApplicationBuilder UseIMiddlewareMiddleware(
        this IApplicationBuilder builder)
    {
        return builder.UseMiddleware<IMiddlewareMiddleware>();
    }
}

```

It isn't possible to pass objects to the factory-activated middleware with `UseMiddleware` :

```

public static IApplicationBuilder UseIMiddlewareMiddleware(
    this IApplicationBuilder builder, bool option)
{
    // Passing 'option' as an argument throws a NotSupportedException at runtime.
    return builder.UseMiddleware<IMiddlewareMiddleware>(option);
}

```

The factory-activated middleware is added to the built-in container in *Startup.cs*:

```

public void ConfigureServices(IServiceCollection services)
{
    services.Configure<CookiePolicyOptions>(options =>
    {
        options.CheckConsentNeeded = context => true;
        options.MinimumSameSitePolicy = SameSiteMode.None;
    });

    services.AddDbContext<AppDbContext>(options =>
        options.UseInMemoryDatabase("InMemoryDb"));

    services.AddTransient<IMiddlewareMiddleware>();

    services.AddMvc();
}

```

Both middlewares are registered in the request processing pipeline in `Configure` :

```
public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
    }
    else
    {
        app.UseExceptionHandler("/Error");
        app.UseHsts();
    }

    app.UseConventionalMiddleware();
    app.UseIMiddlewareMiddleware();

    app.UseHttpsRedirection();
    app.UseStaticFiles();
    app.UseCookiePolicy();
    app.UseMvc();
}
```

## IMiddlewareFactory

[IMiddlewareFactory](#) provides methods to create middleware. The middleware factory implementation is registered in the container as a scoped service.

The default [IMiddlewareFactory](#) implementation, [MiddlewareFactory](#), is found in the [Microsoft.AspNetCore.Http](#) package ([reference source](#)).

## Additional resources

- [Middleware](#)
- [Middleware activation with a third-party container](#)

# Middleware activation with a third-party container in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Luke Latham](#)

This article demonstrates how to use [IMiddlewareFactory](#) and [IMiddleware](#) as an extensibility point for [middleware](#) activation with a third-party container. For introductory information on [IMiddlewareFactory](#) and [IMiddleware](#), see the [Factory-based middleware activation](#) topic.

[View or download sample code \(how to download\)](#)

The sample app demonstrates middleware activation by an [IMiddlewareFactory](#) implementation, [SimpleInjectorMiddlewareFactory](#). The sample uses the [Simple Injector](#) dependency injection (DI) container.

The sample's middleware implementation records the value provided by a query string parameter ([key](#)). The middleware uses an injected database context (a scoped service) to record the query string value in an in-memory database.

## NOTE

The sample app uses [Simple Injector](#) purely for demonstration purposes. Use of Simple Injector isn't an endorsement. Middleware activation approaches described in the Simple Injector documentation and GitHub issues are recommended by the maintainers of Simple Injector. For more information, see the [Simple Injector documentation](#) and [Simple Injector GitHub repository](#).

## IMiddlewareFactory

[IMiddlewareFactory](#) provides methods to create middleware.

In the sample app, a middleware factory is implemented to create an [SimpleInjectorActivatedMiddleware](#) instance. The middleware factory uses the Simple Injector container to resolve the middleware:

```
public class SimpleInjectorMiddlewareFactory : IMiddlewareFactory
{
    private readonly Container _container;

    public SimpleInjectorMiddlewareFactory(Container container)
    {
        _container = container;
    }

    public IMiddleware Create(Type middlewareType)
    {
        return _container.GetInstance(middlewareType) as IMiddleware;
    }

    public void Release(IMiddleware middleware)
    {
        // The container is responsible for releasing resources.
    }
}
```

# IMiddleware

[IMiddleware](#) defines middleware for the app's request pipeline.

Middleware activated by an [IMiddlewareFactory](#) implementation

(*Middleware/SimpleInjectorActivatedMiddleware.cs*):

```
public class SimpleInjectorActivatedMiddleware : IMiddleware
{
    private readonly AppDbContext _db;

    public SimpleInjectorActivatedMiddleware(AppDbContext db)
    {
        _db = db;
    }

    public async Task InvokeAsync(HttpContext context, RequestDelegate next)
    {
        var keyValue = context.Request.Query["key"];

        if (!string.IsNullOrWhiteSpace(keyValue))
        {
            _db.Add(new Request()
            {
                DT = DateTime.UtcNow,
                MiddlewareActivation = "SimpleInjectorActivatedMiddleware",
                Value = keyValue
            });
            await _db.SaveChangesAsync();
        }

        await next(context);
    }
}
```

An extension is created for the middleware (*Middleware/MiddlewareExtensions.cs*):

```
public static class MiddlewareExtensions
{
    public static IApplicationBuilder UseSimpleInjectorActivatedMiddleware(
        this IApplicationBuilder builder)
    {
        return builder.UseMiddleware<SimpleInjectorActivatedMiddleware>();
    }
}
```

`Startup.ConfigureServices` must perform several tasks:

- Set up the Simple Injector container.
- Register the factory and middleware.
- Make the app's database context available from the Simple Injector container for a Razor Page.

```

public void ConfigureServices(IServiceCollection services)
{
    services.Configure<CookiePolicyOptions>(options =>
    {
        options.CheckConsentNeeded = context => true;
        options.MinimumSameSitePolicy = SameSiteMode.None;
    });

    services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1);

    // Replace the default middleware factory with the
    // SimpleInjectorMiddlewareFactory.
    services.AddTransient<IMiddlewareFactory>(_ =>
    {
        return new SimpleInjectorMiddlewareFactory(_container);
    });

    // Wrap ASP.NET requests in a Simple Injector execution
    // context.
    services.UseSimpleInjectorAspNetRequestScoping(_container);

    // Provide the database context from the Simple
    // Injector container whenever it's requested from
    // the default service container.
    services.AddScoped<AppDbContext>(provider =>
        _container.GetInstance<AppDbContext>());

    _container.Options.DefaultScopedLifestyle = new AsyncScopedLifestyle();

    _container.Register<AppDbContext>(() =>
    {
        var optionsBuilder = new DbContextOptionsBuilder<DbContext>();
        optionsBuilder.UseInMemoryDatabase("InMemoryDb");
        return new AppDbContext(optionsBuilder.Options);
    }, Lifestyle.Scoped);

    _container.Register<SimpleInjectorActivatedMiddleware>();

    _container.Verify();
}

```

The middleware is registered in the request processing pipeline in `Startup.Configure` :

```

public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
    }
    else
    {
        app.UseExceptionHandler("/Error");
        app.UseHsts();
    }

    app.UseSimpleInjectorActivatedMiddleware();

    app.UseHttpsRedirection();
    app.UseStaticFiles();
    app.UseCookiePolicy();
    app.UseMvc();
}

```

## Additional resources

- [Middleware](#)
- [Factory-based middleware activation](#)
- [Simple Injector GitHub repository](#)
- [Simple Injector documentation](#)

# Static files in ASP.NET Core

6/21/2018 • 8 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Scott Addie](#)

Static files, such as HTML, CSS, images, and JavaScript, are assets an ASP.NET Core app serves directly to clients. Some configuration is required to enable serving of these files.

[View or download sample code \(how to download\)](#)

## Serve static files

Static files are stored within your project's web root directory. The default directory is `<content_root>/wwwroot`, but it can be changed via the [UseWebRoot](#) method. See [Content root](#) and [Web root](#) for more information.

The app's web host must be made aware of the content root directory.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

The `WebHost.CreateDefaultBuilder` method sets the content root to the current directory:

```
public class Program
{
    public static void Main(string[] args)
    {
        BuildWebHost(args).Run();
    }

    public static IWebHost BuildWebHost(string[] args) =>
        WebHost.CreateDefaultBuilder(args)
            .UseStartup<Startup>()
            .Build();
}
```

Static files are accessible via a path relative to the web root. For example, the **Web Application** project template contains several folders within the `wwwroot` folder:

- **wwwroot**
  - **css**
  - **images**
  - **js**

The URI format to access a file in the `images` subfolder is `http://<server_address>/images/<image_file_name>`. For example, <http://localhost:9189/images/banner3.svg>.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

If targeting .NET Framework, add the [Microsoft.AspNetCore.StaticFiles](#) package to your project. If targeting .NET Core, the [Microsoft.AspNetCore.All](#) metapackage includes this package.

Configure the [middleware](#) which enables the serving of static files.

## Serve files inside of web root

Invoke the [UseStaticFiles](#) method within `Startup.Configure`:

```
public void Configure(IApplicationBuilder app)
{
    app.UseStaticFiles();
}
```

The parameterless `UseStaticFiles` method overload marks the files in web root as servable. The following markup references `wwwroot/images/banner1.svg`:

```

```

## Serve files outside of web root

Consider a directory hierarchy in which the static files to be served reside outside of the web root:

- **wwwroot**
  - **css**
  - **images**
  - **js**
- **MyStaticFiles**
  - **images**
    - *banner1.svg*

A request can access the *banner1.svg* file by configuring the static file middleware as follows:

```
public void Configure(IApplicationBuilder app)
{
    app.UseStaticFiles(); // For the wwwroot folder

    app.UseStaticFiles(new StaticFileOptions
    {
        FileProvider = new PhysicalFileProvider(
            Path.Combine(Directory.GetCurrentDirectory(), "MyStaticFiles")),
        RequestPath = "/StaticFiles"
    });
}
```

In the preceding code, the *MyStaticFiles* directory hierarchy is exposed publicly via the *StaticFiles* URI segment. A request to `http://<server_address>/StaticFiles/images/banner1.svg` serves the *banner1.svg* file.

The following markup references *MyStaticFiles/images/banner1.svg*:

```

```

## Set HTTP response headers

A [StaticFileOptions](#) object can be used to set HTTP response headers. In addition to configuring static file serving from the web root, the following code sets the `Cache-Control` header:

```
public void Configure(IApplicationBuilder app)
{
    app.UseStaticFiles(new StaticFileOptions
    {
        OnPrepareResponse = ctx =>
        {
            // Requires the following import:
            // using Microsoft.AspNetCore.Http;
            ctx.Context.Response.Headers.Append("Cache-Control", "public,max-age=600");
        }
    });
}
```

The [HeaderDictionaryExtensions.Append](#) method exists in the [Microsoft.AspNetCore.Http](#) package.

The files have been made publicly cacheable for 10 minutes (600 seconds):

▼ Response Headers [view source](#)

Accept-Ranges: bytes  
Cache-Control: public,max-age=600  
Content-Length: 143058  
Content-Type: image/png  
Date: Wed, 01 Feb 2017 01:27:01 GMT  
ETag: "1d1909cf92bacd2"  
Last-Modified: Thu, 07 Apr 2016 07:13:24 GMT

## Static file authorization

The static file middleware doesn't provide authorization checks. Any files served by it, including those under `wwwroot`, are publicly accessible. To serve files based on authorization:

- Store them outside of `wwwroot` and any directory accessible to the static file middleware **and**
- Serve them via an action method to which authorization is applied. Return a [FileResult](#) object:

```
[Authorize]
public IActionResult BannerImage()
{
    var file = Path.Combine(Directory.GetCurrentDirectory(),
                           "MyStaticFiles", "images", "banner1.svg");

    return PhysicalFile(file, "image/svg+xml");
}
```

## Enable directory browsing

Directory browsing allows users of your web app to see a directory listing and files within a specified directory. Directory browsing is disabled by default for security reasons (see [Considerations](#)). Enable directory browsing by invoking the [UseDirectoryBrowser](#) method in `Startup.Configure`:

```

public void Configure(IApplicationBuilder app)
{
    app.UseStaticFiles(); // For the wwwroot folder

    app.UseStaticFiles(new StaticFileOptions
    {
        FileProvider = new PhysicalFileProvider(
            Path.Combine(Directory.GetCurrentDirectory(), "wwwroot", "images")),
        RequestPath = "/MyImages"
    });

    app.UseDirectoryBrowser(new DirectoryBrowserOptions
    {
        FileProvider = new PhysicalFileProvider(
            Path.Combine(Directory.GetCurrentDirectory(), "wwwroot", "images")),
        RequestPath = "/MyImages"
    });
}

```

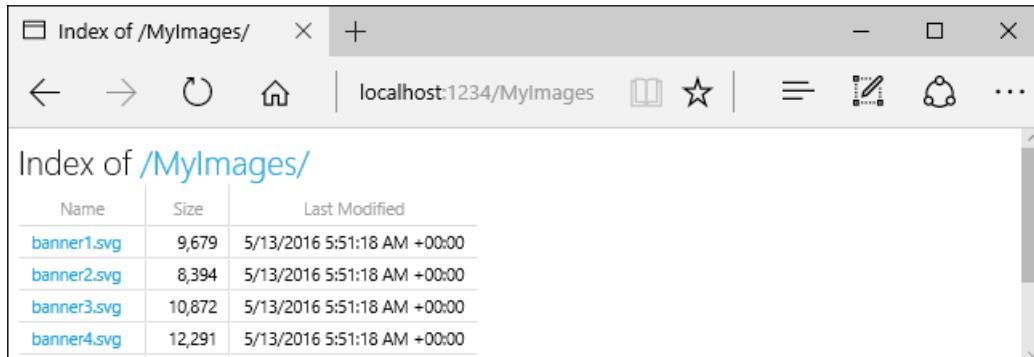
Add required services by invoking the [AddDirectoryBrowser](#) method from `Startup.ConfigureServices`:

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddDirectoryBrowser();
}

```

The preceding code allows directory browsing of the `wwwroot/images` folder using the URL `http://<server_address>/MyImages`, with links to each file and folder:



See [Considerations](#) on the security risks when enabling browsing.

Note the two `UseStaticFiles` calls in the following example. The first call enables the serving of static files in the `wwwroot` folder. The second call enables directory browsing of the `wwwroot/images` folder using the URL `http://<server_address>/MyImages`:

```

public void Configure(IApplicationBuilder app)
{
    app.UseStaticFiles(); // For the wwwroot folder

    app.UseStaticFiles(new StaticFileOptions
    {
        FileProvider = new PhysicalFileProvider(
            Path.Combine(Directory.GetCurrentDirectory(), "wwwroot", "images")),
        RequestPath = "/MyImages"
    });

    app.UseDirectoryBrowser(new DirectoryBrowserOptions
    {
        FileProvider = new PhysicalFileProvider(
            Path.Combine(Directory.GetCurrentDirectory(), "wwwroot", "images")),
        RequestPath = "/MyImages"
    });
}

```

## Serve a default document

Setting a default home page provides visitors a logical starting point when visiting your site. To serve a default page without the user fully qualifying the URI, call the `UseDefaultFiles` method from `Startup.Configure`:

```

public void Configure(IApplicationBuilder app)
{
    app.UseDefaultFiles();
    app.UseStaticFiles();
}

```

### IMPORTANT

`UseDefaultFiles` must be called before `UseStaticFiles` to serve the default file. `UseDefaultFiles` is a URL rewriter that doesn't actually serve the file. Enable the static file middleware via `UseStaticFiles` to serve the file.

With `UseDefaultFiles`, requests to a folder search for:

- *default.htm*
- *default.html*
- *index.htm*
- *index.html*

The first file found from the list is served as though the request were the fully qualified URI. The browser URL continues to reflect the URI requested.

The following code changes the default file name to *mydefault.html*:

```

public void Configure(IApplicationBuilder app)
{
    // Serve my app-specific default file, if present.
    DefaultFilesOptions options = new DefaultFilesOptions();
    options.DefaultFileNames.Clear();
    options.DefaultFileNames.Add("mydefault.html");
    app.UseDefaultFiles(options);
    app.UseStaticFiles();
}

```

# UseFileServer

`UseFileServer` combines the functionality of `UseStaticFiles`, `UseDefaultFiles`, and `UseDirectoryBrowser`.

The following code enables the serving of static files and the default file. Directory browsing isn't enabled.

```
app.UseFileServer();
```

The following code builds upon the parameterless overload by enabling directory browsing:

```
app.UseFileServer(enableDirectoryBrowsing: true);
```

Consider the following directory hierarchy:

- **wwwroot**
  - **css**
  - **images**
  - **js**
- **MyStaticFiles**
  - **images**
    - *banner1.svg*
    - *default.html*

The following code enables static files, default files, and directory browsing of `MyStaticFiles`:

```
public void Configure(IApplicationBuilder app)
{
    app.UseStaticFiles(); // For the wwwroot folder

    app.UseFileServer(new FileServerOptions
    {
        FileProvider = new PhysicalFileProvider(
            Path.Combine(Directory.GetCurrentDirectory(), "MyStaticFiles")),
        RequestPath = "/StaticFiles",
        EnableDirectoryBrowsing = true
    });
}
```

`AddDirectoryBrowser` must be called when the `EnableDirectoryBrowsing` property value is `true`:

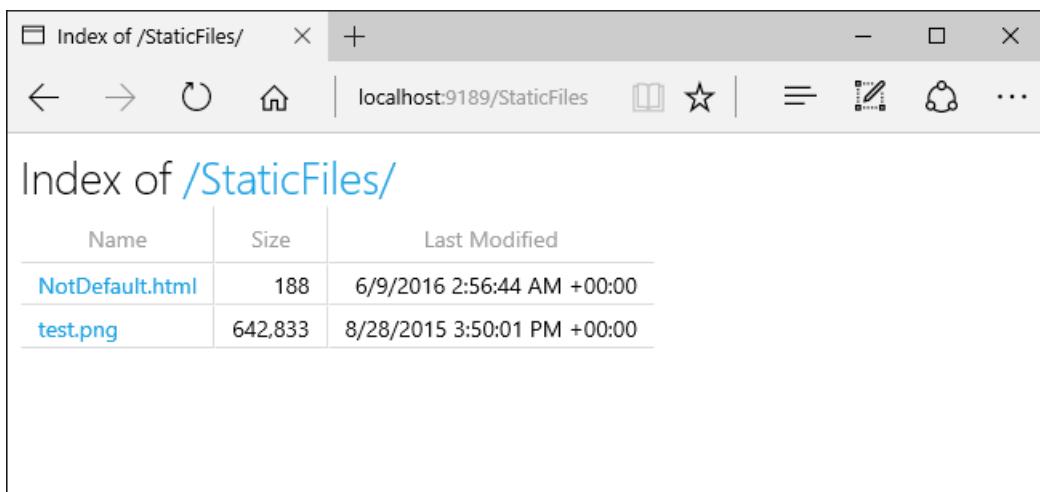
```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDirectoryBrowser();
}
```

Using the file hierarchy and preceding code, URLs resolve as follows:

URI	RESPONSE
<code>http://&lt;server_address&gt;/StaticFiles/images/banner1.svg</code>	MyStaticFiles/images/banner1.svg
<code>http://&lt;server_address&gt;/StaticFiles</code>	MyStaticFiles/default.html

If no default-named file exists in the `MyStaticFiles` directory, `http://<server_address>/StaticFiles` returns the

directory listing with clickable links:



**NOTE**

`UseDefaultFiles` and `UseDirectoryBrowser` use the URL `http://<server_address>/StaticFiles` without the trailing slash to trigger a client-side redirect to `http://<server_address>/StaticFiles/`. Notice the addition of the trailing slash. Relative URLs within the documents are deemed invalid without a trailing slash.

## FileExtensionContentTypeProvider

The `FileExtensionContentTypeProvider` class contains a `Mappings` property serving as a mapping of file extensions to MIME content types. In the following sample, several file extensions are registered to known MIME types. The `.rtf` extension is replaced, and `.mp4` is removed.

```
public void Configure(IApplicationBuilder app)
{
    // Set up custom content types - associating file extension to MIME type
    var provider = new FileExtensionContentTypeProvider();
    // Add new mappings
    provider.Mappings[".myapp"] = "application/x-msdownload";
    provider.Mappings[".htm3"] = "text/html";
    provider.Mappings[".image"] = "image/png";
    // Replace an existing mapping
    provider.Mappings[".rtf"] = "application/x-msdownload";
    // Remove MP4 videos.
    provider.Mappings.Remove(".mp4");

    app.UseStaticFiles(new StaticFileOptions
    {
        FileProvider = new PhysicalFileProvider(
            Path.Combine(Directory.GetCurrentDirectory(), "wwwroot", "images")),
        RequestPath = "/MyImages",
        ContentTypeProvider = provider
    });

    app.UseDirectoryBrowser(new DirectoryBrowserOptions
    {
        FileProvider = new PhysicalFileProvider(
            Path.Combine(Directory.GetCurrentDirectory(), "wwwroot", "images")),
        RequestPath = "/MyImages"
    });
}
```

See [MIME content types](#).

# Non-standard content types

The static file middleware understands almost 400 known file content types. If the user requests a file of an unknown file type, the static file middleware returns a HTTP 404 (Not Found) response. If directory browsing is enabled, a link to the file is displayed. The URI returns an HTTP 404 error.

The following code enables serving unknown types and renders the unknown file as an image:

```
public void Configure(IApplicationBuilder app)
{
    app.UseStaticFiles(new StaticFileOptions
    {
        ServeUnknownFileTypes = true,
        DefaultContentType = "image/png"
    });
}
```

With the preceding code, a request for a file with an unknown content type is returned as an image.

## WARNING

Enabling `ServeUnknownFileTypes` is a security risk. It's disabled by default, and its use is discouraged.

`FileExtensionContentTypeProvider` provides a safer alternative to serving files with non-standard extensions.

## Considerations

### WARNING

`UseDirectoryBrowser` and `UseStaticFiles` can leak secrets. Disabling directory browsing in production is highly recommended. Carefully review which directories are enabled via `UseStaticFiles` or `UseDirectoryBrowser`. The entire directory and its sub-directories become publicly accessible. Store files suitable for serving to the public in a dedicated directory, such as `<content_root>/wwwroot`. Separate these files from MVC views, Razor Pages (2.x only), configuration files, etc.

- The URLs for content exposed with `UseDirectoryBrowser` and `UseStaticFiles` are subject to the case sensitivity and character restrictions of the underlying file system. For example, Windows is case insensitive—macOS and Linux aren't.
- ASP.NET Core apps hosted in IIS use the [ASP.NET Core Module](#) to forward all requests to the app, including static file requests. The IIS static file handler isn't used. It has no chance to handle requests before they're handled by the module.
- Complete the following steps in IIS Manager to remove the IIS static file handler at the server or website level:
  1. Navigate to the **Modules** feature.
  2. Select **StaticFileModule** in the list.
  3. Click **Remove** in the **Actions** sidebar.

### WARNING

If the IIS static file handler is enabled **and** the ASP.NET Core Module is configured incorrectly, static files are served. This happens, for example, if the `web.config` file isn't deployed.

- Place code files (including `.cs` and `.cshtml`) outside of the app project's web root. A logical separation is

therefore created between the app's client-side content and server-based code. This prevents server-side code from being leaked.

## Additional resources

- [Middleware](#)
- [Introduction to ASP.NET Core](#)

# Routing in ASP.NET Core

6/22/2018 • 19 minutes to read • [Edit Online](#)

By [Ryan Nowak](#), [Steve Smith](#), and [Rick Anderson](#)

Routing functionality is responsible for mapping an incoming request to a route handler. Routes are defined in the ASP.NET app and configured when the app starts up. A route can optionally extract values from the URL contained in the request, and these values can then be used for request processing. Using route information from the ASP.NET app, the routing functionality is also able to generate URLs that map to route handlers. Therefore, routing can find a route handler based on a URL, or the URL corresponding to a given route handler based on route handler information.

## IMPORTANT

This document covers the low level ASP.NET Core routing. For ASP.NET Core MVC routing, see [Route to controller actions](#)

[View or download sample code \(how to download\)](#)

## Routing basics

Routing uses *routes* (implementations of [IRouter](#)) to:

- map incoming requests to *route handlers*
- generate URLs used in responses

Generally, an app has a single collection of routes. When a request arrives, the route collection is processed in order. The incoming request looks for a route that matches the request URL by calling the [RouteAsync](#) method on each available route in the route collection. By contrast, a response can use routing to generate URLs (for example, for redirection or links) based on route information, and thus avoid having to hard-code URLs, which helps maintainability.

Routing is connected to the [middleware](#) pipeline by the [RouterMiddleware](#) class. [ASP.NET Core MVC](#) adds routing to the middleware pipeline as part of its configuration. To learn about using routing as a standalone component, see [Using routing middleware](#).

## URL matching

URL matching is the process by which routing dispatches an incoming request to a *handler*. This process is generally based on data in the URL path, but can be extended to consider any data in the request. The ability to dispatch requests to separate handlers is key to scaling the size and complexity of an application.

Incoming requests enter the [RouterMiddleware](#), which calls the [RouteAsync](#) method on each route in sequence. The [IRouter](#) instance chooses whether to *handle* the request by setting the [RouteContext.Handler](#) to a non-null [RequestDelegate](#). If a route sets a handler for the request, route processing stops and the handler will be invoked to process the request. If all routes are tried and no handler is found for the request, the middleware calls *next* and the next middleware in the request pipeline is invoked.

The primary input to [RouteAsync](#) is the [RouteContext.HttpContext](#) associated with the current request. The [RouteContext.Handler](#) and [RouteContext.RouteData](#) are outputs that will be set after a route matches.

A match during [RouteAsync](#) will also set the properties of the [RouteContext.RouteData](#) to appropriate values based on the request processing done so far. If a route matches a request, the [RouteContext.RouteData](#) will

contain important state information about the *result*.

`RouteData.Values` is a dictionary of *route values* produced from the route. These values are usually determined by tokenizing the URL, and can be used to accept user input, or to make further dispatching decisions inside the application.

`RouteData.DataTokens` is a property bag of additional data related to the matched route. `DataTokens` are provided to support associating state data with each route so the application can make decisions later based on which route matched. These values are developer-defined and do **not** affect the behavior of routing in any way. Additionally, values stashed in data tokens can be of any type, in contrast to route values, which must be easily convertible to and from strings.

`RouteData.Routers` is a list of the routes that took part in successfully matching the request. Routes can be nested inside one another, and the `Routers` property reflects the path through the logical tree of routes that resulted in a match. Generally the first item in `Routers` is the route collection, and should be used for URL generation. The last item in `Routers` is the route handler that matched.

## URL generation

URL generation is the process by which routing can create a URL path based on a set of route values. This allows for a logical separation between your handlers and the URLs that access them.

URL generation follows a similar iterative process, but starts with user or framework code calling into the `GetVirtualPath` method of the route collection. Each *route* will then have its `GetVirtualPath` method called in sequence until a non-null `VirtualPathData` is returned.

The primary inputs to `GetVirtualPath` are:

- `VirtualPathContext.HttpContext`
- `VirtualPathContext.Values`
- `VirtualPathContext.AmbientValues`

Routes primarily use the route values provided by the `Values` and `AmbientValues` to decide where it's possible to generate a URL and what values to include. The `AmbientValues` are the set of route values that were produced from matching the current request with the routing system. In contrast, `Values` are the route values that specify how to generate the desired URL for the current operation. The `HttpContext` is provided in case a route needs to get services or additional data associated with the current context.

Tip: Think of `Values` as being a set of overrides for the `AmbientValues`. URL generation tries to reuse route values from the current request to make it easy to generate URLs for links using the same route or route values.

The output of `GetVirtualPath` is a `VirtualPathData`. `VirtualPathData` is a parallel of `RouteData`; it contains the `VirtualPath` for the output URL and some additional properties that should be set by the route.

The `VirtualPathData.VirtualPath` property contains the *virtual path* produced by the route. Depending on your needs you may need to process the path further. For instance, if you want to render the generated URL in HTML you need to prepend the base path of the application.

The `VirtualPathData.Router` is a reference to the route that successfully generated the URL.

The `VirtualPathData.DataTokens` properties is a dictionary of additional data related to the route that generated the URL. This is the parallel of `RouteData.DataTokens`.

## Creating routes

Routing provides the `Route` class as the standard implementation of `IRouter`. `Route` uses the *route template*

syntax to define patterns that will match against the URL path when `RouteAsync` is called. `Route` will use the same route template to generate a URL when `GetVirtualPath` is called.

Most applications will create routes by calling `MapRoute` or one of the similar extension methods defined on `IRouteBuilder`. All of these methods will create an instance of `Route` and add it to the route collection.

Note: `MapRoute` doesn't take a route handler parameter - it only adds routes that will be handled by the `DefaultHandler`. Since the default handler is an `IRouter`, it may decide not to handle the request. For example, ASP.NET MVC is typically configured as a default handler that only handles requests that match an available controller and action. To learn more about routing to MVC, see [Route to controller actions](#).

This is an example of a `MapRoute` call used by a typical ASP.NET MVC route definition:

```
routes.MapRoute(  
    name: "default",  
    template: "{controller=Home}/{action=Index}/{id?}");
```

This template will match a URL path like `/Products/Details/17` and extract the route values `{ controller = Products, action = Details, id = 17 }`. The route values are determined by splitting the URL path into segments, and matching each segment with the *route parameter* name in the route template. Route parameters are named. They're defined by enclosing the parameter name in braces `{ }`.

The template above could also match the URL path `/` and would produce the values `{ controller = Home, action = Index }`. This happens because the `{controller}` and `{action}` route parameters have default values, and the `id` route parameter is optional. An equals `=` sign followed by a value after the route parameter name defines a default value for the parameter. A question mark `?` after the route parameter name defines the parameter as optional. Route parameters with a default value *always* produce a route value when the route matches - optional parameters won't produce a route value if there was no corresponding URL path segment.

See [route-template-reference](#) for a thorough description of route template features and syntax.

This example includes a *route constraint*:

```
routes.MapRoute(  
    name: "default",  
    template: "{controller=Home}/{action=Index}/{id:int}");
```

This template will match a URL path like `/Products/Details/17`, but not `/Products/Details/Apples`. The route parameter definition `{id:int}` defines a *route constraint* for the `id` route parameter. Route constraints implement `IRouteConstraint` and inspect route values to verify them. In this example the route value `id` must be convertible to an integer. See [route-constraint-reference](#) for a more detailed explanation of route constraints that are provided by the framework.

Additional overloads of `MapRoute` accept values for `constraints`, `dataTokens`, and `defaults`. These additional parameters of `MapRoute` are defined as type `object`. The typical usage of these parameters is to pass an anonymously typed object, where the property names of the anonymous type match route parameter names.

The following two examples create equivalent routes:

```

routes.MapRoute(
    name: "default_route",
    template: "{controller}/{action}/{id?}",
    defaults: new { controller = "Home", action = "Index" });

routes.MapRoute(
    name: "default_route",
    template: "{controller=Home}/{action=Index}/{id?}");

```

Tip: The inline syntax for defining constraints and defaults can be more convenient for simple routes. However, there are features such as data tokens which are not supported by inline syntax.

This example demonstrates a few more features:

```

routes.MapRoute(
    name: "blog",
    template: "Blog/{*article}",
    defaults: new { controller = "Blog", action = "ReadArticle" });

```

This template will match a URL path like `/Blog/All-About-Routing/Introduction` and will extract the values `{ controller = Blog, action = ReadArticle, article = All-About-Routing/Introduction }`. The default route values for `controller` and `action` are produced by the route even though there are no corresponding route parameters in the template. Default values can be specified in the route template. The `article` route parameter is defined as a *catch-all* by the appearance of an asterisk `*` before the route parameter name. Catch-all route parameters capture the remainder of the URL path, and can also match the empty string.

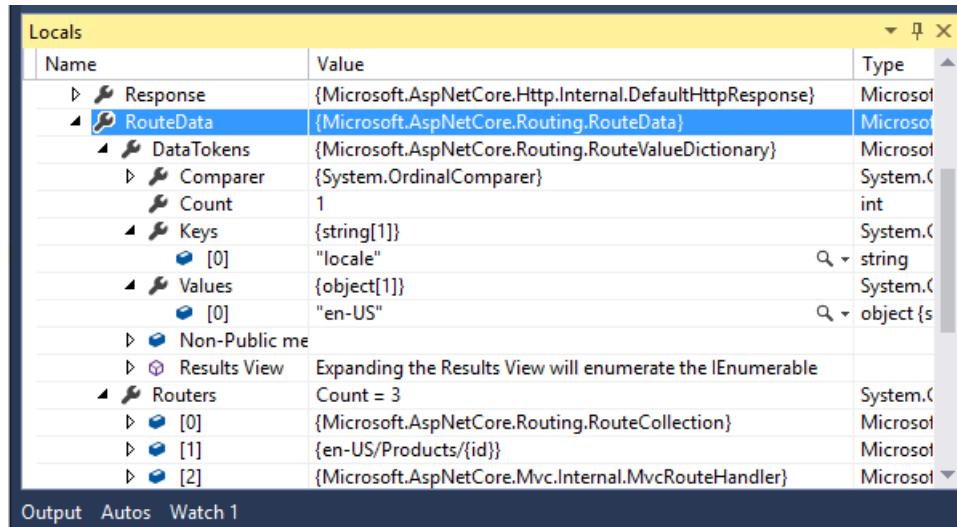
This example adds route constraints and data tokens:

```

routes.MapRoute(
    name: "us_english_products",
    template: "en-US/Products/{id}",
    defaults: new { controller = "Products", action = "Details" },
    constraints: new { id = new IntRouteConstraint() },
    dataTokens: new { locale = "en-US" });

```

This template matches a URL path like `/en-US/Products/5` and extracts the values `{ controller = Products, action = Details, id = 5 }` and the data tokens `{ locale = en-US }`.



## URL generation

The `Route` class can also perform URL generation by combining a set of route values with its route template. This is logically the reverse process of matching the URL path.

Tip: To better understand URL generation, imagine what URL you want to generate and then think about how a route template would match that URL. What values would be produced? This is the rough equivalent of how URL generation works in the `Route` class.

This example uses a basic ASP.NET MVC style route:

```
routes.MapRoute(  
    name: "default",  
    template: "{controller=Home}/{action=Index}/{id?}");
```

With the route values `{ controller = Products, action = List }`, this route will generate the URL `/Products/List`. The route values are substituted for the corresponding route parameters to form the URL path. Since `id` is an optional route parameter, it's no problem that it doesn't have a value.

With the route values `{ controller = Home, action = Index }`, this route will generate the URL `/`. The route values that were provided match the default values so the segments corresponding to those values can be safely omitted. Note that both URLs generated would round-trip with this route definition and produce the same route values that were used to generate the URL.

Tip: An app using ASP.NET MVC should use `UrlHelper` to generate URLs instead of calling into routing directly.

For more details about the URL generation process, see [url-generation-reference](#).

## Using Routing Middleware

Add the NuGet package "Microsoft.AspNetCore.Routing".

Add routing to the service container in `Startup.cs`:

```
public void ConfigureServices(IServiceCollection services)  
{  
    services.AddRouting();  
}
```

Routes must be configured in the `Configure` method in the `Startup` class. The sample below uses these APIs:

- `RouteBuilder`
- `Build`
- `MapGet` Matches only HTTP GET requests
- `UseRouter`

```

public void Configure(IApplicationBuilder app, ILoggerFactory loggerFactory)
{
    var trackPackageRouteHandler = new RouteHandler(context =>
    {
        var routeValues = context.GetRouteData().Values;
        return context.Response.WriteAsync(
            $"Hello! Route values: {string.Join(", ", routeValues)}");
    });

    var routeBuilder = new RouteBuilder(app, trackPackageRouteHandler);

    routeBuilder.MapRoute(
        "Track Package Route",
        "package/{operation:regex(^track|create|detonate)$}/{id:int}");

    routeBuilder.MapGet("hello/{name}", context =>
    {
        var name = context.GetRouteValue("name");
        // This is the route handler when HTTP GET "hello/<anything>" matches
        // To match HTTP GET "hello/<anything>/<anything>",
        // use routeBuilder.MapGet("hello/{*name}")
        return context.Response.WriteAsync($"Hi, {name}!");
    });

    var routes = routeBuilder.Build();
    app.UseRouter(routes);
}

```

The table below shows the responses with the given URIs.

URI	RESPONSE
/package/create/3	Hello! Route values: [operation, create], [id, 3]
/package/track/-3	Hello! Route values: [operation, track], [id, -3]
/package/track/-3/	Hello! Route values: [operation, track], [id, -3]
/package/track/	<Fall through, no match>
GET /hello/Joe	Hi, Joe!
POST /hello/Joe	<Fall through, matches HTTP GET only>
GET /hello/Joe/Smith	<Fall through, no match>

If you are configuring a single route, call `app.UseRouter` passing in an `IRouter` instance. You won't need to call `RouteBuilder`.

The framework provides a set of extension methods for creating routes such as:

- `MapRoute`
- `MapGet`
- `MapPost`
- `MapPut`
- `MapDelete`
- `MapVerb`

Some of these methods such as `MapGet` require a `RequestDelegate` to be provided. The `RequestDelegate` will be used as the *route handler* when the route matches. Other methods in this family allow configuring a middleware pipeline which will be used as the route handler. If the `Map` method doesn't accept a handler, such as `MapRoute`, then it will use the `DefaultHandler`.

The `Map[Verb]` methods use constraints to limit the route to the HTTP Verb in the method name. For example, see [MapGet](#) and [MapVerb](#).

## Route Template Reference

Tokens within curly braces (`{ }`) define *route parameters* which will be bound if the route is matched. You can define more than one route parameter in a route segment, but they must be separated by a literal value. For example `{controller=Home}{action=Index}` wouldn't be a valid route, since there's no literal value between `{controller}` and `{action}`. These route parameters must have a name, and may have additional attributes specified.

Literal text other than route parameters (for example, `{id}`) and the path separator `/` must match the text in the URL. Text matching is case-insensitive and based on the decoded representation of the URLs path. To match the literal route parameter delimiter `{` or `}`, escape it by repeating the character (`{}{}` or `{}{}`).

URL patterns that attempt to capture a filename with an optional file extension have additional considerations. For example, using the template `files/{filename}.{ext?}` - When both `filename` and `ext` exist, both values will be populated. If only `filename` exists in the URL, the route matches because the trailing period `.` is optional. The following URLs would match this route:

- `/files/myFile.txt`
- `/files/myFile`

You can use the `*` character as a prefix to a route parameter to bind to the rest of the URI - this is called a *catch-all* parameter. For example, `blog/{*slug}` would match any URI that started with `/blog` and had any value following it (which would be assigned to the `slug` route value). Catch-all parameters can also match the empty string.

Route parameters may have *default values*, designated by specifying the default after the parameter name, separated by an `=`. For example, `{controller=Home}` would define `Home` as the default value for `controller`. The default value is used if no value is present in the URL for the parameter. In addition to default values, route parameters may be optional (specified by appending a `?` to the end of the parameter name, as in `id?`). The difference between optional and "has default" is that a route parameter with a default value always produces a value; an optional parameter has a value only when one is provided.

Route parameters may also have constraints, which must match the route value bound from the URL. Adding a colon `:` and constraint name after the route parameter name specifies an *inline constraint* on a route parameter. If the constraint requires arguments those are provided enclosed in parentheses `( )` after the constraint name. Multiple inline constraints can be specified by appending another colon `:` and constraint name. The constraint name is passed to the `IInlineConstraintResolver` service to create an instance of `IRouteConstraint` to use in URL processing. For example, the route template `blog/{article:minlength(10)}` specifies the `minlength` constraint with the argument `10`. For more description route constraints, and a listing of the constraints provided by the framework, see [route-constraint-reference](#).

The following table demonstrates some route templates and their behavior.

ROUTE TEMPLATE	EXAMPLE MATCHING URL	NOTES
hello	/hello	Only matches the single path <code>/hello</code>

ROUTE TEMPLATE	EXAMPLE MATCHING URL	NOTES
{Page=Home}	/	Matches and sets <code>Page</code> to <code>Home</code>
{Page=Home}	/Contact	Matches and sets <code>Page</code> to <code>Contact</code>
{controller}/{action}/{id?}	/Products/List	Maps to <code>Products</code> controller and <code>List</code> action
{controller}/{action}/{id?}	/Products/Details/123	Maps to <code>Products</code> controller and <code>Details</code> action. <code>id</code> set to 123
{controller=Home}/{action=Index}/{id?}	/	Maps to <code>Home</code> controller and <code>Index</code> method; <code>id</code> is ignored.

Using a template is generally the simplest approach to routing. Constraints and defaults can also be specified outside the route template.

Tip: Enable [Logging](#) to see how the built in routing implementations, such as `Route`, match requests.

## Reserved routing names

The following keywords are reserved names and can't be used as route names or parameters:

- `action`
- `area`
- `controller`
- `handler`
- `page`

## Route constraint reference

Route constraints execute when a `Route` has matched the syntax of the incoming URL and tokenized the URL path into route values. Route constraints generally inspect the route value associated via the route template and make a simple yes/no decision about whether or not the value is acceptable. Some route constraints use data outside the route value to consider whether the request can be routed. For example, the `HttpMethodRouteConstraint` can accept or reject a request based on its HTTP verb.

### WARNING

Avoid using constraints for **input validation**, because doing so means that invalid input will result in a 404 (Not Found) instead of a 400 with an appropriate error message. Route constraints should be used to **disambiguate** between similar routes, not to validate the inputs for a particular route.

The following table demonstrates some route constraints and their expected behavior.

CONSTRAINT	EXAMPLE	EXAMPLE MATCHES	NOTES
<code>int</code>	<code>{id:int}</code>	<code>123456789</code> , <code>-123456789</code>	Matches any integer
<code>bool</code>	<code>{active:bool}</code>	<code>true</code> , <code>FALSE</code>	Matches <code>true</code> or <code>false</code> (case-insensitive)

CONSTRAINT	EXAMPLE	EXAMPLE MATCHES	NOTES
<code>datetime</code>	<code>{dob:datetime}</code>	<code>2016-12-31</code> , <code>2016-12-31 7:32pm</code>	Matches a valid <code>DateTime</code> value (in the invariant culture - see warning)
<code>decimal</code>	<code>{price:decimal}</code>	<code>49.99</code> , <code>-1,000.01</code>	Matches a valid <code>decimal</code> value (in the invariant culture - see warning)
<code>double</code>	<code>{weight:double}</code>	<code>1.234</code> , <code>-1,001.01e8</code>	Matches a valid <code>double</code> value (in the invariant culture - see warning)
<code>float</code>	<code>{weight:float}</code>	<code>1.234</code> , <code>-1,001.01e8</code>	Matches a valid <code>float</code> value (in the invariant culture - see warning)
<code>guid</code>	<code>{id:guid}</code>	<code>CD2C1638-1638-72D5-1638-DEADBEEF1638</code> , ,	Matches a valid <code>Guid</code> value
<code>long</code>	<code>{ticks:long}</code>	<code>123456789</code> , <code>-123456789</code>	Matches a valid <code>long</code> value
<code>minlength(value)</code>	<code>{username:minlength(4)}</code>	<code>Rick</code>	String must be at least 4 characters
<code>maxlength(value)</code>	<code>{filename:maxlength(8)}</code>	<code>Richard</code>	String must be no more than 8 characters
<code>length(length)</code>	<code>{filename:length(12)}</code>	<code>somefile.txt</code>	String must be exactly 12 characters long
<code>length(min,max)</code>	<code>{filename:length(8,16)}</code>	<code>somefile.txt</code>	String must be at least 8 and no more than 16 characters long
<code>min(value)</code>	<code>{age:min(18)}</code>	<code>19</code>	Integer value must be at least 18
<code>max(value)</code>	<code>{age:max(120)}</code>	<code>91</code>	Integer value must be no more than 120
<code>range(min,max)</code>	<code>{age:range(18,120)}</code>	<code>91</code>	Integer value must be at least 18 but no more than 120
<code>alpha</code>	<code>{name:alpha}</code>	<code>Rick</code>	String must consist of one or more alphabetical characters ( <code>a</code> - <code>z</code> , case-insensitive)

CONSTRAINT	EXAMPLE	EXAMPLE MATCHES	NOTES
<code>regex(expression)</code>	<code>{ssn:regex(^\\d{3}-\\d{2}-\\d{4}\$)}</code>	<code>123-45-6789</code>	String must match the regular expression (see tips about defining a regular expression)
<code>required</code>	<code>{name:required}</code>	<code>Rick</code>	Used to enforce that a non-parameter value is present during URL generation

### WARNING

Route constraints that verify the URL can be converted to a CLR type (such as `int` or `DateTime`) always use the invariant culture - they assume the URL is non-localizable. The framework-provided route constraints don't modify the values stored in route values. All route values parsed from the URL will be stored as strings. For example, the [Float route constraint](#) will attempt to convert the route value to a float, but the converted value is used only to verify it can be converted to a float.

## Regular expressions

The ASP.NET Core framework adds

`RegexOptions.IgnoreCase` | `RegexOptions.Compiled` | `RegexOptions.CultureInvariant` to the regular expression constructor. See [RegexOptions Enumeration](#) for a description of these members.

Regular expressions use delimiters and tokens similar to those used by Routing and the C# language. Regular expression tokens must be escaped. For example, to use the regular expression `^\\d{3}-\\d{2}-\\d{4}$` in Routing, it needs to have the `\` characters typed in as `\\` in the C# source file to escape the `\` string escape character (unless using [verbatim string literals](#)). The `{`, `}`, `'` and `'` characters need to be escaped by doubling them to escape the Routing parameter delimiter characters. The table below shows a regular expression and the escaped version.

EXPRESSION	NOTE
<code>^\\d{3}-\\d{2}-\\d{4}\$</code>	Regular expression
<code>^\\\\d{3}-\\\\d{2}-\\\\d{4}\$</code>	Escaped
<code>^[a-z]{2}\$</code>	Regular expression
<code>^[[a-z]]{{2}}\$</code>	Escaped

Regular expressions used in routing will often start with the `^` character (match starting position of the string) and end with the `$` character (match ending position of the string). The `^` and `$` characters ensure that the regular expression match the entire route parameter value. Without the `^` and `$` characters the regular expression will match any sub-string within the string, which is often not what you want. The table below shows some examples and explains why they match or fail to match.

EXPRESSION	STRING	MATCH	COMMENT
<code>[a-z]{2}</code>	<code>hello</code>	<code>yes</code>	substring matches

EXPRESSION	STRING	MATCH	COMMENT
[a-z]{2}	123abc456	yes	substring matches
[a-z]{2}	mz	yes	matches expression
[a-z]{2}	MZ	yes	not case sensitive
^[a-z]{2}\$	hello	no	see <code>^</code> and <code>\$</code> above
^[a-z]{2}\$	123abc456	no	see <code>^</code> and <code>\$</code> above

Refer to [.NET Framework Regular Expressions](#) for more information on regular expression syntax.

To constrain a parameter to a known set of possible values, use a regular expression. For example `{action:regex(^list|get|create)$)}` only matches the `action` route value to `list`, `get`, or `create`. If passed into the constraints dictionary, the string "`^(list|get|create)$`" would be equivalent. Constraints that are passed in the constraints dictionary (not inline within a template) that don't match one of the known constraints are also treated as regular expressions.

## URL Generation Reference

The example below shows how to generate a link to a route given a dictionary of route values and a `RouteCollection`.

```
app.Run(async (context) =>
{
    var dictionary = new RouteValueDictionary
    {
        { "operation", "create" },
        { "id", 123 }
    };

    var vpc = new VirtualPathContext(context, null, dictionary, "Track Package Route");
    var path = routes.GetVirtualPath(vpc).VirtualPath;

    context.Response.ContentType = "text/html";
    await context.Response.WriteAsync("Menu<hr/>");
    await context.Response.WriteAsync($"<a href='{path}'>Create Package 123</a><br/>");
});
```

The `VirtualPath` generated at the end of the sample above is `/package/create/123`.

The second parameter to the `VirtualPathContext` constructor is a collection of *ambient values*. Ambient values provide convenience by limiting the number of values a developer must specify within a certain request context. The current route values of the current request are considered ambient values for link generation. For example, in an ASP.NET MVC app if you are in the `About` action of the `HomeController`, you don't need to specify the controller route value to link to the `Index` action (the ambient value of `Home` will be used).

Ambient values that don't match a parameter are ignored, and ambient values are also ignored when an explicitly-provided value overrides it, going from left to right in the URL.

Values that are explicitly provided but which don't match anything are added to the query string. The following table shows the result when using the route template `{controller}/{action}/{id?}`.

AMBIENT VALUES	EXPLICIT VALUES	RESULT
controller="Home"	action="About"	/Home/About
controller="Home"	controller="Order",action="About"	/Order/About
controller="Home",color="Red"	action="About"	/Home/About
controller="Home"	action="About",color="Red"	/Home/About?color=Red

If a route has a default value that doesn't correspond to a parameter and that value is explicitly provided, it must match the default value. For example:

```
routes.MapRoute("blog_route", "blog/{*slug}",
    defaults: new { controller = "Blog", action = "ReadPost" });
```

Link generation would only generate a link for this route when the matching values for controller and action are provided.

# URL Rewriting Middleware in ASP.NET Core

6/21/2018 • 16 minutes to read • [Edit Online](#)

By [Luke Latham](#) and [Mikael Mengistu](#)

[View or download sample code](#) ([how to download](#))

URL rewriting is the act of modifying request URLs based on one or more predefined rules. URL rewriting creates an abstraction between resource locations and their addresses so that the locations and addresses are not tightly linked. There are several scenarios where URL rewriting is valuable:

- Moving or replacing server resources temporarily or permanently while maintaining stable locators for those resources.
- Splitting request processing across different apps or across areas of one app.
- Removing, adding, or reorganizing URL segments on incoming requests.
- Optimizing public URLs for Search Engine Optimization (SEO).
- Permitting the use of friendly public URLs to help people predict the content they will find by following a link.
- Redirecting insecure requests to secure endpoints.
- Preventing image hotlinking.

You can define rules for changing the URL in several ways, including Regex, Apache mod\_rewrite module rules, IIS Rewrite Module rules, and using custom rule logic. This document introduces URL rewriting with instructions on how to use URL Rewriting Middleware in ASP.NET Core apps.

## NOTE

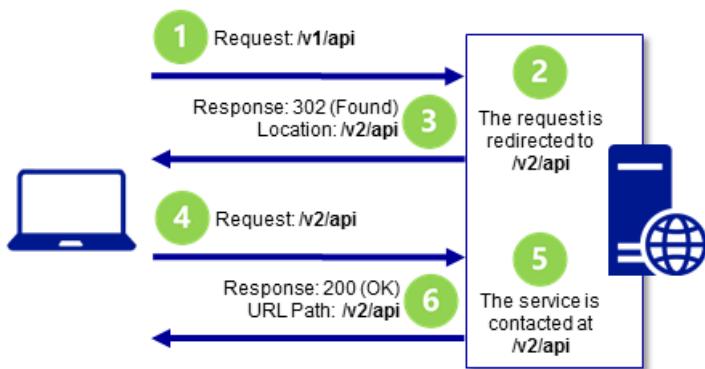
URL rewriting can reduce the performance of an app. Where feasible, you should limit the number and complexity of rules.

## URL redirect and URL rewrite

The difference in wording between *URL redirect* and *URL rewrite* may seem subtle at first but has important implications for providing resources to clients. ASP.NET Core's URL Rewriting Middleware is capable of meeting the need for both.

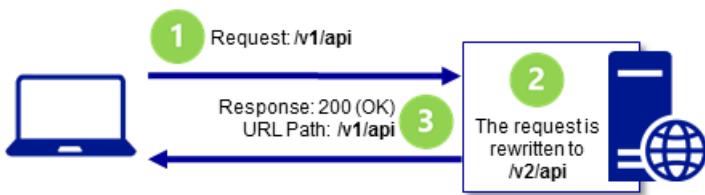
A *URL redirect* is a client-side operation, where the client is instructed to access a resource at another address. This requires a round-trip to the server. The redirect URL returned to the client appears in the browser's address bar when the client makes a new request for the resource.

If `/resource` is *redirected* to `/different-resource`, the client requests `/resource`. The server responds that the client should obtain the resource at `/different-resource` with a status code indicating that the redirect is either temporary or permanent. The client executes a new request for the resource at the redirect URL.



When redirecting requests to a different URL, you indicate whether the redirect is permanent or temporary. The 301 (Moved Permanently) status code is used where the resource has a new, permanent URL and you wish to instruct the client that all future requests for the resource should use the new URL. *The client may cache the response when a 301 status code is received.* The 302 (Found) status code is used where the redirection is temporary or generally subject to change, such that the client shouldn't store and reuse the redirect URL in the future. For more information, see [RFC 2616: Status Code Definitions](#).

A *URL rewrite* is a server-side operation to provide a resource from a different resource address. Rewriting a URL doesn't require a round-trip to the server. The rewritten URL isn't returned to the client and won't appear in the browser's address bar. When `/resource` is rewritten to `/different-resource`, the client requests `/resource`, and the server *internally* fetches the resource at `/different-resource`. Although the client might be able to retrieve the resource at the rewritten URL, the client won't be informed that the resource exists at the rewritten URL when it makes its request and receives the response.



## URL rewriting sample app

You can explore the features of the URL Rewriting Middleware with the [URL rewriting sample app](#). The app applies rewrite and redirect rules and shows the rewritten or redirected URL.

## When to use URL Rewriting Middleware

Use URL Rewriting Middleware when you are unable to use the [URL Rewrite module](#) with IIS on Windows Server, the [Apache mod\\_rewrite module](#) on Apache Server, [URL rewriting on Nginx](#), or your app is hosted on [HTTP.sys server](#) (formerly called [WebListener](#)). The main reasons to use the server-based URL rewriting technologies in IIS, Apache, or Nginx are that the middleware doesn't support the full features of these modules and the performance of the middleware probably won't match that of the modules. However, there are some features of the server modules that don't work with ASP.NET Core projects, such as the `IsFile` and `IsDirectory` constraints of the IIS Rewrite module. In these scenarios, use the middleware instead.

## Package

To include the middleware in your project, add a reference to the `Microsoft.AspNetCore.Rewrite` package. This feature is available for apps that target ASP.NET Core 1.1 or later.

## Extension and options

Establish your URL rewrite and redirect rules by creating an instance of the `RewriteOptions` class with extension

methods for each of your rules. Chain multiple rules in the order that you would like them processed. The `RewriteOptions` are passed into the URL Rewriting Middleware as it's added to the request pipeline with

```
app.UseRewriter(options);
```

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
public void Configure(IApplicationBuilder app)
{
    using (StreamReader apacheModRewriteStreamReader =
        File.OpenText("ApacheModRewrite.txt"))
    using (StreamReader iisUrlRewriteStreamReader =
        File.OpenText("IISUrlRewrite.xml"))
    {
        var options = new RewriteOptions()
            .AddRedirect("redirect-rule/(.*)", "redirected/$1")
            .AddRewrite(@"^rewrite-rule/(\d+)/(\d+)", "rewritten?var1=$1&var2=$2",
                skipRemainingRules: true)
            .AddApacheModRewrite(apacheModRewriteStreamReader)
            .AddIISUrlRewrite(iisUrlRewriteStreamReader)
            .Add(MethodRules.RedirectXMLRequests)
            .Add(new RedirectImageRequests(".png", "/png-images"))
            .Add(new RedirectImageRequests(".jpg", "/jpg-images"));

        app.UseRewriter(options);
    }

    app.Run(context => context.Response.WriteAsync(
        $"Rewritten or Redirected Url: " +
        $"{context.Request.Path + context.Request.QueryString}"));
}
```

## URL redirect

Use `AddRedirect` to redirect requests. The first parameter contains your regex for matching on the path of the incoming URL. The second parameter is the replacement string. The third parameter, if present, specifies the status code. If you don't specify the status code, it defaults to 302 (Found), which indicates that the resource is temporarily moved or replaced.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```

public void Configure(IApplicationBuilder app)
{
    using (StreamReader apacheModRewriteStreamReader =
        File.OpenText("ApacheModRewrite.txt"))
    using (StreamReader iisUrlRewriteStreamReader =
        File.OpenText("IISUrlRewrite.xml"))
    {
        var options = new RewriteOptions()
            .AddRedirect("redirect-rule/(.*)", "redirected/$1")
            .AddRewrite(@"^rewrite-rule/(\d+)/(\d+)", "rewritten?var1=$1&var2=$2",
                skipRemainingRules: true)
            .AddApacheModRewrite(apacheModRewriteStreamReader)
            .AddIISUrlRewrite(iisUrlRewriteStreamReader)
            .Add(MethodRules.RedirectXMLRequests)
            .Add(new RedirectImageRequests(".png", "/png-images"))
            .Add(new RedirectImageRequests(".jpg", "/jpg-images"));

        app.UseRewriter(options);
    }

    app.Run(context => context.Response.WriteAsync(
        $"Rewritten or Redirected Url: " +
        $"{context.Request.Path + context.Request.QueryString}"));
}

```

In a browser with developer tools enabled, make a request to the sample app with the path

`/redirect-rule/1234/5678`. The regex matches the request path on `redirect-rule/(.*)`, and the path is replaced with `/redirected/1234/5678`. The redirect URL is sent back to the client with a 302 (Found) status code. The browser makes a new request at the redirect URL, which appears in the browser's address bar. Since no rules in the sample app match on the redirect URL, the second request receives a 200 (OK) response from the app and the body of the response shows the redirect URL. A roundtrip is made to the server when a URL is *redirected*.

#### WARNING

Be cautious when establishing your redirect rules. Your redirect rules are evaluated on each request to the app, including after a redirect. It's easy to accidentally create a loop of infinite redirects.

Original Request: `/redirect-rule/1234/5678`

Name / Path	Protocol	Method	Result / Description
5678 http://localhost:5000/redirect-rule/1234/	HTTP	GET	302 Found
5678 http://localhost:5000/redirected/1234/	HTTP	GET	200 OK

The part of the expression contained within parentheses is called a *capture group*. The dot (`.`) of the expression means *match any character*. The asterisk (`*`) indicates *match the preceding character zero or more times*. Therefore, the last two path segments of the URL, `1234/5678`, are captured by capture group `(.*)`. Any value you provide in the request URL after `redirect-rule/` is captured by this single capture group.

In the replacement string, captured groups are injected into the string with the dollar sign (`$`) followed by the

sequence number of the capture. The first capture group value is obtained with `$1`, the second with `$2`, and they continue in sequence for the capture groups in your regex. There's only one captured group in the redirect rule regex in the sample app, so there's only one injected group in the replacement string, which is `$1`. When the rule is applied, the URL becomes `/redirected/1234/5678`.

## URL redirect to a secure endpoint

Use `AddRedirectToHttps` to redirect HTTP requests to the same host and path using HTTPS (`https://`). If the status code isn't supplied, the middleware defaults to 302 (Found). If the port isn't supplied, the middleware defaults to `null`, which means the protocol changes to `https://` and the client accesses the resource on port 443. The example shows how to set the status code to 301 (Moved Permanently) and change the port to 5001.

```
public void Configure(IApplicationBuilder app)
{
    var options = new RewriteOptions()
        .AddRedirectToHttps(301, 5001);

    app.UseRewriter(options);
}
```

Use `AddRedirectToHttpsPermanent` to redirect insecure requests to the same host and path with secure HTTPS protocol (`https://` on port 443). The middleware sets the status code to 301 (Moved Permanently).

```
public void Configure(IApplicationBuilder app)
{
    var options = new RewriteOptions()
        .AddRedirectToHttpsPermanent();

    app.UseRewriter(options);
}
```

### NOTE

When redirecting to HTTPS without the requirement for additional redirect rules, we recommend using HTTPS Redirection Middleware. For more information, see the [Enforce HTTPS](#) topic.

The sample app is capable of demonstrating how to use `AddRedirectToHttps` or `AddRedirectToHttpsPermanent`. Add the extension method to the `RewriteOptions`. Make an insecure request to the app at any URL. Dismiss the browser security warning that the self-signed certificate is untrusted or create an exception to trust the certificate.

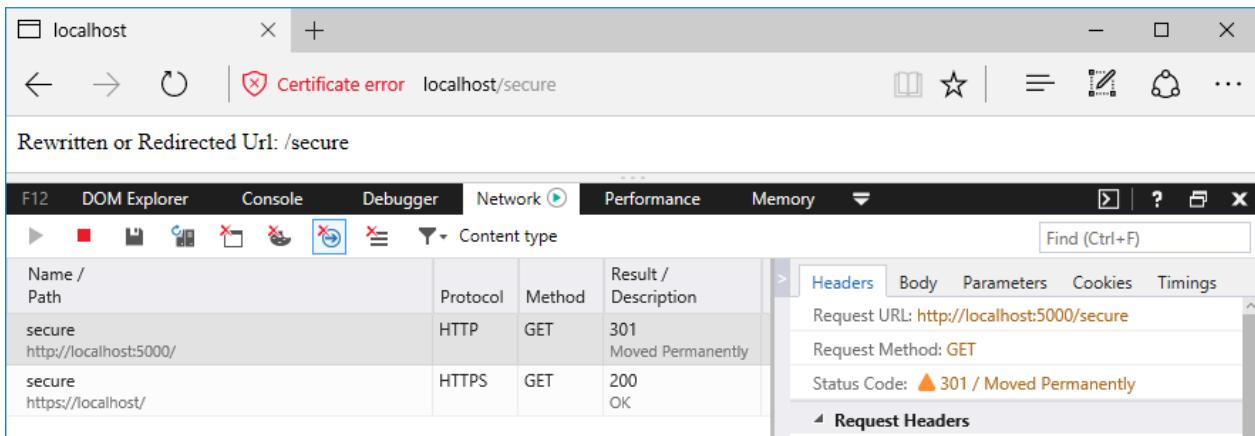
Original Request using `AddRedirectToHttps(301, 5001)` : `http://localhost:5000/secure`

The screenshot shows the Microsoft Edge DevTools Network tab. A request for `http://localhost:5000/secure` was made, resulting in a `301 Moved Permanently` response to `https://localhost:5001/secure`. The Headers section shows the following:

Name / Path	Protocol	Method	Result / Description
<code>secure</code> <code>http://localhost:5000/</code>	HTTP	GET	301 Moved Permanently
<code>secure</code> <code>https://localhost:5001/</code>	HTTPS	GET	200 OK

The Body section shows the response content: "Status Code: ▲ 301 / Moved Permanently".

Original Request using `AddRedirectToHttpsPermanent` : `http://localhost:5000/secure`



## URL rewrite

Use `AddRewrite` to create a rule for rewriting URLs. The first parameter contains your regex for matching on the incoming URL path. The second parameter is the replacement string. The third parameter, `skipRemainingRules: {true|false}`, indicates to the middleware whether or not to skip additional rewrite rules if the current rule is applied.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
public void Configure(IApplicationBuilder app)
{
    using (StreamReader apacheModRewriteStreamReader =
        File.OpenText("ApacheModRewrite.txt"))
    using (StreamReader iisUrlRewriteStreamReader =
        File.OpenText("IISUrlRewrite.xml"))
    {
        var options = new RewriteOptions()
            .AddRedirect("redirect-rule/(.*)", "redirected/$1")
            .AddRewrite(@"^rewrite-rule/(\d+)/(\d+)", "rewritten?var1=$1&var2=$2",
                skipRemainingRules: true)
            .AddApacheModRewrite(apacheModRewriteStreamReader)
            .AddIISUrlRewrite(iisUrlRewriteStreamReader)
            .Add(MethodRules.RedirectXMLRequests)
            .Add(new RedirectImageRequests(".png", "/png-images"))
            .Add(new RedirectImageRequests(".jpg", "/jpg-images"));

        app.UseRewriter(options);
    }

    app.Run(context => context.Response.WriteAsync(
        $"Rewritten or Redirected Url: " +
        $"{context.Request.Path + context.Request.QueryString}"));
}
```

Original Request: `/rewrite-rule/1234/5678`

The screenshot shows the Microsoft Edge DevTools Network tab. The URL in the address bar is `localhost:5000/rewrite-rule/1234/5678`. The network table has one row with the following details:

Name / Path	Protocol	Method	Result / Description
<code>5678 http://localhost:5000/rewrite-rule/1234/</code>	HTTP	GET	200 OK

On the right side of the Network tab, the Headers section shows:

- Request URL: `http://localhost:5000/rewrite-rule/1234/...`
- Request Method: `GET`
- Status Code: `200 / OK`

The first thing you notice in the regex is the carat (^) at the beginning of the expression. This means that matching starts at the beginning of the URL path.

In the earlier example with the redirect rule, `redirect-rule/(.*)`, there's no carat at the start of the regex; therefore, any characters may precede `redirect-rule/` in the path for a successful match.

PATH	MATCH
<code>/redirect-rule/1234/5678</code>	Yes
<code>/my-cool-redirect-rule/1234/5678</code>	Yes
<code>/anotherredirect-rule/1234/5678</code>	Yes

The rewrite rule `^rewrite-rule/(\d+)/(\d+)` only matches paths if they start with `rewrite-rule/`. Notice the difference in matching between the rewrite rule below and the redirect rule above.

PATH	MATCH
<code>/rewrite-rule/1234/5678</code>	Yes
<code>/my-cool-rewrite-rule/1234/5678</code>	No
<code>/anotherrewrite-rule/1234/5678</code>	No

Following the `^rewrite-rule/` portion of the expression, there are two capture groups, `(\d+)/(\d+)`. The `\d` signifies *match a digit (number)*. The plus sign (+) means *match one or more of the preceding character*.

Therefore, the URL must contain a number followed by a forward-slash followed by another number. These capture groups are injected into the rewritten URL as `$1` and `$2`. The rewrite rule replacement string places the captured groups into the querystring. The requested path of `/rewrite-rule/1234/5678` is rewritten to obtain the resource at `/rewritten?var1=1234&var2=5678`. If a querystring is present on the original request, it's preserved when the URL is rewritten.

There's no roundtrip to the server to obtain the resource. If the resource exists, it's fetched and returned to the client with a 200 (OK) status code. Because the client isn't redirected, the URL in the browser address bar doesn't change. As far as the client is concerned, the URL rewrite operation never occurred.

## NOTE

Use `skipRemainingRules: true` whenever possible, because matching rules is an expensive process and reduces app response time. For the fastest app response:

- Order your rewrite rules from the most frequently matched rule to the least frequently matched rule.
- Skip the processing of the remaining rules when a match occurs and no additional rule processing is required.

## Apache mod\_rewrite

Apply Apache mod\_rewrite rules with `AddApacheModRewrite`. Make sure that the rules file is deployed with the app. For more information and examples of mod\_rewrite rules, see [Apache mod\\_rewrite](#).

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

A `StreamReader` is used to read the rules from the *ApacheModRewrite.txt* rules file.

```
public void Configure(IApplicationBuilder app)
{
    using (StreamReader apacheModRewriteStreamReader =
        File.OpenText("ApacheModRewrite.txt"))
    using (StreamReader iisUrlRewriteStreamReader =
        File.OpenText("IISUrlRewrite.xml"))
    {
        var options = new RewriteOptions()
            .AddRedirect("redirect-rule/(.*)", "redirected/$1")
            .AddRewrite(@"^rewrite-rule/(\d+)/(\d+)", "rewritten?var1=$1&var2=$2",
                skipRemainingRules: true)
            .AddApacheModRewrite(apacheModRewriteStreamReader)
            .AddIISUrlRewrite(iisUrlRewriteStreamReader)
            .Add(MethodRules.RedirectXMLRequests)
            .Add(new RedirectImageRequests(".png", "/png-images"))
            .Add(new RedirectImageRequests(".jpg", "/jpg-images"));

        app.UseRewriter(options);
    }

    app.Run(context => context.Response.WriteAsync(
        $"Rewritten or Redirected Url: " +
        $"{context.Request.Path + context.Request.QueryString}"));
}
```

The sample app redirects requests from `/apache-mod-rules-redirect/(.\\*)` to `/redirected?id=$1`. The response status code is 302 (Found).

```
# Rewrite path with additional sub directory
RewriteRule ^/apache-mod-rules-redirect/(.*) /redirected?id=$1 [L,R=302]
```

Original Request: `/apache-mod-rules-redirect/1234`

The screenshot shows the Microsoft Edge DevTools Network tab. The URL in the address bar is `localhost:5000/redirected?id=1234`. The network table shows two entries:

Name / Path	Protocol	Method	Result / Description
1234 <code>http://localhost:5000/apache-mod-rules-redirect/</code>	HTTP	GET	302 Found
redirected?id=1234 <code>http://localhost:5000/</code>	HTTP	GET	200 OK

The Headers panel shows the following details:

- Request URL: `http://localhost:5000/apache-mod-rules...`
- Request Method: `GET`
- Status Code: `302 / Found`

#### Supported server variables

The middleware supports the following Apache mod\_rewrite server variables:

- `CONN_REMOTE_ADDR`
- `HTTP_ACCEPT`
- `HTTP_CONNECTION`
- `HTTP_COOKIE`
- `HTTP_FORWARDED`
- `HTTP_HOST`
- `HTTP_REFERER`
- `HTTP_USER_AGENT`
- `HTTPS`
- `IPV6`
- `QUERY_STRING`
- `REMOTE_ADDR`
- `REMOTE_PORT`
- `REQUEST_FILENAME`
- `REQUEST_METHOD`
- `REQUEST_SCHEME`
- `REQUEST_URI`
- `SCRIPT_FILENAME`
- `SERVER_ADDR`
- `SERVER_PORT`
- `SERVER_PROTOCOL`
- `TIME`
- `TIME_DAY`
- `TIME_HOUR`
- `TIME_MIN`
- `TIME_MON`
- `TIME_SEC`
- `TIME_WDAY`
- `TIME_YEAR`

#### IIS URL Rewrite Module rules

To use rules that apply to the IIS URL Rewrite Module, use `AddIISUrlRewrite`. Make sure that the rules file is deployed with the app. Don't direct the middleware to use your `web.config` file when running on Windows Server IIS. With IIS, these rules should be stored outside of your `web.config` to avoid conflicts with the IIS Rewrite module. For more information and examples of IIS URL Rewrite Module rules, see [Using Url Rewrite Module 2.0](#)

and [URL Rewrite Module Configuration Reference](#).

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

A `StreamReader` is used to read the rules from the `IISUrlRewrite.xml` rules file.

```
public void Configure(IApplicationBuilder app)
{
    using (StreamReader apacheModRewriteStreamReader =
        File.OpenText("ApacheModRewrite.txt"))
    using (StreamReader iisUrlRewriteStreamReader =
        File.OpenText("IISUrlRewrite.xml"))
    {
        var options = new RewriteOptions()
            .AddRedirect("redirect-rule/(.*)", "redirected/$1")
            .AddRewrite(@"^rewrite-rule/(\d+)/(\d+)", "rewritten?var1=$1&var2=$2",
                skipRemainingRules: true)
            .AddApacheModRewrite(apacheModRewriteStreamReader)
            .AddIISUrlRewrite(iisUrlRewriteStreamReader)
            .Add(MethodRules.RedirectXMLRequests)
            .Add(new RedirectImageRequests(".png", "/png-images"))
            .Add(new RedirectImageRequests(".jpg", "/jpg-images"));

        app.UseRewriter(options);
    }

    app.Run(context => context.Response.WriteAsync(
        $"Rewritten or Redirected Url: " +
        $"{context.Request.Path + context.Request.QueryString}"));
}
```

The sample app rewrites requests from `/iis-rules-rewrite/(.*)` to `/rewritten?id=$1`. The response is sent to the client with a 200 (OK) status code.

```
<rewrite>
<rules>
    <rule name="Rewrite segment to id querystring" stopProcessing="true">
        <match url="^iis-rules-rewrite/(.*)$" />
        <action type="Rewrite" url="rewritten?id={R:1}" appendQueryString="false"/>
    </rule>
</rules>
</rewrite>
```

Original Request: `/iis-rules-rewrite/1234`

The screenshot shows the Microsoft Edge DevTools Network tab. The request URL is `localhost:5000/iis-rules-rewrite/1234`. The response status is `Rewritten or Redirected Url: /rewritten?id=1234`. The Network tab details table shows the following:

Name / Path	Protocol	Method	Result / Description
1234 http://localhost:5000/iis-rules-rewrite/	HTTP	GET	200 OK

The Headers section shows the following:

- Request URL: `http://localhost:5000/iis-rules-rewrite/1234`
- Request Method: `GET`
- Status Code: `200 / OK`

If you have an active IIS Rewrite Module with server-level rules configured that would impact your app in

undesirable ways, you can disable the IIS Rewrite Module for an app. For more information, see [Disabling IIS modules](#).

#### Unsupported features

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

The middleware released with ASP.NET Core 2.x doesn't support the following IIS URL Rewrite Module features:

- Outbound Rules
- Custom Server Variables
- Wildcards
- LogRewrittenUrl

#### Supported server variables

The middleware supports the following IIS URL Rewrite Module server variables:

- CONTENT\_LENGTH
- CONTENT\_TYPE
- HTTP\_ACCEPT
- HTTP\_CONNECTION
- HTTP\_COOKIE
- HTTP\_HOST
- HTTP\_REFERER
- HTTP\_URL
- HTTP\_USER\_AGENT
- HTTPS
- LOCAL\_ADDR
- QUERY\_STRING
- REMOTE\_ADDR
- REMOTE\_PORT
- REQUEST\_FILENAME
- REQUEST\_URI

#### NOTE

You can also obtain an `IFileProvider` via a `PhysicalFileProvider`. This approach may provide greater flexibility for the location of your rewrite rules files. Make sure that your rewrite rules files are deployed to the server at the path you provide.

```
PhysicalFileProvider fileProvider = new PhysicalFileProvider(Directory.GetCurrentDirectory());
```

#### Method-based rule

Use `Add(Action<RewriteContext> applyRule)` to implement your own rule logic in a method. The `RewriteContext` exposes the `HttpContext` for use in your method. The `context.Result` determines how additional pipeline processing is handled.

CONTEXT.RESULT	ACTION
<code>RuleResult.ContinueRules</code> (default)	Continue applying rules

CONTEXT.RESULT	ACTION
RuleResult.EndResponse	Stop applying rules and send the response
RuleResult.SkipRemainingRules	Stop applying rules and send the context to the next middleware

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
public void Configure(IApplicationBuilder app)
{
    using (StreamReader apacheModRewriteStreamReader =
        File.OpenText("ApacheModRewrite.txt"))
    using (StreamReader iisUrlRewriteStreamReader =
        File.OpenText("IISUrlRewrite.xml"))
    {
        var options = new RewriteOptions()
            .AddRedirect("redirect-rule/(.*)", "redirected/$1")
            .AddRewrite(@"^rewrite-rule/(\d+)(\d+)", "rewritten?var1=$1&var2=$2",
                skipRemainingRules: true)
            .AddApacheModRewrite(apacheModRewriteStreamReader)
            .AddIISUrlRewrite(iisUrlRewriteStreamReader)
            .Add(MethodRules.RedirectXMLRequests)
            .Add(new RedirectImageRequests(".png", "/png-images"))
            .Add(new RedirectImageRequests(".jpg", "/jpg-images"));

        app.UseRewriter(options);
    }

    app.Run(context => context.Response.WriteAsync(
        $"Rewritten or Redirected Url: " +
        $"{context.Request.Path + context.Request.QueryString}"));
}
```

The sample app demonstrates a method that redirects requests for paths that end with `.xml`. If you make a request for `/file.xml`, it's redirected to `/xmlfiles/file.xml`. The status code is set to 301 (Moved Permanently). For a redirect, you must explicitly set the status code of the response; otherwise, a 200 (OK) status code is returned and the redirect won't occur on the client.

```
public static void RedirectXMLRequests(RewriteContext context)
{
    var request = context.HttpContext.Request;

    // Because we're redirecting back to the same app, stop
    // processing if the request has already been redirected
    if (request.Path.StartsWithSegments(new PathString("/xmlfiles")))
    {
        return;
    }

    if (request.Path.Value.EndsWith(".xml", StringComparison.OrdinalIgnoreCase))
    {
        var response = context.HttpContext.Response;
        response.StatusCode = StatusCodes.Status301MovedPermanently;
        context.Result = RuleResult.EndResponse;
        response.Headers[HeaderNames.Location] =
            "/xmlfiles" + request.Path + request.QueryString;
    }
}
```

Original Request: /file.xml

The screenshot shows the Network tab of the F12 developer tools. It lists two requests: one for 'file.xml' at 'http://localhost:5000/' with a 301 status code and another for 'file.xml' at 'http://localhost:5000/xmlfiles/'. The status bar indicates the redirected URL is 'localhost:5000/xmlfiles/file.xml'. The Headers section shows the response includes 'Status Code: ▲ 301 / Moved Permanently'.

## IRule-based rule

Use `Add(IRule)` to implement your own rule logic in a class that derives from `IRule`. Using an `IRule` provides greater flexibility over using the method-based rule approach. Your derived class may include a constructor, where you can pass in parameters for the `ApplyRule` method.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
public void Configure(IApplicationBuilder app)
{
    using (StreamReader apacheModRewriteStreamReader =
        File.OpenText("ApacheModRewrite.txt"))
    using (StreamReader iisUrlRewriteStreamReader =
        File.OpenText("IISUrlRewrite.xml"))
    {
        var options = new RewriteOptions()
            .AddRedirect("redirect-rule/(.*)", "redirected/$1")
            .AddRewrite(@"^rewrite-rule/(\d+)/(d+)", "rewritten?var1=$1&var2=$2",
                skipRemainingRules: true)
            .AddApacheModRewrite(apacheModRewriteStreamReader)
            .AddIISUrlRewrite(iisUrlRewriteStreamReader)
            .Add(MethodRules.RedirectXMLRequests)
            .Add(new RedirectImageRequests(".png", "/png-images"))
            .Add(new RedirectImageRequests(".jpg", "/jpg-images"));

        app.UseRewriter(options);
    }

    app.Run(context => context.Response.WriteAsync(
        $"Rewritten or Redirected Url: " +
        $"{context.Request.Path + context.Request.QueryString}"));
}
```

The values of the parameters in the sample app for the `extension` and the `newPath` are checked to meet several conditions. The `extension` must contain a value, and the value must be `.png`, `.jpg`, or `.gif`. If the `newPath` isn't valid, an `ArgumentException` is thrown. If you make a request for `image.png`, it's redirected to `/png-images/image.png`. If you make a request for `image.jpg`, it's redirected to `/jpg-images/image.jpg`. The status code is set to 301 (Moved Permanently), and the `context.Result` is set to stop processing rules and send the response.

```

public class RedirectImageRequests : IRule
{
    private readonly string _extension;
    private readonly PathString _newPath;

    public RedirectImageRequests(string extension, string newPath)
    {
        if (string.IsNullOrEmpty(extension))
        {
            throw new ArgumentException(nameof(extension));
        }

        if (!Regex.IsMatch(extension, @"^\.png|jpg|gif$"))
        {
            throw new ArgumentException("Invalid extension", nameof(extension));
        }

        if (!Regex.IsMatch(newPath, @"^/[A-Za-z0-9]+"))
        {
            throw new ArgumentException("Invalid path", nameof(newPath));
        }

        _extension = extension;
        _newPath = new PathString(newPath);
    }

    public void ApplyRule(RewriteContext context)
    {
        var request = context.HttpContext.Request;

        // Because we're redirecting back to the same app, stop
        // processing if the request has already been redirected
        if (request.Path.StartsWithSegments(_newPath))
        {
            return;
        }

        if (request.Path.Value.EndsWith(_extension, StringComparison.OrdinalIgnoreCase))
        {
            var response = context.HttpContext.Response;
            response.StatusCode = StatusCodes.Status301MovedPermanently;
            context.Result = RuleResult.EndResponse;
            response.Headers[HeaderNames.Location] =
                _newPath + request.Path + request.QueryString;
        }
    }
}

```

Original Request: /image.png

The screenshot shows a browser window with the address bar containing "localhost:5000/png-images/image.png". Below the address bar, the status bar displays "Rewritten or Redirected Url: /png-images/image.png". The browser interface includes standard navigation buttons (back, forward, search) and a toolbar with various icons.

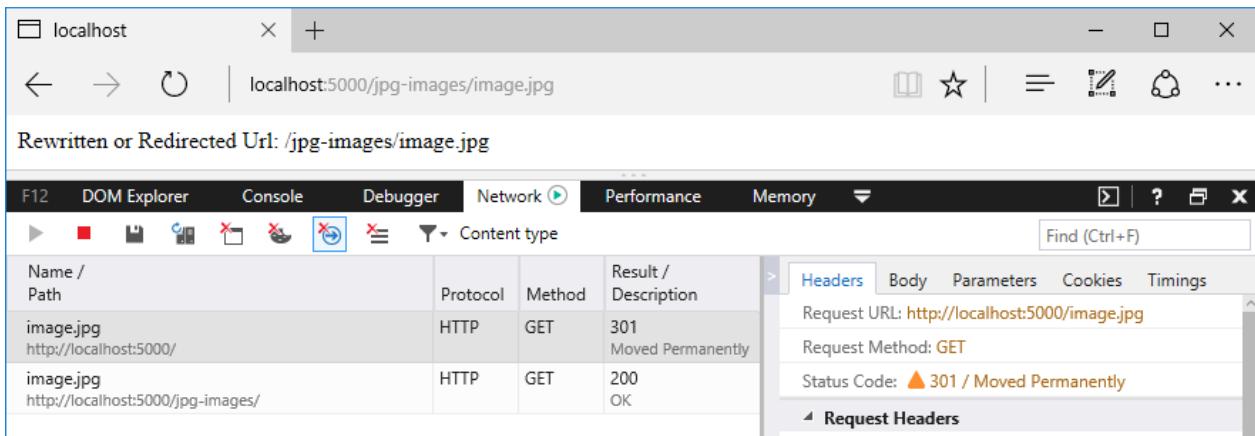
The Network tab of the developer tools is selected, showing the following table:

Name / Path	Protocol	Method	Result / Description
image.png http://localhost:5000/	HTTP	GET	301 Moved Permanently
image.png http://localhost:5000/png-images/	HTTP	GET	200 OK

Details pane on the right side of the developer tools shows the following information:

- Request URL: <http://localhost:5000/image.png>
- Request Method: GET
- Status Code: ▲ 301 / Moved Permanently
- Request Headers (partial list):

Original Request: /image.jpg



## Regex examples

GOAL	REGEX STRING & MATCH EXAMPLE	REPLACEMENT STRING & OUTPUT EXAMPLE
Rewrite path into querystring	<code>^path/(.*)/(.*)</code> <code>/path/abc/123</code>	<code>path?var1=\$1&amp;var2=\$2</code> <code>/path?var1=abc&amp;var2=123</code>
Strip trailing slash	<code>(.*)/\$</code> <code>/path/</code>	<code>\$1</code> <code>/path</code>
Enforce trailing slash	<code>(.*[^/])\$</code> <code>/path</code>	<code>\$1/</code> <code>/path/</code>
Avoid rewriting specific requests	<code>^(.*)(?&lt;!\.axd)\$</code> or <code>^(?!.*\.axd\$)(.*)\$</code> Yes: <code>/resource.htm</code> No: <code>/resource.axd</code>	<code>rewritten/\$1</code> <code>/rewritten/resource.htm</code> <code>/resource.axd</code>
Rearrange URL segments	<code>path/(.*)/(.*)/(.*)</code> <code>path/1/2/3</code>	<code>path/\$3/\$2/\$1</code> <code>path/3/2/1</code>
Replace a URL segment	<code>^(.*)/segment2/(.*)</code> <code>/segment1/segment2/segment3</code>	<code>\$1/replaced/\$2</code> <code>/segment1/replaced/segment3</code>

## Additional resources

- [Application Startup](#)
- [Middleware](#)
- [Regular expressions in .NET](#)
- [Regular expression language - quick reference](#)
- [Apache mod\\_rewrite](#)
- [Using Url Rewrite Module 2.0 \(for IIS\)](#)
- [URL Rewrite Module Configuration Reference](#)
- [IIS URL Rewrite Module Forum](#)
- [Keep a simple URL structure](#)
- [10 URL Rewriting Tips and Tricks](#)
- [To slash or not to slash](#)

# Use multiple environments in ASP.NET Core

7/11/2018 • 8 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

ASP.NET Core configures app behavior based on the runtime environment using an environment variable.

[View or download sample code \(how to download\)](#)

## Environments

ASP.NET Core reads the environment variable `ASPNETCORE_ENVIRONMENT` at app startup and stores the value in `IHostingEnvironment.EnvironmentName`. You can set `ASPNETCORE_ENVIRONMENT` to any value, but [three values](#) are supported by the framework: [Development](#), [Staging](#), and [Production](#). If `ASPNETCORE_ENVIRONMENT` isn't set, it defaults to `Production`.

```
public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
    }

    if (env.IsProduction() || env.IsStaging() || env.IsEnvironment("Staging_2"))
    {
        app.UseExceptionHandler("/Error");
        app.UseHsts();
    }

    app.UseHttpsRedirection();
    app.UseStaticFiles();
    app.UseCookiePolicy();
    app.UseMvc();
}
```

The preceding code:

- Calls [UseDeveloperExceptionPage](#) and [UseBrowserLink](#) when `ASPNETCORE_ENVIRONMENT` is set to `Development`.
- Calls [UseExceptionHandler](#) when the value of `ASPNETCORE_ENVIRONMENT` is set one of the following:
  - `Staging`
  - `Production`
  - `Staging_2`

The [Environment Tag Helper](#) uses the value of `IHostingEnvironment.EnvironmentName` to include or exclude markup in the element:

```

@page
@inject Microsoft.AspNetCore.Hosting.IHostingEnvironment hostingEnv
@model AboutModel
 @{
     ViewData["Title"] = "About";
 }
<h2>@ViewData["Title"]</h2>
<h3>@Model.Message</h3>

<p> ASPNETCORE_ENVIRONMENT = @hostingEnv.EnvironmentName</p>

```

On Windows and macOS, environment variables and values aren't case sensitive. Linux environment variables and values are **case sensitive** by default.

## Development

The development environment can enable features that shouldn't be exposed in production. For example, the ASP.NET Core templates enable the [developer exception page](#) in the development environment.

The environment for local machine development can be set in the *Properties\launchSettings.json* file of the project. Environment values set in *launchSettings.json* override values set in the system environment.

The following JSON shows three profiles from a *launchSettings.json* file:

```
{
  "iisSettings": {
    "windowsAuthentication": false,
    "anonymousAuthentication": true,
    "iisExpress": {
      "applicationUrl": "http://localhost:54339/",
      "sslPort": 0
    }
  },
  "profiles": {
    "IIS Express": {
      "commandName": "IISExpress",
      "launchBrowser": true,
      "environmentVariables": {
        "ASPNETCORE_My_Environment": "1",
        "ASPNETCORE_DETAILEDERRORS": "1",
        "ASPNETCORE_ENVIRONMENT": "Staging"
      }
    },
    "EnvironmentsSample": {
      "commandName": "Project",
      "launchBrowser": true,
      "environmentVariables": {
        "ASPNETCORE_ENVIRONMENT": "Staging"
      },
      "applicationUrl": "http://localhost:54340/"
    },
    "Kestrel Staging": {
      "commandName": "Project",
      "launchBrowser": true,
      "environmentVariables": {
        "ASPNETCORE_My_Environment": "1",
        "ASPNETCORE_DETAILEDERRORS": "1",
        "ASPNETCORE_ENVIRONMENT": "Staging"
      },
      "applicationUrl": "http://localhost:51997/"
    }
  }
}
```

## NOTE

The `applicationUrl` property in `launchSettings.json` can specify a list of server URLs. Use a semicolon between the URLs in the list:

```
"EnvironmentsSample": {  
    "commandName": "Project",  
    "launchBrowser": true,  
    "applicationUrl": "https://localhost:5001;http://localhost:5000",  
    "environmentVariables": {  
        "ASPNETCORE_ENVIRONMENT": "Development"  
    }  
}
```

When the app is launched with `dotnet run`, the first profile with `"commandName": "Project"` is used. The value of `commandName` specifies the web server to launch. `commandName` can be any one of the following:

- IIS Express
- IIS
- Project (which launches Kestrel)

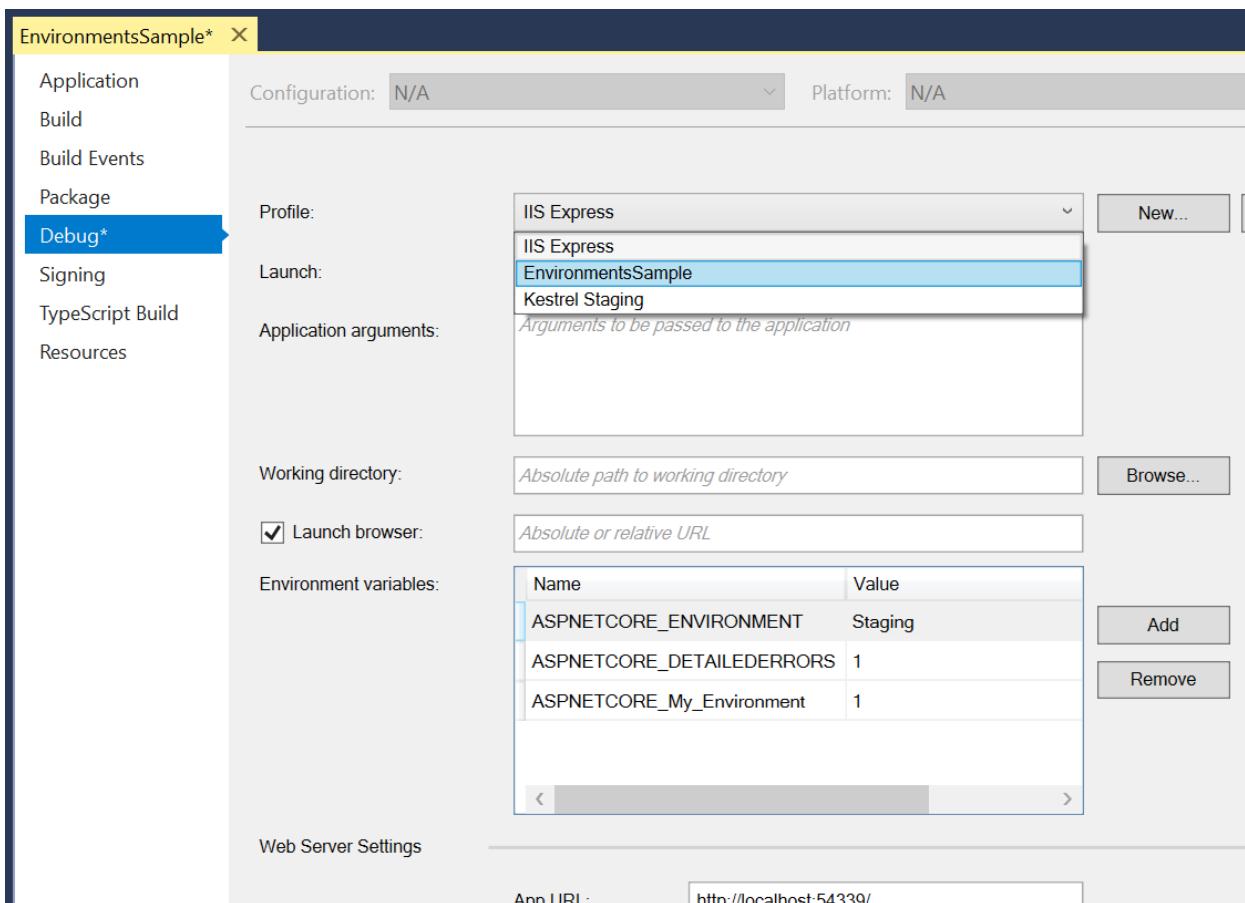
When an app is launched with `dotnet run`:

- `launchSettings.json` is read if available. `environmentVariables` settings in `launchSettings.json` override environment variables.
- The hosting environment is displayed.

The following output shows an app started with `dotnet run`:

```
PS C:\Websites\EnvironmentsSample> dotnet run  
Using launch settings from C:\Websites\EnvironmentsSample\Properties\launchSettings.json...  
Hosting environment: Staging  
Content root path: C:\Websites\EnvironmentsSample  
Now listening on: http://localhost:54340  
Application started. Press Ctrl+C to shut down.
```

The Visual Studio project properties **Debug** tab provides a GUI to edit the `launchSettings.json` file:



### WARNING

*launchSettings.json* shouldn't store secrets. The [Secret Manager tool](#) can be used to store secrets for local development.

When using [Visual Studio Code](#), environment variables can be set in the `.vscode/launch.json` file. The following example sets the environment to `Development`:

```
{  
  "version": "0.2.0",  
  "configurations": [  
    {  
      "name": ".NET Core Launch (web)",  
      ... additional VS Code configuration settings ...  
      "env": {  
        "ASPNETCORE_ENVIRONMENT": "Development"  
      }  
    ]  
}
```

A `.vscode/launch.json` file in the project isn't read when starting the app with `dotnet run` in the same way as `Properties/launchSettings.json`. When launching an app in development that doesn't have a `launchSettings.json` file, either set the environment with an environment variable or a command-line argument to the `dotnet run` command.

### Production

The production environment should be configured to maximize security, performance, and app robustness. Some common settings that differ from development include:

- Caching.
- Client-side resources are bundled, minified, and potentially served from a CDN.
- Diagnostic error pages disabled.
- Friendly error pages enabled.
- Production logging and monitoring enabled. For example, [Application Insights](#).

## Set the environment

It's often useful to set a specific environment for testing. If the environment isn't set, it defaults to `Production`, which disables most debugging features. The method for setting the environment depends on the operating system.

### Azure App Service

To set the environment in [Azure App Service](#), perform the following steps:

1. Select the app from the **App Services** blade.
2. In the **SETTINGS** group, select the **Application settings** blade.
3. In the **Application settings** area, select **Add new setting**.
4. For **Enter a name**, provide `ASPNETCORE_ENVIRONMENT`. For **Enter a value**, provide the environment (for example, `staging`).
5. Select the **Slot Setting** check box if you wish the environment setting to remain with the current slot when deployment slots are swapped. For more information, see [Azure Documentation: Which settings are swapped?](#).
6. Select **Save** at the top of the blade.

Azure App Service automatically restarts the app after an app setting (environment variable) is added, changed, or deleted in the Azure portal.

### Windows

To set the `ASPNETCORE_ENVIRONMENT` for the current session when the app is started using `dotnet run`, the following commands are used:

#### Command prompt

```
set ASPNETCORE_ENVIRONMENT=Development
```

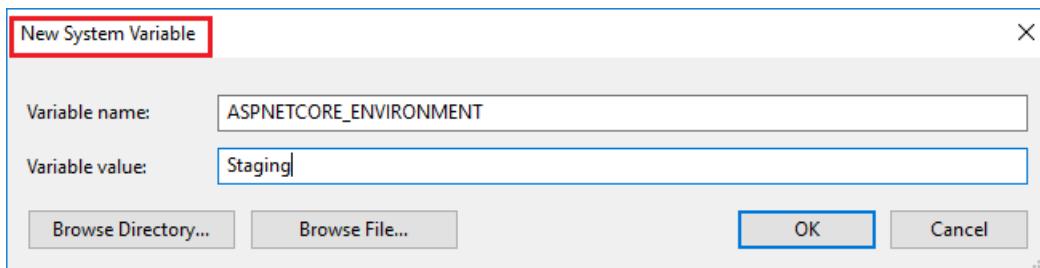
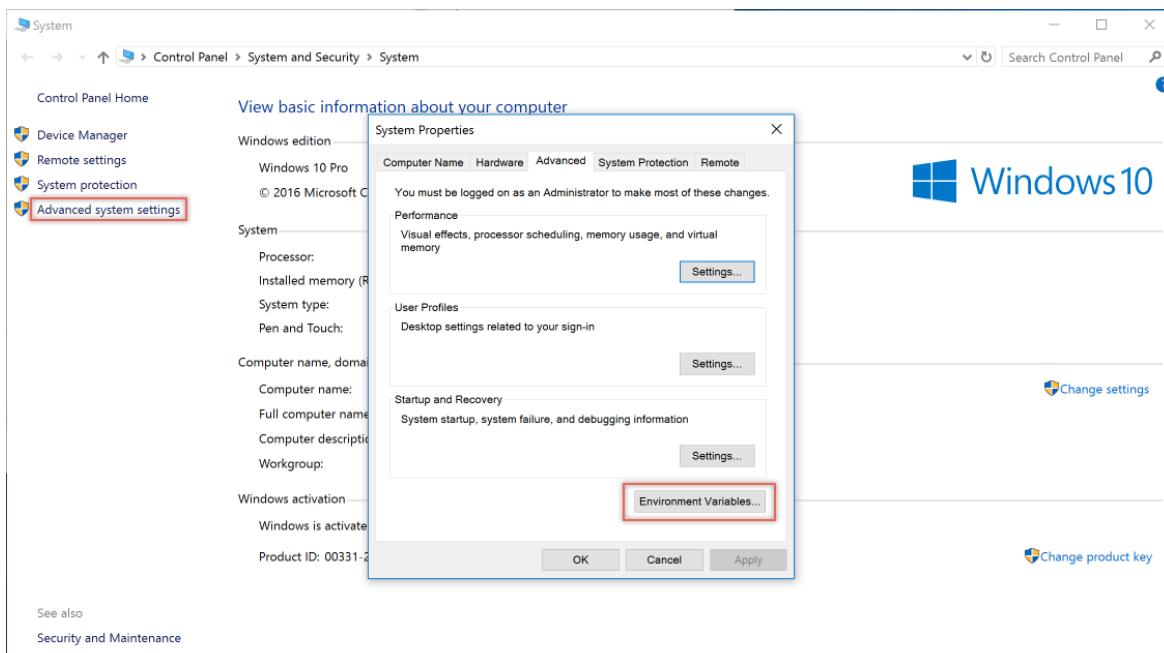
#### PowerShell

```
$Env:ASPNETCORE_ENVIRONMENT = "Development"
```

These commands only take effect for the current window. When the window is closed, the `ASPNETCORE_ENVIRONMENT` setting reverts to the default setting or machine value.

To set the value globally in Windows, use either of the following approaches:

- Open the **Control Panel > System > Advanced system settings** and add or edit the `ASPNETCORE_ENVIRONMENT` value:



- Open an administrative command prompt and use the `setx` command or open an administrative PowerShell command prompt and use `[Environment]::SetEnvironmentVariable`:

### Command prompt

```
setx ASPNETCORE_ENVIRONMENT=Development /M
```

The `/M` switch indicates to set the environment variable at the system level. If the `/M` switch isn't used, the environment variable is set for the user account.

### PowerShell

```
[Environment]::SetEnvironmentVariable("ASPNETCORE_ENVIRONMENT", "Development", "Machine")
```

The `Machine` option value indicates to set the environment variable at the system level. If the option value is changed to `user`, the environment variable is set for the user account.

When the `ASPNETCORE_ENVIRONMENT` environment variable is set globally, it takes effect for `dotnet run` in any command window opened after the value is set.

### web.config

To set the `ASPNETCORE_ENVIRONMENT` environment variable with `web.config`, see the *Setting environment variables* section of [ASP.NET Core Module configuration reference](#). When the `ASPNETCORE_ENVIRONMENT` environment variable is set with `web.config`, its value overrides a setting at the system level.

### Per IIS Application Pool

To set the `ASPNETCORE_ENVIRONMENT` environment variable for an app running in an isolated Application Pool

(supported on IIS 10.0 or later), see the [AppCmd.exe command](#) section of the [Environment Variables <environmentVariables>](#) topic. When the `ASPNETCORE_ENVIRONMENT` environment variable is set for an app pool, its value overrides a setting at the system level.

### IMPORTANT

When hosting an app in IIS and adding or changing the `ASPNETCORE_ENVIRONMENT` environment variable, use any one of the following approaches to have the new value picked up by apps:

- Restart an app's app pool.
- Execute `net stop was /y` followed by `net start w3svc` from a command prompt.
- Restart the server.

## macOS

Setting the current environment for macOS can be performed in-line when running the app:

```
ASPNETCORE_ENVIRONMENT=Development dotnet run
```

Alternatively, set the environment with `export` prior to running the app:

```
export ASPNETCORE_ENVIRONMENT=Development
```

Machine-level environment variables are set in the `.bashrc` or `.bash_profile` file. Edit the file using any text editor. Add the following statement:

```
export ASPNETCORE_ENVIRONMENT=Development
```

## Linux

For Linux distros, use the `export` command at a command prompt for session-based variable settings and `bash_profile` file for machine-level environment settings.

### Configuration by environment

See the *Configuration by environment* section of [Configuration in ASP.NET Core](#).

## Environment-based Startup class and methods

### Startup class conventions

When an ASP.NET Core app starts, the [Startup class](#) bootstraps the app. The app can define separate `Startup` classes for different environments (for example, `StartupDevelopment`), and the appropriate `Startup` class is selected at runtime. The class whose name suffix matches the current environment is prioritized. If a matching `Startup{EnvironmentName}` class isn't found, the `Startup` class is used.

To implement environment-based `Startup` classes, create a `Startup{EnvironmentName}` class for each environment in use and a fallback `Startup` class:

```

// Startup class to use in the Development environment
public class StartupDevelopment
{
    public void ConfigureServices(IServiceCollection services)
    {
        ...
    }

    public void Configure(IApplicationBuilder app, IHostingEnvironment env)
    {
        ...
    }
}

// Startup class to use in the Production environment
public class StartupProduction
{
    public void ConfigureServices(IServiceCollection services)
    {
        ...
    }

    public void Configure(IApplicationBuilder app, IHostingEnvironment env)
    {
        ...
    }
}

// Fallback Startup class
// Selected if the environment doesn't match a Startup{EnvironmentName} class
public class Startup
{
    public void ConfigureServices(IServiceCollection services)
    {
        ...
    }

    public void Configure(IApplicationBuilder app, IHostingEnvironment env)
    {
        ...
    }
}

```

Use the [UseStartup\(IWebHostBuilder, String\)](#) overload that accepts an assembly name:

```

public static void Main(string[] args)
{
    CreateWebHostBuilder(args).Build().Run();
}

public static IWebHostBuilder CreateWebHostBuilder(string[] args)
{
    var assemblyName = typeof(Startup).GetTypeInfo().Assembly.FullName;

    return WebHost.CreateDefaultBuilder(args)
        .UseStartup(assemblyName);
}

```

```
public static void Main(string[] args)
{
CreateWebHost(args).Run();
}

public static IWebHost CreateWebHost(string[] args)
{
var assemblyName = typeof(Startup).GetTypeInfo().Assembly.FullName;

return WebHost.CreateDefaultBuilder(args)
.UseStartup(assemblyName)
.Build();
}
```

```
public class Program
{
public static void Main(string[] args)
{
var assemblyName = typeof(Startup).GetTypeInfo().Assembly.FullName;

var host = new WebHostBuilder()
.UseStartup(assemblyName)
.Build();

host.Run();
}
}
```

## Startup method conventions

[Configure](#) and [ConfigureServices](#) support environment-specific versions of the form

`Configure<EnvironmentName>` and `Configure<EnvironmentName>Services` :

```
public class Startup
{
    public Startup(IConfiguration configuration)
    {
        Configuration = configuration;
    }

    public IConfiguration Configuration { get; }

    public void ConfigureServices(IServiceCollection services)
    {
        StartupConfigureServices(services);
    }

    public void ConfigureStagingServices(IServiceCollection services)
    {
        StartupConfigureServices(services);
    }

    private void StartupConfigureServices(IServiceCollection services)
    {
        services.Configure<CookiePolicyOptions>(options =>
        {
            options.CheckConsentNeeded = context => true;
            options.MinimumSameSitePolicy = SameSiteMode.None;
        });

        services.AddMvc()
            .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
    }

    public void Configure(IApplicationBuilder app, IHostingEnvironment env)
    {
        if (env.IsDevelopment())
        {
            app.UseDeveloperExceptionPage();
        }

        if (env.IsProduction() || env.IsStaging() || env.IsEnvironment("Staging_2"))
        {
            app.UseExceptionHandler("/Error");
            app.UseHsts();
        }

        app.UseHttpsRedirection();
        app.UseStaticFiles();
        app.UseCookiePolicy();
        app.UseMvc();
    }

    public void ConfigureStaging(IApplicationBuilder app, IHostingEnvironment env)
    {
        if (!env.IsStaging())
        {
            throw new Exception("Not staging.");
        }

        app.UseExceptionHandler("/Error");
        app.UseHsts();
        app.UseHttpsRedirection();
        app.UseStaticFiles();
        app.UseCookiePolicy();
        app.UseMvc();
    }
}
```

## Additional resources

- [Application startup in ASP.NET Core](#)
- [Configuration in ASP.NET Core](#)
- [IHostingEnvironment.EnvironmentName](#)

# Configuration in ASP.NET Core

6/21/2018 • 15 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [Mark Michaelis](#), [Steve Smith](#), [Daniel Roth](#), and [Luke Latham](#)

The Configuration API provides a way to configure an ASP.NET Core web app based on a list of name-value pairs. Configuration is read at runtime from multiple sources. Name-value pairs can be grouped into a multi-level hierarchy.

There are configuration providers for:

- File formats (INI, JSON, and XML).
- Command-line arguments.
- Environment variables.
- In-memory .NET objects.
- The unencrypted [Secret Manager](#) storage.
- An encrypted user store, such as [Azure Key Vault](#).
- Custom providers (installed or created).

Each configuration value maps to a string key. There's built-in binding support to deserialize settings into a custom [POCO](#) object (a simple .NET class with properties).

The options pattern uses options classes to represent groups of related settings. For more information on using the options pattern, see the [Options](#) topic.

[View or download sample code](#) ([how to download](#))

## JSON configuration

The following console app uses the JSON configuration provider:

```

using System;
using System.IO;
// Requires NuGet package
// Microsoft.Extensions.Configuration.Json
using Microsoft.Extensions.Configuration;

public class Program
{
    public static IConfiguration Configuration { get; set; }

    public static void Main(string[] args = null)
    {
        var builder = new ConfigurationBuilder()
            .SetBasePath(Directory.GetCurrentDirectory())
            .AddJsonFile("appsettings.json");

        Configuration = builder.Build();

        Console.WriteLine($"option1 = {Configuration["Option1"]}");
        Console.WriteLine($"option2 = {Configuration["option2"]}");
        Console.WriteLine(
            $"suboption1 = {Configuration["subsection:suboption1"]}");
        Console.WriteLine();

        Console.WriteLine("Wizards:");
        Console.Write($"{Configuration["wizards:0:Name"]}, ");
        Console.WriteLine($"{Configuration["wizards:0:Age"]}");
        Console.Write($"{Configuration["wizards:1:Name"]}, ");
        Console.WriteLine($"{Configuration["wizards:1:Age"]}");
        Console.WriteLine();

        Console.WriteLine("Press a key...");
        Console.ReadKey();
    }
}

```

The app reads and displays the following configuration settings:

```
{
    "option1": "value1_from_json",
    "option2": 2,

    "subsection": {
        "suboption1": "subvalue1_from_json"
    },
    "wizards": [
        {
            "Name": "Gandalf",
            "Age": "1000"
        },
        {
            "Name": "Harry",
            "Age": "17"
        }
    ]
}
```

Configuration consists of a hierarchical list of name-value pairs in which the nodes are separated by a colon ( `:` ). To retrieve a value, access the `Configuration` indexer with the corresponding item's key:

```
Console.WriteLine(
    $"suboption1 = {Configuration["subsection:suboption1"]});
```

To work with arrays in JSON-formatted configuration sources, use an array index as part of the colon-separated string. The following example gets the name of the first item in the preceding `wizards` array:

```
Console.WriteLine(Configuration["wizards:0:Name"]);
// Output: Gandalf
```

Name-value pairs written to the built-in [Configuration](#) providers are **not** persisted. However, a custom provider that saves values can be created. See [custom configuration provider](#).

The preceding sample uses the configuration indexer to read values. To access configuration outside of `Startup`, use the *options pattern*. For more information, see the [Options](#) topic.

## XML configuration

To work with arrays in XML-formatted configuration sources, provide a `name` index to each element. Use the index to access the values:

```
<wizards>
  <wizard name="Gandalf">
    <age>1000</age>
  </wizard>
  <wizard name="Harry">
    <age>17</age>
  </wizard>
</wizards>
```

```
Console.WriteLine(Configuration["wizard:Harry:age"]);
// Output: 17
```

## Configuration by environment

It's typical to have different configuration settings for different environments, for example, development, testing, and production. The `CreateDefaultBuilder` extension method in an ASP.NET Core 2.x app (or using `AddJsonFile` and `AddEnvironmentVariables` directly in an ASP.NET Core 1.x app) adds configuration providers for reading JSON files and system configuration sources:

- `appsettings.json`
- `appsettings.<EnvironmentName>.json`
- Environment variables

ASP.NET Core 1.x apps need to call `AddJsonFile` and `AddEnvironmentVariables`.

See [AddJsonFile](#) for an explanation of the parameters. `reloadOnChange` is only supported in ASP.NET Core 1.1 and later.

Configuration sources are read in the order that they're specified. In the preceding code, the environment variables are read last. Any configuration values set through the environment replace those set in the two previous providers.

Consider the following `appsettings.Staging.json` file:

```
{
    "Logging": {
        "IncludeScopes": false,
        "LogLevel": {
            "System": "Information",
            "Microsoft": "Information"
        }
    },
    "MyConfig": "My Config Value for staging."
}
```

In the following code, `Configure` reads the value of `MyConfig`:

```
public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    var myConfig = Configuration["MyConfig"];
    // use myConfig
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
        app.UseBrowserLink();
    }

    if (env.IsProduction() || env.IsStaging())
    {
        app.UseExceptionHandler("/Error");
    }

    app.UseStaticFiles();
    app.UseMvcWithDefaultRoute();
}
```

The environment is typically set to `Development`, `Staging`, or `Production`. For more information, see [Use multiple environments](#).

Configuration considerations:

- [IOptionsSnapshot](#) can reload configuration data when it changes.
- Configuration keys are **not** case-sensitive.
- **Never** store passwords or other sensitive data in configuration provider code or in plain text configuration files. Don't use production secrets in development or test environments. Specify secrets outside of the project so that they can't be accidentally committed to a source code repository. Learn more about [how to use multiple environments](#) and managing [safe storage of app secrets in development](#).
- For hierarchical config values specified in environment variables, a colon (`:`) may not work on all platforms. Double underscore (`__`) is supported by all platforms.
- When interacting with the configuration API, a colon (`:`) works on all platforms.

## In-memory provider and binding to a POCO class

The following sample shows how to use the in-memory provider and bind to a class:

```

using System;
using System.Collections.Generic;
using Microsoft.Extensions.Configuration;

public class Program
{
    public static IConfiguration Configuration { get; set; }

    public static void Main(string[] args = null)
    {
        var dict = new Dictionary<string, string>
        {
            {"Profile:MachineName", "Rick"},
            {"App:MainWindow:Height", "11"},
            {"App:MainWindow:Width", "11"},
            {"App:MainWindow:Top", "11"},
            {"App:MainWindow:Left", "11"}
        };
        var builder = new ConfigurationBuilder();
        builder.AddInMemoryCollection(dict);

        Configuration = builder.Build();

        Console.WriteLine($"Hello {Configuration["Profile:MachineName"]}");

        var window = new MyWindow();
        // Bind requires NuGet package
        // Microsoft.Extensions.Configuration.Binder
        Configuration.GetSection("App:MainWindow").Bind(window);
        Console.WriteLine($"Left {window.Left}");
        Console.WriteLine();

        Console.WriteLine("Press any key...");
        Console.ReadKey();
    }
}

public class MyWindow
{
    public int Height { get; set; }
    public int Width { get; set; }
    public int Top { get; set; }
    public int Left { get; set; }
}

```

Configuration values are returned as strings, but binding enables the construction of objects. Binding allows the retrieval of POCO objects or even entire object graphs.

## GetValue

The following sample demonstrates the `GetValue<T>` extension method:

```

using System;
using System.Collections.Generic;
using Microsoft.Extensions.Configuration;

public class Program
{
    public static IConfiguration Configuration { get; set; }

    public static void Main(string[] args = null)
    {
        var dict = new Dictionary<string, string>
        {
            {"Profile:MachineName", "Rick"},
            {"App:MainWindow:Height", "11"},
            {"App:MainWindow:Width", "11"},
            {"App:MainWindow:Top", "11"},
            {"App:MainWindow:Left", "11"}
        };
    }

    var builder = new ConfigurationBuilder();
    builder.AddInMemoryCollection(dict);

    Configuration = builder.Build();

    Console.WriteLine($"Hello {Configuration["Profile:MachineName"]}");

    // Show GetValue overload and set the default value to 80
    // Requires NuGet package "Microsoft.Extensions.Configuration.Binder"
    var left = Configuration.GetValue<int>("App:MainWindow:Left", 80);
    Console.WriteLine($"Left {left}");

    var window = new MyWindow();
    Configuration.GetSection("App:MainWindow").Bind(window);
    Console.WriteLine($"Left {window.Left}");
    Console.WriteLine();

    Console.WriteLine("Press a key...");
    Console.ReadKey();
}
}

public class MyWindow
{
    public int Height { get; set; }
    public int Width { get; set; }
    public int Top { get; set; }
    public int Left { get; set; }
}

```

The ConfigurationBinder's `GetValue<T>` method allows the specification of a default value (80 in the sample). `GetValue<T>` is for simple scenarios and doesn't bind to entire sections. `GetValue<T>` obtains scalar values from `GetSection(key).Value` converted to a specific type.

## Bind to an object graph

Each object in a class can be recursively bound. Consider the following `AppSettings` class:

```

public class AppSettings
{
    public Window Window { get; set; }
    public Connection Connection { get; set; }
    public Profile Profile { get; set; }
}

public class Window
{
    public int Height { get; set; }
    public int Width { get; set; }
}

public class Connection
{
    public string Value { get; set; }
}

public class Profile
{
    public string Machine { get; set; }
}

```

The following sample binds to the `AppSettings` class:

```

using System;
using System.IO;
using Microsoft.Extensions.Configuration;

public class Program
{
    public static void Main(string[] args = null)
    {
        var builder = new ConfigurationBuilder()
            .SetBasePath(Directory.GetCurrentDirectory())
            .AddJsonFile("appsettings.json");

        var config = builder.Build();

        var appConfig = new AppSettings();
        config.GetSection("App").Bind(appConfig);

        Console.WriteLine($"Height {appConfig.Window.Height}");
        Console.WriteLine();

        Console.WriteLine("Press a key...");
        Console.ReadKey();
    }
}

```

**ASP.NET Core 1.1** and higher can use `Get<T>`, which works with entire sections. `Get<T>` can be more convenient than using `Bind`. The following code shows how to use `Get<T>` with the preceding sample:

```
var appConfig = config.GetSection("App").Get<AppSettings>();
```

Using the following `appsettings.json` file:

```
{
    "App": {
        "Profile": {
            "Machine": "Rick"
        },
        "Connection": {
            "Value": "connectionstring"
        },
        "Window": {
            "Height": "11",
            "Width": "11"
        }
    }
}
```

The program displays `Height 11`.

The following code can be used to unit test the configuration:

```
[Fact]
public void CanBindObjectTree()
{
    var dict = new Dictionary<string, string>
    {
        {"App:Profile:Machine", "Rick"},
        {"App:Connection:Value", "connectionstring"},
        {"App:Window:Height", "11"},
        {"App:Window:Width", "11"}
    };
    var builder = new ConfigurationBuilder();
    builder.AddInMemoryCollection(dict);
    var config = builder.Build();

    var settings = new AppSettings();
    config.GetSection("App").Bind(settings);

    Assert.Equal("Rick", settings.Profile.Machine);
    Assert.Equal(11, settings.Window.Height);
    Assert.Equal(11, settings.Window.Width);
    Assert.Equal("connectionstring", settings.Connection.Value);
}
```

## Create an Entity Framework custom provider

In this section, a basic configuration provider that reads name-value pairs from a database using EF is created.

Define a `ConfigurationValue` entity for storing configuration values in the database:

```
public class ConfigurationValue
{
    public string Id { get; set; }
    public string Value { get; set; }
}
```

Add a `ConfigurationContext` to store and access the configured values:

```
public class ConfigurationContext : DbContext
{
    public ConfigurationContext(DbContextOptions options) : base(options)
    {
    }

    public DbSet<ConfigurationValue> Values { get; set; }
}
```

Create a class that implements [IConfigurationSource](#):

```
using System;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.Configuration;

namespace CustomConfigurationProvider
{
    public class EFConfigSource : IConfigurationSource
    {
        private readonly Action<DbContextOptionsBuilder> _optionsAction;

        public EFConfigSource(Action<DbContextOptionsBuilder> optionsAction)
        {
            _optionsAction = optionsAction;
        }

        public IConfigurationProvider Build(IConfigurationBuilder builder)
        {
            return new EFConfigProvider(_optionsAction);
        }
    }
}
```

Create the custom configuration provider by inheriting from [ConfigurationProvider](#). The configuration provider initializes the database when it's empty:

```

using System;
using System.Collections.Generic;
using System.Linq;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.Configuration;

namespace CustomConfigurationProvider
{
    public class EFConfigProvider : ConfigurationProvider
    {
        public EFConfigProvider(Action<DbContextOptionsBuilder> optionsAction)
        {
            OptionsAction = optionsAction;
        }

        Action<DbContextOptionsBuilder> OptionsAction { get; }

        // Load config data from EF DB.
        public override void Load()
        {
            var builder = new DbContextOptionsBuilder<ConfigurationContext>();
            OptionsAction(builder);

            using (var dbContext = new ConfigurationContext(builder.Options))
            {
                dbContext.Database.EnsureCreated();
                Data = !dbContext.Values.Any()
                    ? CreateAndSaveDefaultValues(dbContext)
                    : dbContext.Values.ToDictionary(c => c.Id, c => c.Value);
            }
        }

        private static IDictionary<string, string> CreateAndSaveDefaultValues(
            ConfigurationContext dbContext)
        {
            var configValues = new Dictionary<string, string>
            {
                { "key1", "value_from_ef_1" },
                { "key2", "value_from_ef_2" }
            };
            dbContext.Values.AddRange(configValues
                .Select(kvp => new ConfigurationValue { Id = kvp.Key, Value = kvp.Value })
                .ToArray());
            dbContext.SaveChanges();
            return configValues;
        }
    }
}

```

The highlighted values from the database ("value\_from\_ef\_1" and "value\_from\_ef\_2") are displayed when the sample is run.

An `EFConfigSource` extension method for adding the configuration source can be used:

```

using System;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.Configuration;

namespace CustomConfigurationProvider
{
    public static class EntityFrameworkExtensions
    {
        public static IConfigurationBuilder AddEntityFrameworkConfig(
            this IConfigurationBuilder builder, Action<DbContextOptionsBuilder> setup)
        {
            return builder.Add(new EFConfigSource(setup));
        }
    }
}

```

The following code shows how to use the custom `EFConfigProvider`:

```

using System;
using System.IO;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.Configuration;
using CustomConfigurationProvider;

public static class Program
{
    public static void Main()
    {
        var builder = new ConfigurationBuilder()
            .SetBasePath(Directory.GetCurrentDirectory())
            .AddJsonFile("appsettings.json");

        var connectionStringConfig = builder.Build();

        var config = new ConfigurationBuilder()
            .SetBasePath(Directory.GetCurrentDirectory())
            // Add "appsettings.json" to bootstrap EF config.
            .AddJsonFile("appsettings.json")
            // Add the EF configuration provider, which will override any
            // config made with the JSON provider.
            .AddEntityFrameworkConfig(options =>
                options.UseSqlServer(connectionStringConfig.GetConnectionString(
                    "DefaultConnection"))
            )
            .Build();

        Console.WriteLine("key1={0}", config["key1"]);
        Console.WriteLine("key2={0}", config["key2"]);
        Console.WriteLine("key3={0}", config["key3"]);
        Console.WriteLine();

        Console.WriteLine("Press a key...");
        Console.ReadKey();
    }
}

```

Note the sample adds the custom `EFConfigProvider` after the JSON provider, so any settings from the database will override settings from the `appsettings.json` file.

Using the following `appsettings.json` file:

```
{  
    "ConnectionStrings": {  
        "DefaultConnection": "Server=  
        (localdb)\\mssqllocaldb;Database=CustomConfigurationProvider;Trusted_Connection=True;MultipleActiveResultSets=t  
        rue"  
    },  
    "key1": "value_from_json_1",  
    "key2": "value_from_json_2",  
    "key3": "value_from_json_3"  
}
```

The following output is displayed:

```
key1=value_from_ef_1  
key2=value_from_ef_2  
key3=value_from_json_3
```

## CommandLine configuration provider

The [CommandLine configuration provider](#) receives command-line argument key-value pairs for configuration at runtime.

[View or download the CommandLine configuration sample](#)

### Setup and use the CommandLine configuration provider

- [Basic Configuration](#)
- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

To activate command-line configuration, call the `AddCommandLine` extension method on an instance of `ConfigurationBuilder`:

```

using System;
using System.Collections.Generic;
using System.Linq;
using Microsoft.Extensions.Configuration;

public class Program
{
    public static IConfiguration Configuration { get; set; }

    public static void Main(string[] args = null)
    {
        var dict = new Dictionary<string, string>
        {
            {"Profile:MachineName", "MairaPC"},
            {"App:MainWindow:Left", "1980"}
        };

        var builder = new ConfigurationBuilder();

        builder.AddInMemoryCollection(dict)
            .AddCommandLine(args);

        Configuration = builder.Build();

        Console.WriteLine($"MachineName: {Configuration["Profile:MachineName"]}");
        Console.WriteLine($"Left: {Configuration["App:MainWindow:Left"]}");
        Console.WriteLine();

        Console.WriteLine("Press a key...");
        Console.ReadKey();
    }
}

```

Running the code, the following output is displayed:

```

MachineName: MairaPC
Left: 1980

```

Passing argument key-value pairs on the command line changes the values of `Profile:MachineName` and `App:MainWindow:Left`:

```
dotnet run Profile:MachineName=BartPC App:MainWindow:Left=1979
```

The console window displays:

```

MachineName: BartPC
Left: 1979

```

To override configuration provided by other configuration providers with command-line configuration, call `AddCommandLine` last on `ConfigurationBuilder`:

```

var config = new ConfigurationBuilder()
    .SetBasePath(Directory.GetCurrentDirectory())
    .AddJsonFile("appsettings.json", optional: true, reloadOnChange: true)
    .AddEnvironmentVariables()
    .AddCommandLine(args)
    .Build();

```

## Arguments

Arguments passed on the command line must conform to one of two formats shown in the following table:

ARGUMENT FORMAT	EXAMPLE
Single argument: a key-value pair separated by an equals sign ( <code>=</code> )	<code>key1=value</code>
Sequence of two arguments: a key-value pair separated by a space	<code>/key1 value1</code>

### Single argument

The value must follow an equals sign (`=`). The value can be null (for example, `mykey=`).

The key may have a prefix.

KEY PREFIX	EXAMPLE
No prefix	<code>key1=value1</code>
Single dash ( <code>-</code> ) <sup>†</sup>	<code>-key2=value2</code>
Two dashes ( <code>--</code> )	<code>--key3=value3</code>
Forward slash ( <code>/</code> )	<code>/key4=value4</code>

<sup>†</sup>A key with a single dash prefix (`-`) must be provided in [switch mappings](#), described below.

Example command:

```
dotnet run key1=value1 -key2=value2 --key3=value3 /key4=value4
```

Note: If `-key2` isn't present in the [switch mappings](#) given to the configuration provider, a `FormatException` is thrown.

### Sequence of two arguments

The value can't be null and must follow the key separated by a space.

The key must have a prefix.

KEY PREFIX	EXAMPLE
Single dash ( <code>-</code> ) <sup>†</sup>	<code>-key1 value1</code>
Two dashes ( <code>--</code> )	<code>--key2 value2</code>
Forward slash ( <code>/</code> )	<code>/key3 value3</code>

<sup>†</sup>A key with a single dash prefix (`-`) must be provided in [switch mappings](#), described below.

Example command:

```
dotnet run -key1 value1 --key2 value2 /key3 value3
```

Note: If `-key1` isn't present in the [switch mappings](#) given to the configuration provider, a `FormatException` is thrown.

## Duplicate keys

If duplicate keys are provided, the last key-value pair is used.

## Switch mappings

When manually building configuration with `ConfigurationBuilder`, a switch mappings dictionary can be added to the `AddCommandLine` method. Switch mappings allow key name replacement logic.

When the switch mappings dictionary is used, the dictionary is checked for a key that matches the key provided by a command-line argument. If the command-line key is found in the dictionary, the dictionary value (the key replacement) is passed back to set the configuration. A switch mapping is required for any command-line key prefixed with a single dash (`-`).

Switch mappings dictionary key rules:

- Switches must start with a dash (`-`) or double-dash (`--`).
- The switch mappings dictionary must not contain duplicate keys.

In the following example, the `GetSwitchMappings` method allows command-line arguments to use a single dash (`-`) key prefix and avoid leading subkey prefixes.

```

using System;
using System.Collections.Generic;
using System.Linq;
using Microsoft.Extensions.Configuration;

public class Program
{
    public static IConfiguration Configuration { get; set; }

    public static Dictionary<string, string> GetSwitchMappings(
        IReadOnlyDictionary<string, string> configurationStrings)
    {
        return configurationStrings.Select(item =>
            new KeyValuePair<string, string>(
                "-" + item.Key.Substring(item.Key.LastIndexOf(':') + 1),
                item.Key))
            .ToDictionary(
                item => item.Key, item => item.Value);
    }

    public static void Main(string[] args = null)
    {
        var dict = new Dictionary<string, string>
        {
            {"Profile:MachineName", "RickPC"},
            {"App:MainWindow:Left", "1980"}
        };

        var builder = new ConfigurationBuilder();

        builder.AddInMemoryCollection(dict)
            .AddCommandLine(args, GetSwitchMappings(dict));

        Configuration = builder.Build();

        Console.WriteLine($"MachineName: {Configuration["Profile:MachineName"]}");
        Console.WriteLine($"Left: {Configuration["App:MainWindow:Left"]}");
        Console.WriteLine();

        Console.WriteLine("Press a key...");
        Console.ReadKey();
    }
}

```

Without providing command-line arguments, the dictionary provided to `AddInMemoryCollection` sets the configuration values. Run the app with the following command:

```
dotnet run
```

The console window displays:

```
MachineName: RickPC
Left: 1980
```

Use the following to pass in configuration settings:

```
dotnet run /Profile:MachineName=DahliaPC /App:MainWindow:Left=1984
```

The console window displays:

```
MachineName: DahliaPC
Left: 1984
```

After the switch mappings dictionary is created, it contains the data shown in the following table:

KEY	VALUE
-MachineName	Profile:MachineName
-Left	App:MainWindow:Left

To demonstrate key switching using the dictionary, run the following command:

```
dotnet run -MachineName=ChadPC -Left=1988
```

The command-line keys are swapped. The console window displays the configuration values for `Profile:MachineName` and `App:MainWindow:Left`:

```
MachineName: ChadPC
Left: 1988
```

## web.config file

A `web.config` file is required when hosting the app in IIS or IIS Express. Settings in `web.config` enable the [ASP.NET Core Module](#) to launch the app and configure other IIS settings and modules. If the `web.config` file isn't present and the project file includes `<Project Sdk="Microsoft.NET.Sdk.Web">`, publishing the project creates a `web.config` file in the published output (the *publish* folder). For more information, see [Host ASP.NET Core on Windows with IIS](#).

## Access configuration during startup

To access configuration within `ConfigureServices` or `Configure` during startup, see the examples in the [Application startup](#) topic.

## Adding configuration from an external assembly

An [IHostingStartup](#) implementation allows adding enhancements to an app at startup from an external assembly outside of the app's `Startup` class. For more information, see [Enhance an app from an external assembly](#).

## Access configuration in a Razor Page or MVC view

To access configuration settings in a Razor Pages page or an MVC view, add a [using directive \(C# reference: using directive\)](#) for the [Microsoft.Extensions.Configuration namespace](#) and inject  [IConfiguration](#) into the page or view.

In a Razor Pages page:

```

@page
@model IndexModel

@using Microsoft.Extensions.Configuration
@inject IConfiguration Configuration

<!DOCTYPE html>
<html lang="en">
<head>
    <title>Index Page</title>
</head>
<body>
    <h1>Access configuration in a Razor Pages page</h1>
    <p>Configuration["key"]:</p>
</body>
</html>

```

In an MVC view:

```

@using Microsoft.Extensions.Configuration
@inject IConfiguration Configuration

<!DOCTYPE html>
<html lang="en">
<head>
    <title>Index View</title>
</head>
<body>
    <h1>Access configuration in an MVC view</h1>
    <p>Configuration["key"]:</p>
</body>
</html>

```

## Additional notes

- Dependency Injection (DI) isn't set up until after `ConfigureServices` is invoked.
- The configuration system isn't DI aware.
- `IConfiguration` has two specializations:
  - `IConfigurationRoot` Used for the root node. Can trigger a reload.
  - `IConfigurationSection` Represents a section of configuration values. The `GetSection` and `GetChildren` methods return an `IConfigurationSection`.
  - Use `IConfigurationRoot` when reloading configuration or for access to each provider. Neither of these situations are common.

## Additional resources

- [Options](#)
- [Use multiple environments](#)
- [Safe storage of app secrets in development](#)
- [Host in ASP.NET Core](#)
- [Dependency Injection](#)
- [Azure Key Vault configuration provider](#)

# Configuration in ASP.NET Core

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The Configuration API provides a way to configure an ASP.NET Core web app based on a list of name-value pairs. Configuration is read at runtime from multiple sources. Name-value pairs can be grouped into a multi-level hierarchy.

There are configuration providers for:

- File formats (INI, JSON, and XML).
- Command-line arguments.
- Environment variables.
- In-memory .NET objects.
- The unencrypted [Secret Manager](#) storage.
- An encrypted user store, such as [Azure Key Vault](#).
- Custom providers (installed or created).

Each configuration value maps to a string key. There's built-in binding support to deserialize settings into a custom [POCO](#) object (a simple .NET class with properties).

The options pattern uses options classes to represent groups of related settings. For more information on using the options pattern, see the [Options](#) topic.

[View or download sample code \(how to download\)](#)

## JSON configuration

The following console app uses the JSON configuration provider:

```

using System;
using System.IO;
// Requires NuGet package
// Microsoft.Extensions.Configuration.Json
using Microsoft.Extensions.Configuration;

public class Program
{
    public static IConfiguration Configuration { get; set; }

    public static void Main(string[] args = null)
    {
        var builder = new ConfigurationBuilder()
            .SetBasePath(Directory.GetCurrentDirectory())
            .AddJsonFile("appsettings.json");

        Configuration = builder.Build();

        Console.WriteLine($"option1 = {Configuration["Option1"]}");
        Console.WriteLine($"option2 = {Configuration["option2"]}");
        Console.WriteLine(
            $"suboption1 = {Configuration["subsection:suboption1"]}");
        Console.WriteLine();

        Console.WriteLine("Wizards:");
        Console.Write($"{Configuration["wizards:0:Name"]}, ");
        Console.WriteLine($"{Configuration["wizards:0:Age"]}");
        Console.Write($"{Configuration["wizards:1:Name"]}, ");
        Console.WriteLine($"{Configuration["wizards:1:Age"]}");
        Console.WriteLine();

        Console.WriteLine("Press a key...");
        Console.ReadKey();
    }
}

```

The app reads and displays the following configuration settings:

```
{
    "option1": "value1_from_json",
    "option2": 2,

    "subsection": {
        "suboption1": "subvalue1_from_json"
    },
    "wizards": [
        {
            "Name": "Gandalf",
            "Age": "1000"
        },
        {
            "Name": "Harry",
            "Age": "17"
        }
    ]
}
```

Configuration consists of a hierarchical list of name-value pairs in which the nodes are separated by a colon ( : ). To retrieve a value, access the `Configuration` indexer with the corresponding item's key:

```

Console.WriteLine(
    $"suboption1 = {Configuration["subsection:suboption1"]}");

```

To work with arrays in JSON-formatted configuration sources, use an array index as part of the colon-separated string. The following example gets the name of the first item in the preceding `wizards` array:

```
Console.WriteLine("${Configuration["wizards:0:Name"]}");
// Output: Gandalf
```

Name-value pairs written to the built-in [Configuration](#) providers are **not** persisted. However, a custom provider that saves values can be created. See [custom configuration provider](#).

The preceding sample uses the configuration indexer to read values. To access configuration outside of `Startup`, use the *options pattern*. For more information, see the [Options](#) topic.

## XML configuration

To work with arrays in XML-formatted configuration sources, provide a `name` index to each element. Use the index to access the values:

```
<wizards>
  <wizard name="Gandalf">
    <age>1000</age>
  </wizard>
  <wizard name="Harry">
    <age>17</age>
  </wizard>
</wizards>
```

```
Console.WriteLine("${Configuration["wizard:Harry:age"]}");
// Output: 17
```

## Configuration by environment

It's typical to have different configuration settings for different environments, for example, development, testing, and production. The `createDefaultBuilder` extension method in an ASP.NET Core 2.x app (or using `AddJsonFile` and `AddEnvironmentVariables` directly in an ASP.NET Core 1.x app) adds configuration providers for reading JSON files and system configuration sources:

- `appsettings.json`
- `appsettings.<EnvironmentName>.json`
- Environment variables

ASP.NET Core 1.x apps need to call `AddJsonFile` and [AddEnvironmentVariables](#).

See [AddJsonFile](#) for an explanation of the parameters. `reloadOnChange` is only supported in ASP.NET Core 1.1 and later.

Configuration sources are read in the order that they're specified. In the preceding code, the environment variables are read last. Any configuration values set through the environment replace those set in the two previous providers.

Consider the following `appsettings.Staging.json` file:

```
{
    "Logging": {
        "IncludeScopes": false,
        "LogLevel": {
            "System": "Information",
            "Microsoft": "Information"
        }
    },
    "MyConfig": "My Config Value for staging."
}
```

In the following code, `Configure` reads the value of `MyConfig`:

```
public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    var myConfig = Configuration["MyConfig"];
    // use myConfig
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
        app.UseBrowserLink();
    }

    if (env.IsProduction() || env.IsStaging())
    {
        app.UseExceptionHandler("/Error");
    }

    app.UseStaticFiles();
    app.UseMvcWithDefaultRoute();
}
```

The environment is typically set to `Development`, `Staging`, or `Production`. For more information, see [Use multiple environments](#).

Configuration considerations:

- [IOptionsSnapshot](#) can reload configuration data when it changes.
- Configuration keys are **not** case-sensitive.
- **Never** store passwords or other sensitive data in configuration provider code or in plain text configuration files. Don't use production secrets in development or test environments. Specify secrets outside of the project so that they can't be accidentally committed to a source code repository. Learn more about [how to use multiple environments](#) and managing [safe storage of app secrets in development](#).
- For hierarchical config values specified in environment variables, a colon (`:`) may not work on all platforms. Double underscore (`__`) is supported by all platforms.
- When interacting with the configuration API, a colon (`:`) works on all platforms.

## In-memory provider and binding to a POCO class

The following sample shows how to use the in-memory provider and bind to a class:

```

using System;
using System.Collections.Generic;
using Microsoft.Extensions.Configuration;

public class Program
{
    public static IConfiguration Configuration { get; set; }

    public static void Main(string[] args = null)
    {
        var dict = new Dictionary<string, string>
        {
            {"Profile:MachineName", "Rick"},
            {"App:MainWindow:Height", "11"},
            {"App:MainWindow:Width", "11"},
            {"App:MainWindow:Top", "11"},
            {"App:MainWindow:Left", "11"}
        };
    }

    var builder = new ConfigurationBuilder();
    builder.AddInMemoryCollection(dict);

    Configuration = builder.Build();

    Console.WriteLine($"Hello {Configuration["Profile:MachineName"]}");

    var window = new MyWindow();
    // Bind requires NuGet package
    // Microsoft.Extensions.Configuration.Binder
    Configuration.GetSection("App:MainWindow").Bind(window);
    Console.WriteLine($"Left {window.Left}");
    Console.WriteLine();

    Console.WriteLine("Press any key...");
    Console.ReadKey();
}
}

public class MyWindow
{
    public int Height { get; set; }
    public int Width { get; set; }
    public int Top { get; set; }
    public int Left { get; set; }
}

```

Configuration values are returned as strings, but binding enables the construction of objects. Binding allows the retrieval of POCO objects or even entire object graphs.

## GetValue

The following sample demonstrates the `GetValue<T>` extension method:

```

using System;
using System.Collections.Generic;
using Microsoft.Extensions.Configuration;

public class Program
{
    public static IConfiguration Configuration { get; set; }

    public static void Main(string[] args = null)
    {
        var dict = new Dictionary<string, string>
        {
            {"Profile:MachineName", "Rick"},
            {"App:MainWindow:Height", "11"},
            {"App:MainWindow:Width", "11"},
            {"App:MainWindow:Top", "11"},
            {"App:MainWindow:Left", "11"}
        };
    }

    var builder = new ConfigurationBuilder();
    builder.AddInMemoryCollection(dict);

    Configuration = builder.Build();

    Console.WriteLine($"Hello {Configuration["Profile:MachineName"]}");

    // Show GetValue overload and set the default value to 80
    // Requires NuGet package "Microsoft.Extensions.Configuration.Binder"
    var left = Configuration.GetValue<int>("App:MainWindow:Left", 80);
    Console.WriteLine($"Left {left}");

    var window = new MyWindow();
    Configuration.GetSection("App:MainWindow").Bind(window);
    Console.WriteLine($"Left {window.Left}");
    Console.WriteLine();

    Console.WriteLine("Press a key...");
    Console.ReadKey();
}
}

public class MyWindow
{
    public int Height { get; set; }
    public int Width { get; set; }
    public int Top { get; set; }
    public int Left { get; set; }
}

```

The ConfigurationBinder's `GetValue<T>` method allows the specification of a default value (80 in the sample). `GetValue<T>` is for simple scenarios and doesn't bind to entire sections. `GetValue<T>` obtains scalar values from `GetSection(key).Value` converted to a specific type.

## Bind to an object graph

Each object in a class can be recursively bound. Consider the following `AppSettings` class:

```

public class AppSettings
{
    public Window Window { get; set; }
    public Connection Connection { get; set; }
    public Profile Profile { get; set; }
}

public class Window
{
    public int Height { get; set; }
    public int Width { get; set; }
}

public class Connection
{
    public string Value { get; set; }
}

public class Profile
{
    public string Machine { get; set; }
}

```

The following sample binds to the `AppSettings` class:

```

using System;
using System.IO;
using Microsoft.Extensions.Configuration;

public class Program
{
    public static void Main(string[] args = null)
    {
        var builder = new ConfigurationBuilder()
            .SetBasePath(Directory.GetCurrentDirectory())
            .AddJsonFile("appsettings.json");

        var config = builder.Build();

        var appConfig = new AppSettings();
        config.GetSection("App").Bind(appConfig);

        Console.WriteLine($"Height {appConfig.Window.Height}");
        Console.WriteLine();

        Console.WriteLine("Press a key...");
        Console.ReadKey();
    }
}

```

**ASP.NET Core 1.1** and higher can use `Get<T>`, which works with entire sections. `Get<T>` can be more convenient than using `Bind`. The following code shows how to use `Get<T>` with the preceding sample:

```
var appConfig = config.GetSection("App").Get<AppSettings>();
```

Using the following `appsettings.json` file:

```
{
    "App": {
        "Profile": {
            "Machine": "Rick"
        },
        "Connection": {
            "Value": "connectionstring"
        },
        "Window": {
            "Height": "11",
            "Width": "11"
        }
    }
}
```

The program displays `Height 11`.

The following code can be used to unit test the configuration:

```
[Fact]
public void CanBindObjectTree()
{
    var dict = new Dictionary<string, string>
    {
        {"App:Profile:Machine", "Rick"},
        {"App:Connection:Value", "connectionstring"},
        {"App:Window:Height", "11"},
        {"App:Window:Width", "11"}
    };
    var builder = new ConfigurationBuilder();
    builder.AddInMemoryCollection(dict);
    var config = builder.Build();

    var settings = new AppSettings();
    config.GetSection("App").Bind(settings);

    Assert.Equal("Rick", settings.Profile.Machine);
    Assert.Equal(11, settings.Window.Height);
    Assert.Equal(11, settings.Window.Width);
    Assert.Equal("connectionstring", settings.Connection.Value);
}
```

## Create an Entity Framework custom provider

In this section, a basic configuration provider that reads name-value pairs from a database using EF is created.

Define a `ConfigurationValue` entity for storing configuration values in the database:

```
public class ConfigurationValue
{
    public string Id { get; set; }
    public string Value { get; set; }
}
```

Add a `ConfigurationContext` to store and access the configured values:

```
public class ConfigurationContext : DbContext
{
    public ConfigurationContext(DbContextOptions options) : base(options)
    {
    }

    public DbSet<ConfigurationValue> Values { get; set; }
}
```

Create a class that implements [IConfigurationSource](#):

```
using System;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.Configuration;

namespace CustomConfigurationProvider
{
    public class EFConfigSource : IConfigurationSource
    {
        private readonly Action<DbContextOptionsBuilder> _optionsAction;

        public EFConfigSource(Action<DbContextOptionsBuilder> optionsAction)
        {
            _optionsAction = optionsAction;
        }

        public IConfigurationProvider Build(IConfigurationBuilder builder)
        {
            return new EFConfigProvider(_optionsAction);
        }
    }
}
```

Create the custom configuration provider by inheriting from [ConfigurationProvider](#). The configuration provider initializes the database when it's empty:

```

using System;
using System.Collections.Generic;
using System.Linq;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.Configuration;

namespace CustomConfigurationProvider
{
    public class EFConfigProvider : ConfigurationProvider
    {
        public EFConfigProvider(Action<DbContextOptionsBuilder> optionsAction)
        {
            OptionsAction = optionsAction;
        }

        Action<DbContextOptionsBuilder> OptionsAction { get; }

        // Load config data from EF DB.
        public override void Load()
        {
            var builder = new DbContextOptionsBuilder<ConfigurationContext>();
            OptionsAction(builder);

            using (var dbContext = new ConfigurationContext(builder.Options))
            {
                dbContext.Database.EnsureCreated();
                Data = !dbContext.Values.Any()
                    ? CreateAndSaveDefaultValues(dbContext)
                    : dbContext.Values.ToDictionary(c => c.Id, c => c.Value);
            }
        }

        private static IDictionary<string, string> CreateAndSaveDefaultValues(
            ConfigurationContext dbContext)
        {
            var configValues = new Dictionary<string, string>
            {
                { "key1", "value_from_ef_1" },
                { "key2", "value_from_ef_2" }
            };
            dbContext.Values.AddRange(configValues
                .Select(kvp => new ConfigurationValue { Id = kvp.Key, Value = kvp.Value })
                .ToArray());
            dbContext.SaveChanges();
            return configValues;
        }
    }
}

```

The highlighted values from the database ("value\_from\_ef\_1" and "value\_from\_ef\_2") are displayed when the sample is run.

An `EFConfigSource` extension method for adding the configuration source can be used:

```

using System;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.Configuration;

namespace CustomConfigurationProvider
{
    public static class EntityFrameworkExtensions
    {
        public static IConfigurationBuilder AddEntityFrameworkConfig(
            this IConfigurationBuilder builder, Action<DbContextOptionsBuilder> setup)
        {
            return builder.Add(new EFConfigSource(setup));
        }
    }
}

```

The following code shows how to use the custom `EFConfigProvider`:

```

using System;
using System.IO;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.Configuration;
using CustomConfigurationProvider;

public static class Program
{
    public static void Main()
    {
        var builder = new ConfigurationBuilder()
            .SetBasePath(Directory.GetCurrentDirectory())
            .AddJsonFile("appsettings.json");

        var connectionStringConfig = builder.Build();

        var config = new ConfigurationBuilder()
            .SetBasePath(Directory.GetCurrentDirectory())
            // Add "appsettings.json" to bootstrap EF config.
            .AddJsonFile("appsettings.json")
            // Add the EF configuration provider, which will override any
            // config made with the JSON provider.
            .AddEntityFrameworkConfig(options =>
                options.UseSqlServer(connectionStringConfig.GetConnectionString(
                    "DefaultConnection"))
            )
            .Build();

        Console.WriteLine("key1={0}", config["key1"]);
        Console.WriteLine("key2={0}", config["key2"]);
        Console.WriteLine("key3={0}", config["key3"]);
        Console.WriteLine();

        Console.WriteLine("Press a key...");
        Console.ReadKey();
    }
}

```

Note the sample adds the custom `EFConfigProvider` after the JSON provider, so any settings from the database will override settings from the `appsettings.json` file.

Using the following `appsettings.json` file:

```
{  
    "ConnectionStrings": {  
        "DefaultConnection": "Server=localdb\\mssqllocaldb;Database=CustomConfigurationProvider;Trusted_Connection=True;MultipleActiveResultSets=true"  
    },  
    "key1": "value_from_ef_1",  
    "key2": "value_from_ef_2",  
    "key3": "value_from_json_3"  
}
```

The following output is displayed:

```
key1=value_from_ef_1  
key2=value_from_ef_2  
key3=value_from_json_3
```

## CommandLine configuration provider

The [CommandLine configuration provider](#) receives command-line argument key-value pairs for configuration at runtime.

[View or download the CommandLine configuration sample](#)

### Setup and use the CommandLine configuration provider

- [Basic Configuration](#)
- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

To activate command-line configuration, call the `AddCommandLine` extension method on an instance of `ConfigurationBuilder`:

```

using System;
using System.Collections.Generic;
using System.Linq;
using Microsoft.Extensions.Configuration;

public class Program
{
    public static IConfiguration Configuration { get; set; }

    public static void Main(string[] args = null)
    {
        var dict = new Dictionary<string, string>
        {
            {"Profile:MachineName", "MairaPC"},
            {"App:MainWindow:Left", "1980"}
        };

        var builder = new ConfigurationBuilder();

        builder.AddInMemoryCollection(dict)
            .AddCommandLine(args);

        Configuration = builder.Build();

        Console.WriteLine($"MachineName: {Configuration["Profile:MachineName"]}");
        Console.WriteLine($"Left: {Configuration["App:MainWindow:Left"]}");
        Console.WriteLine();

        Console.WriteLine("Press a key...");
        Console.ReadKey();
    }
}

```

Running the code, the following output is displayed:

```

MachineName: MairaPC
Left: 1980

```

Passing argument key-value pairs on the command line changes the values of `Profile:MachineName` and `App:MainWindow:Left`:

```

dotnet run Profile:MachineName=BartPC App:MainWindow:Left=1979

```

The console window displays:

```

MachineName: BartPC
Left: 1979

```

To override configuration provided by other configuration providers with command-line configuration, call `AddCommandLine` last on `ConfigurationBuilder`:

```

var config = new ConfigurationBuilder()
    .SetBasePath(Directory.GetCurrentDirectory())
    .AddJsonFile("appsettings.json", optional: true, reloadOnChange: true)
    .AddEnvironmentVariables()
    .AddCommandLine(args)
    .Build();

```

## Arguments

Arguments passed on the command line must conform to one of two formats shown in the following table:

ARGUMENT FORMAT	EXAMPLE
Single argument: a key-value pair separated by an equals sign ( = )	key1=value
Sequence of two arguments: a key-value pair separated by a space	/key1 value1

### Single argument

The value must follow an equals sign ( = ). The value can be null (for example, mykey= ).

The key may have a prefix.

KEY PREFIX	EXAMPLE
No prefix	key1=value1
Single dash ( - )†	-key2=value2
Two dashes ( -- )	--key3=value3
Forward slash ( / )	/key4=value4

†A key with a single dash prefix ( - ) must be provided in [switch mappings](#), described below.

Example command:

```
dotnet run key1=value1 -key2=value2 --key3=value3 /key4=value4
```

Note: If -key2 isn't present in the [switch mappings](#) given to the configuration provider, a [FormatException](#) is thrown.

### Sequence of two arguments

The value can't be null and must follow the key separated by a space.

The key must have a prefix.

KEY PREFIX	EXAMPLE
Single dash ( - )†	-key1 value1
Two dashes ( -- )	--key2 value2
Forward slash ( / )	/key3 value3

†A key with a single dash prefix ( - ) must be provided in [switch mappings](#), described below.

Example command:

```
dotnet run -key1 value1 --key2 value2 /key3 value3
```

Note: If `-key1` isn't present in the [switch mappings](#) given to the configuration provider, a [FormatException](#) is thrown.

## Duplicate keys

If duplicate keys are provided, the last key-value pair is used.

## Switch mappings

When manually building configuration with [ConfigurationBuilder](#), a switch mappings dictionary can be added to the [AddCommandLine](#) method. Switch mappings allow key name replacement logic.

When the switch mappings dictionary is used, the dictionary is checked for a key that matches the key provided by a command-line argument. If the command-line key is found in the dictionary, the dictionary value (the key replacement) is passed back to set the configuration. A switch mapping is required for any command-line key prefixed with a single dash (`-`).

Switch mappings dictionary key rules:

- Switches must start with a dash (`-`) or double-dash (`--`).
- The switch mappings dictionary must not contain duplicate keys.

In the following example, the [GetSwitchMappings](#) method allows command-line arguments to use a single dash (`-`) key prefix and avoid leading subkey prefixes.

```

using System;
using System.Collections.Generic;
using System.Linq;
using Microsoft.Extensions.Configuration;

public class Program
{
    public static IConfiguration Configuration { get; set; }

    public static Dictionary<string, string> GetSwitchMappings(
        IReadOnlyDictionary<string, string> configurationStrings)
    {
        return configurationStrings.Select(item =>
            new KeyValuePair<string, string>(
                "-" + item.Key.Substring(item.Key.LastIndexOf(':') + 1),
                item.Key))
            .ToDictionary(
                item => item.Key, item => item.Value);
    }

    public static void Main(string[] args = null)
    {
        var dict = new Dictionary<string, string>
        {
            {"Profile:MachineName", "RickPC"},
            {"App:MainWindow:Left", "1980"}
        };

        var builder = new ConfigurationBuilder();

        builder.AddInMemoryCollection(dict)
            .AddCommandLine(args, GetSwitchMappings(dict));

        Configuration = builder.Build();

        Console.WriteLine($"MachineName: {Configuration["Profile:MachineName"]}");
        Console.WriteLine($"Left: {Configuration["App:MainWindow:Left"]}");
        Console.WriteLine();

        Console.WriteLine("Press a key...");
        Console.ReadKey();
    }
}

```

Without providing command-line arguments, the dictionary provided to `AddInMemoryCollection` sets the configuration values. Run the app with the following command:

```
dotnet run
```

The console window displays:

```
MachineName: RickPC
Left: 1980
```

Use the following to pass in configuration settings:

```
dotnet run /Profile:MachineName=DahliaPC /App:MainWindow:Left=1984
```

The console window displays:

```
MachineName: DahliaPC
Left: 1984
```

After the switch mappings dictionary is created, it contains the data shown in the following table:

KEY	VALUE
-MachineName	Profile:MachineName
-Left	App:MainWindow:Left

To demonstrate key switching using the dictionary, run the following command:

```
dotnet run -MachineName=ChadPC -Left=1988
```

The command-line keys are swapped. The console window displays the configuration values for `Profile:MachineName` and `App:MainWindow:Left`:

```
MachineName: ChadPC
Left: 1988
```

## web.config file

A `web.config` file is required when hosting the app in IIS or IIS Express. Settings in `web.config` enable the [ASP.NET Core Module](#) to launch the app and configure other IIS settings and modules. If the `web.config` file isn't present and the project file includes `<Project Sdk="Microsoft.NET.Sdk.Web">`, publishing the project creates a `web.config` file in the published output (the `publish` folder). For more information, see [Host ASP.NET Core on Windows with IIS](#).

## Access configuration during startup

To access configuration within `ConfigureServices` or `Configure` during startup, see the examples in the [Application startup](#) topic.

## Adding configuration from an external assembly

An [IHostingStartup](#) implementation allows adding enhancements to an app at startup from an external assembly outside of the app's `Startup` class. For more information, see [Enhance an app from an external assembly](#).

## Access configuration in a Razor Page or MVC view

To access configuration settings in a Razor Pages page or an MVC view, add a [using directive \(C# reference: using directive\)](#) for the [Microsoft.Extensions.Configuration](#) namespace and inject `IConfiguration` into the page or view.

In a Razor Pages page:

```

@page
@model IndexModel

@using Microsoft.Extensions.Configuration
@inject IConfiguration Configuration

<!DOCTYPE html>
<html lang="en">
<head>
    <title>Index Page</title>
</head>
<body>
    <h1>Access configuration in a Razor Pages page</h1>
    <p>Configuration["key"]: @Configuration["key"]</p>
</body>
</html>

```

In an MVC view:

```

@using Microsoft.Extensions.Configuration
@inject IConfiguration Configuration

<!DOCTYPE html>
<html lang="en">
<head>
    <title>Index View</title>
</head>
<body>
    <h1>Access configuration in an MVC view</h1>
    <p>Configuration["key"]: @Configuration["key"]</p>
</body>
</html>

```

## Additional notes

- Dependency Injection (DI) isn't set up until after `ConfigureServices` is invoked.
- The configuration system isn't DI aware.
- `IConfiguration` has two specializations:
  - `IConfigurationRoot` Used for the root node. Can trigger a reload.
  - `IConfigurationSection` Represents a section of configuration values. The `GetSection` and `GetChildren` methods return an `IConfigurationSection`.
- Use `IConfigurationRoot` when reloading configuration or for access to each provider. Neither of these situations are common.

## Additional resources

- [Options](#)
- [Use multiple environments](#)
- [Safe storage of app secrets in development](#)
- [Host in ASP.NET Core](#)
- [Dependency Injection](#)
- [Azure Key Vault configuration provider](#)

# Options pattern in ASP.NET Core

7/11/2018 • 10 minutes to read • [Edit Online](#)

By [Luke Latham](#)

The options pattern uses classes to represent groups of related settings. When configuration settings are isolated by feature into separate classes, the app adheres to two important software engineering principles:

- The [Interface Segregation Principle \(ISP\)](#): Features (classes) that depend on configuration settings depend only on the configuration settings that they use.
- [Separation of Concerns](#): Settings for different parts of the app aren't dependent or coupled to one another.

[View or download sample code \(how to download\)](#) This article is easier to follow with the sample app.

## Basic options configuration

Basic options configuration is demonstrated as Example #1 in the [sample app](#).

An options class must be non-abstract with a public parameterless constructor. The following class, `MyOptions`, has two properties, `Option1` and `Option2`. Setting default values is optional, but the class constructor in the following example sets the default value of `option1`. `Option2` has a default value set by initializing the property directly (*Models/MyOptions.cs*):

```
public class MyOptions
{
    public MyOptions()
    {
        // Set default value.
        Option1 = "value1_from_ctor";
    }

    public string Option1 { get; set; }
    public int Option2 { get; set; } = 5;
}
```

The `MyOptions` class is added to the service container with `Configure<TOptions>(IServiceCollection, IConfiguration)` and bound to configuration:

```
// Example #1: Basic options
// Register the Configuration instance which MyOptions binds against.
services.Configure<MyOptions>(Configuration);
```

The following page model uses [constructor dependency injection](#) with `IOptions<TOptions>` to access the settings (*Pages/Index.cshtml.cs*):

```
private readonly MyOptions _options;
```

```
public IndexModel(
    IOptions<MyOptions> optionsAccessor,
    IOptions<MyOptionsWithDelegateConfig> optionsAccessorWithDelegateConfig,
    IOptions<MySubOptions> subOptionsAccessor,
    IOptionsSnapshot<MyOptions> snapshotOptionsAccessor,
    IOptionsSnapshot<MyOptions> namedOptionsAccessor)
{
    _options = optionsAccessor.Value;
    _optionsWithDelegateConfig = optionsAccessorWithDelegateConfig.Value;
    _subOptions = subOptionsAccessor.Value;
    _snapshotOptions = snapshotOptionsAccessor.Value;
    _named_options_1 = namedOptionsAccessor.Get("named_options_1");
    _named_options_2 = namedOptionsAccessor.Get("named_options_2");
}
```

```
// Example #1: Simple options
var option1 = _options.Option1;
var option2 = _options.Option2;
SimpleOptions = $"option1 = {option1}, option2 = {option2}";
```

The sample's `appsettings.json` file specifies values for `option1` and `option2`:

```
{
    "option1": "value1_from_json",
    "option2": -1,
    "subsection": {
        "suboption1": "subvalue1_from_json",
        "suboption2": 200
    },
    "Logging": {
        "LogLevel": {
            "Default": "Warning"
        }
    },
    "AllowedHosts": "*"
}
```

When the app is run, the page model's `OnGet` method returns a string showing the option class values:

```
option1 = value1_from_json, option2 = -1
```

#### NOTE

When using a custom [ConfigurationBuilder](#) to load options configuration from a settings file, confirm that the base path is set correctly:

```
var configBuilder = new ConfigurationBuilder()
    .SetBasePath(Directory.GetCurrentDirectory())
    .AddJsonFile("appsettings.json", optional: true);
var config = configBuilder.Build();

services.Configure<MyOptions>(config);
```

Explicitly setting the base path isn't required when loading options configuration from the settings file via [CreateDefaultBuilder](#).

## Configure simple options with a delegate

Configuring simple options with a delegate is demonstrated as Example #2 in the [sample app](#).

Use a delegate to set options values. The sample app uses the `MyOptionsWithDelegateConfig` class (`Models/MyOptionsWithDelegateConfig.cs`):

```
public class MyOptionsWithDelegateConfig
{
    public MyOptionsWithDelegateConfig()
    {
        // Set default value.
        Option1 = "value1_from_ctor";
    }

    public string Option1 { get; set; }
    public int Option2 { get; set; } = 5;
}
```

In the following code, a second `IConfigureOptions<TOptions>` service is added to the service container. It uses a delegate to configure the binding with `MyOptionsWithDelegateConfig`:

```
// Example #2: Options bound and configured by a delegate
services.Configure<MyOptionsWithDelegateConfig>(myOptions =>
{
    myOptions.Option1 = "value1_configured_by_delegate";
    myOptions.Option2 = 500;
});
```

*Index.cshtml.cs:*

```
private readonly MyOptionsWithDelegateConfig _optionsWithDelegateConfig;
```

```
public IndexModel(
    IOptions<MyOptions> optionsAccessor,
    IOptions<MyOptionsWithDelegateConfig> optionsAccessorWithDelegateConfig,
    IOptions<MySubOptions> subOptionsAccessor,
    IOptionsSnapshot<MyOptions> snapshotOptionsAccessor,
    IOptionsSnapshot<MyOptions> namedOptionsAccessor)
{
    _options = optionsAccessor.Value;
    _optionsWithDelegateConfig = optionsAccessorWithDelegateConfig.Value;
    _subOptions = subOptionsAccessor.Value;
    _snapshotOptions = snapshotOptionsAccessor.Value;
    _named_options_1 = namedOptionsAccessor.Get("named_options_1");
    _named_options_2 = namedOptionsAccessor.Get("named_options_2");
}
```

```
// Example #2: Options configured by delegate
var delegate_config_option1 = _optionsWithDelegateConfig.Option1;
var delegate_config_option2 = _optionsWithDelegateConfig.Option2;
SimpleOptionsWithDelegateConfig =
    $"delegate_option1 = {delegate_config_option1}, " +
    $"delegate_option2 = {delegate_config_option2}";
```

You can add multiple configuration providers. Configuration providers are available in NuGet packages. They're applied in order that they're registered.

Each call to `Configure<TOptions>` adds an `IConfigureOptions<TOptions>` service to the service container. In the preceding example, the values of `option1` and `option2` are both specified in `appsettings.json`, but the values of

`Option1` and `Option2` are overridden by the configured delegate.

When more than one configuration service is enabled, the last configuration source specified `wins` and sets the configuration value. When the app is run, the page model's `OnGet` method returns a string showing the option class values:

```
delegate_option1 = value1_configured_by_delegate, delegate_option2 = 500
```

## Suboptions configuration

Suboptions configuration is demonstrated as Example #3 in the [sample app](#).

Apps should create options classes that pertain to specific feature groups (classes) in the app. Parts of the app that require configuration values should only have access to the configuration values that they use.

When binding options to configuration, each property in the options type is bound to a configuration key of the form `property[:sub-property:]`. For example, the `MyOptions.Option1` property is bound to the key `Option1`, which is read from the `option1` property in `appsettings.json`.

In the following code, a third `IConfigureOptions<TOptions>` service is added to the service container. It binds `MySubOptions` to the section `subsection` of the `appsettings.json` file:

```
// Example #3: Sub-options
// Bind options using a sub-section of the appsettings.json file.
services.Configure<MySubOptions>(Configuration.GetSection("subsection"));
```

The `GetSection` extension method requires the [Microsoft.Extensions.Options.ConfigurationExtensions](#) NuGet package. If the app uses the [Microsoft.AspNetCore.App metapackage](#) (ASP.NET Core 2.1 or later), the package is automatically included.

The sample's `appsettings.json` file defines a `subsection` member with keys for `suboption1` and `suboption2`:

```
{
  "option1": "value1_from_json",
  "option2": -1,
  "subsection": {
    "suboption1": "subvalue1_from_json",
    "suboption2": 200
  },
  "Logging": {
    "LogLevel": {
      "Default": "Warning"
    }
  },
  "AllowedHosts": "*"
}
```

The `MySubOptions` class defines properties, `SubOption1` and `SubOption2`, to hold the sub-option values (`Models/MySubOptions.cs`):

```

public class MySubOptions
{
    public MySubOptions()
    {
        // Set default values.
        SubOption1 = "value1_from_ctor";
        SubOption2 = 5;
    }

    public string SubOption1 { get; set; }
    public int SubOption2 { get; set; }
}

```

The page model's `OnGet` method returns a string with the sub-option values (*Pages/Index.cshtml.cs*):

```
private readonly MySubOptions _subOptions;
```

```

public IndexModel(
    IOptions<MyOptions> optionsAccessor,
    IOptions<MyOptionsWithDelegateConfig> optionsAccessorWithDelegateConfig,
    IOptions<MySubOptions> subOptionsAccessor,
    IOptionsSnapshot<MyOptions> snapshotOptionsAccessor,
    IOptionsSnapshot<MyOptions> namedOptionsAccessor)
{
    _options = optionsAccessor.Value;
    _optionsWithDelegateConfig = optionsAccessorWithDelegateConfig.Value;
    _subOptions = subOptionsAccessor.Value;
    _snapshotOptions = snapshotOptionsAccessor.Value;
    _named_options_1 = namedOptionsAccessor.Get("named_options_1");
    _named_options_2 = namedOptionsAccessor.Get("named_options_2");
}

```

```

// Example #3: Sub-options
var subOption1 = _subOptions.SubOption1;
var subOption2 = _subOptions.SubOption2;
SubOptions = $"subOption1 = {subOption1}, subOption2 = {subOption2}";

```

When the app is run, the `OnGet` method returns a string showing the sub-option class values:

```
subOption1 = subvalue1_from_json, subOption2 = 200
```

## Options provided by a view model or with direct view injection

Options provided by a view model or with direct view injection is demonstrated as Example #4 in the [sample app](#).

Options can be supplied in a view model or by injecting `IOptions<TOptions>` directly into a view (*Pages/Index.cshtml.cs*):

```
private readonly MyOptions _options;
```

```
public IndexModel(
    IOptions<MyOptions> optionsAccessor,
    IOptions<MyOptionsWithDelegateConfig> optionsAccessorWithDelegateConfig,
    IOptions<MySubOptions> subOptionsAccessor,
    IOptionsSnapshot<MyOptions> snapshotOptionsAccessor,
    IOptionsSnapshot<MyOptions> namedOptionsAccessor)
{
    _options = optionsAccessor.Value;
    _optionsWithDelegateConfig = optionsAccessorWithDelegateConfig.Value;
    _subOptions = subOptionsAccessor.Value;
    _snapshotOptions = snapshotOptionsAccessor.Value;
    _named_options_1 = namedOptionsAccessor.Get("named_options_1");
    _named_options_2 = namedOptionsAccessor.Get("named_options_2");
}
```

```
// Example #4: Bind options directly to the page
MyOptions = _options;
```

For direct injection, inject `IOptions<MyOptions>` with an `@inject` directive:

```
@page
@model IndexModel
@using Microsoft.Extensions.Options
@using UsingOptionsSample.Models
@inject IOptions<MyOptions> OptionsAccessor
 @{
    ViewData["Title"] = "Using Options Sample";
}

<h1>@ViewData["Title"]</h1>
```

When the app is run, the option values are shown in the rendered page:

#### Example #4: Model and injected options

##### Options provided by the model

Options provided by the model: `@Model.MyOptions.Option1` and `@Model.MyOptions.Option2`

**Option1:** value1\_from\_json

**Option2:** -1

##### Options injected into the page

Options injected into the page: `@inject IOptions<MyOptions> OptionsAccessor` with `@OptionsAccessor.Value.Option1` and `@OptionsAccessor.Value.Option2`

**Option1:** value1\_from\_json

**Option2:** -1

## Reload configuration data with `IOptionsSnapshot`

Reloading configuration data with `IOptionsSnapshot` is demonstrated in Example #5 in the [sample app](#).

`IOptionsSnapshot` supports reloading options with minimal processing overhead.

Options are computed once per request when accessed and cached for the lifetime of the request.

`IOptionsSnapshot` is a snapshot of `IOptionsMonitor<TOptions>` and updates automatically whenever the monitor triggers changes based on the data source changing.

The following example demonstrates how a new `IOptionsSnapshot` is created after `appsettings.json` changes (`Pages/Index.cshtml.cs`). Multiple requests to the server return constant values provided by the `appsettings.json` file until the file is changed and configuration reloads.

```
private readonly MyOptions _snapshotOptions;

public IndexModel(
    IOptions<MyOptions> optionsAccessor,
    IOptions<MyOptionsWithDelegateConfig> optionsAccessorWithDelegateConfig,
    IOptions<MySubOptions> subOptionsAccessor,
    IOptionsSnapshot<MyOptions> snapshotOptionsAccessor,
    IOptionsSnapshot<MyOptions> namedOptionsAccessor)
{
    _options = optionsAccessor.Value;
    _optionsWithDelegateConfig = optionsAccessorWithDelegateConfig.Value;
    _subOptions = subOptionsAccessor.Value;
    _snapshotOptions = snapshotOptionsAccessor.Value;
    _named_options_1 = namedOptionsAccessor.Get("named_options_1");
    _named_options_2 = namedOptionsAccessor.Get("named_options_2");
}

// Example #5: Snapshot options
var snapshotOption1 = _snapshotOptions.Option1;
var snapshotOption2 = _snapshotOptions.Option2;
SnapshotOptions =
    $"snapshot option1 = {snapshotOption1}, " +
    $"snapshot option2 = {snapshotOption2}";
```

The following image shows the initial `option1` and `option2` values loaded from the `appsettings.json` file:

```
snapshot option1 = value1_from_json, snapshot option2 = -1
```

Change the values in the `appsettings.json` file to `value1_from_json UPDATED` and `200`. Save the `appsettings.json` file. Refresh the browser to see that the options values are updated:

```
snapshot option1 = value1_from_json UPDATED, snapshot option2 = 200
```

## Named options support with `IConfigureNamedOptions`

Named options support with `IConfigureNamedOptions` is demonstrated as Example #6 in the [sample app](#).

*Named options* support allows the app to distinguish between named options configurations. In the sample app, named options are declared with the `OptionsServiceCollectionExtensions.Configure<TOptions>(IServiceCollection, String, Action<TOptions>)` which in turn calls the extension method `ConfigureNamedOptions<TOptions>.Configure` method:

```

// Example #6: Named options (named_options_1)
// Register the ConfigurationBuilder instance which MyOptions binds against.
// Specify that the options loaded from configuration are named
// "named_options_1".
services.Configure<MyOptions>("named_options_1", Configuration);

// Example #6: Named options (named_options_2)
// Specify that the options loaded from the MyOptions class are named
// "named_options_2".
// Use a delegate to configure option values.
services.Configure<MyOptions>("named_options_2", myOptions =>
{
    myOptions.Option1 = "named_options_2_value1_from_action";
});

```

The sample app accesses the named options with [IOptionsSnapshot<TOptions>.Get \(Pages/Index.cshtml.cs\)](#):

```

private readonly MyOptions _named_options_1;
private readonly MyOptions _named_options_2;

```

```

public IndexModel(
    IOptions<MyOptions> optionsAccessor,
    IOptions<MyOptionsWithDelegateConfig> optionsAccessorWithDelegateConfig,
    IOptions<MySubOptions> subOptionsAccessor,
    IOptionsSnapshot<MyOptions> snapshotOptionsAccessor,
    IOptionsSnapshot<MyOptions> namedOptionsAccessor)
{
    _options = optionsAccessor.Value;
    _optionsWithDelegateConfig = optionsAccessorWithDelegateConfig.Value;
    _subOptions = subOptionsAccessor.Value;
    _snapshotOptions = snapshotOptionsAccessor.Value;
    _named_options_1 = namedOptionsAccessor.Get("named_options_1");
    _named_options_2 = namedOptionsAccessor.Get("named_options_2");
}

```

```

// Example #6: Named options
var named_options_1 =
    $"named_options_1: option1 = {_named_options_1.Option1}, " +
    $"option2 = {_named_options_1.Option2}";
var named_options_2 =
    $"named_options_2: option1 = {_named_options_2.Option1}, " +
    $"option2 = {_named_options_2.Option2}";
NamedOptions = $"{named_options_1} {named_options_2}";

```

Running the sample app, the named options are returned:

```

named_options_1: option1 = value1_from_json, option2 = -1
named_options_2: option1 = named_options_2_value1_from_action, option2 = 5

```

`named_options_1` values are provided from configuration, which are loaded from the *appsettings.json* file.  
`named_options_2` values are provided by:

- The `named_options_2` delegate in `ConfigureServices` for `Option1`.
- The default value for `Option2` provided by the `MyOptions` class.

Configure all named options instances with the [OptionsServiceCollectionExtensions.ConfigureAll](#) method. The following code configures `Option1` for all named configuration instances with a common value. Add the

following code manually to the `Configure` method:

```
services.ConfigureAll<MyOptions>(myOptions =>
{
    myOptions.Option1 = "ConfigureAll replacement value";
});
```

Running the sample app after adding the code produces the following result:

```
named_options_1: option1 = ConfigureAll replacement value, option2 = -1
named_options_2: option1 = ConfigureAll replacement value, option2 = 5
```

#### NOTE

All options are named instances. Existing `IConfigureOption` instances are treated as targeting the `Options.DefaultName` instance, which is `string.Empty`. `IConfigureNamedOptions` also implements `IConfigureOptions`. The default implementation of the `IOptionsFactory<TOptions>` ([reference source](#)) has logic to use each appropriately. The `null` named option is used to target all of the named instances instead of a specific named instance (`ConfigureAll` and `PostConfigureAll` use this convention).

## IPostConfigureOptions

Set postconfiguration with `IPostConfigureOptions<TOptions>`. Postconfiguration runs after all `IConfigureOptions<TOptions>` configuration occurs:

```
services.PostConfigure<MyOptions>(myOptions =>
{
    myOptions.Option1 = "post_configured_option1_value";
});
```

`PostConfigure<TOptions>` is available to post-configure named options:

```
services.PostConfigure<MyOptions>("named_options_1", myOptions =>
{
    myOptions.Option1 = "post_configured_option1_value";
});
```

Use `PostConfigureAll<TOptions>` to post-configure all named configuration instances:

```
services.PostConfigureAll<MyOptions>("named_options_1", myOptions =>
{
    myOptions.Option1 = "post_configured_option1_value";
});
```

## Options factory, monitoring, and cache

`IOptionsMonitor` is used for notifications when `TOptions` instances change. `IOptionsMonitor` supports reloadable options, change notifications, and `IPostConfigureOptions`.

`IOptionsFactory<TOptions>` is responsible for creating new options instances. It has a single `Create` method. The default implementation takes all registered `IConfigureOptions` and `IPostConfigureOptions` and runs all the configures first, followed by the post-configures. It distinguishes between `IConfigureNamedOptions` and

`IConfigureOptions` and only calls the appropriate interface.

`IOptionsMonitorCache<TOptions>` is used by `IOptionsMonitor` to cache `TOptions` instances. The `IOptionsMonitorCache` invalidates options instances in the monitor so that the value is recomputed (`TryRemove`). Values can be manually introduced as well with `TryAdd`. The `Clear` method is used when all named instances should be recreated on demand.

## Accessing options during startup

`IOptions` can be used in `Configure`, since services are built before the `Configure` method executes. If a service provider is built in `ConfigureServices` to access options, it wouldn't contain any options configurations provided after the service provider is built. Therefore, an inconsistent options state may exist due to the ordering of service registrations.

Since options are typically loaded from configuration, configuration can be used in startup in both `Configure` and `ConfigureServices`. For examples of using configuration during startup, see the [Application startup](#) topic.

## See also

- [Configuration](#)

# Enhance an app from an external assembly in ASP.NET Core with IHostingStartup

6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Luke Latham](#)

An [IHostingStartup](#) implementation allows adding enhancements to an app at startup from an external assembly outside of the app's `Startup` class. For example, an external tooling library can use an `IHostingStartup` implementation to provide additional configuration providers or services to an app. `IHostingStartup` is available in ASP.NET Core 2.0 and later.

[View or download sample code \(how to download\)](#)

## Discover loaded hosting startup assemblies

To discover hosting startup assemblies loaded by the app or by libraries, enable logging and check the application logs. Errors that occur when loading assemblies are logged. Loaded hosting startup assemblies are logged at the Debug level, and all errors are logged.

The sample app reads the `HostingStartupAssembliesKey` into a `string` array and displays the result in the app's Index page:

```
public class IndexModel : PageModel
{
    private readonly IConfiguration _config;

    public IndexModel(IConfiguration config)
    {
        _config = config;
    }

    public string[] LoadedHostingStartupAssemblies { get; private set; }

    public void OnGet()
    {
        LoadedHostingStartupAssemblies =
            _config[WebHostDefaults.HostingStartupAssembliesKey]
            .Split(new[] { ';' }, StringSplitOptions.RemoveEmptyEntries) ?? new string[0];
    }
}
```

## Disable automatic loading of hosting startup assemblies

There are two ways to disable the automatic loading of hosting startup assemblies:

- Set the [Prevent Hosting Startup](#) host configuration setting.
- Set the `ASPNETCORE_PREVENTHOSTINGSTARTUP` environment variable.

When either the host setting or the environment variable is set to `true` or `1`, hosting startup assemblies aren't automatically loaded. If both are set, the host setting controls the behavior.

Disabling hosting startup assemblies using the host setting or environment variable disables them globally and may disable several characteristics of an app. It isn't currently possible to selectively disable a hosting startup

assembly added by a library unless the library offers its own configuration option. A future release will offer the ability to selectively disable hosting startup assemblies (see [GitHub issue aspnet/Hosting #1243](#)).

## Implement IHostingStartup

### Create the assembly

An `IHostingStartup` enhancement is deployed as an assembly based on a console app without an entry point. The assembly references the `Microsoft.AspNetCore.Hosting.Abstractions` package:

```
<Project Sdk="Microsoft.NET.Sdk">

<PropertyGroup>
  <TargetFramework>netcoreapp2.1</TargetFramework>
</PropertyGroup>

<ItemGroup>
  <PackageReference Include="Microsoft.AspNetCore.Hosting.Abstractions"
    Version="2.1.0" />
</ItemGroup>

</Project>
```

A `HostingStartup` attribute identifies a class as an implementation of `IHostingStartup` for loading and execution when building the `IWebHost`. In the following example, the namespace is `StartupEnhancement`, and the class is `StartupEnhancementHostingStartup`:

```
[assembly: HostingStartup(typeof(StartupEnhancement.StartupEnhancementHostingStartup))]
```

A class implements `IHostingStartup`. The class's `Configure` method uses an `IWebHostBuilder` to add enhancements to an app. `IHostingStartup.Configure` in the hosting startup assembly is called by the runtime before `Startup.Configure` in user code, which allows user code to overwrite any configuration provided by the hosting startup assembly.

```
namespace StartupEnhancement
{
    public class StartupEnhancementHostingStartup : IHostingStartup
    {
        public void Configure(IWebHostBuilder builder)
        {
            // Use the IWebHostBuilder to add app enhancements.
        }
    }
}
```

When building an `IHostingStartup` project, the dependencies file (`*.deps.json`) sets the `runtime` location of the assembly to the `bin` folder:

```
"targets": {
  ".NETCoreApp,Version=v2.1": {
    "StartupEnhancement/1.0.0": {
      "dependencies": {
        "Microsoft.AspNetCore.Hosting.Abstractions": "2.1.0"
      },
      "runtime": {
        "StartupEnhancement.dll": {}
      }
    }
  }
}
```

Only part of the file is shown. The assembly name in the example is `StartupEnhancement`.

## Update the dependencies file

The runtime location is specified in the `*.deps.json` file. To active the enhancement, the `runtime` element must specify the location of the enhancement's runtime assembly. Prefix the `runtime` location with

```
lib/<TARGET_FRAMEWORK_MONIKER> :
```

```
"targets": {
  ".NETCoreApp,Version=v2.1": {
    "StartupEnhancement/1.0.0": {
      "dependencies": {
        "Microsoft.AspNetCore.Hosting.Abstractions": "2.1.0"
      },
      "runtime": {
        "lib/netcoreapp2.1/StartupEnhancement.dll": {}
      }
    }
  }
}
```

In the sample app, modification of the `*.deps.json` file is performed by a [PowerShell](#) script. The PowerShell script is automatically triggered by a build target in the project file.

## Enhancement activation

### Place the assembly file

The `IHostingStartup` implementation's assembly file must be *bin*-deployed in the app or placed in the [runtime store](#):

For per-user use, place the assembly in the user profile's runtime store at:

```
<DRIVE>\Users\<USER>\.dotnet\store\x64\<TARGET_FRAMEWORK_MONIKER>\<ENHANCEMENT_ASSEMBLY_NAME>\  
<ENHANCEMENT_VERSION>\lib\<TARGET_FRAMEWORK_MONIKER>\
```

For global use, place the assembly in the .NET Core installation's runtime store:

```
<DRIVE>\Program Files\dotnet\store\x64\<TARGET_FRAMEWORK_MONIKER>\<ENHANCEMENT_ASSEMBLY_NAME>\  
<ENHANCEMENT_VERSION>\lib\<TARGET_FRAMEWORK_MONIKER>\
```

When deploying the assembly to the runtime store, the symbols file may be deployed as well but isn't required for the enhancement to work.

### Place the dependencies file

The implementation's `*.deps.json` file must be in an accessible location.

For per-user use, place the file in the `additionalDeps` folder of the user profile's `.dotnet` settings:

```
<DRIVE>\Users\<USER>\.dotnet\x64\additionalDeps\<ENHANCEMENT_ASSEMBLY_NAME>\shared\Microsoft.NETCore.App\  
<SHARED_FRAMEWORK_VERSION>\
```

For global use, place the file in the `additionalDeps` folder of the .NET Core installation:

```
<DRIVE>\Program Files\dotnet\additionalDeps\<ENHANCEMENT_ASSEMBLY_NAME>\shared\Microsoft.NETCore.App\  
<SHARED_FRAMEWORK_VERSION>\
```

The shared framework version reflects the version of the shared runtime that the target app uses. The shared runtime is shown in the `*.runtimeconfig.json` file. In the sample app, the shared runtime is specified in the `HostingStartupSample.runtimeconfig.json` file.

### Set environment variables

Set the following environment variables in the context of the app that uses the enhancement.

#### ASPNETCORE\_HOSTINGSTARTUPASSEMBLIES

Only hosting startup assemblies are scanned for the `HostingStartupAttribute`. The assembly name of the implementation is provided in this environment variable. The sample app sets this value to `StartupDiagnostics`.

The value can also be set using the [Hosting Startup Assemblies](#) host configuration setting.

When multiple hosting startup assemblies are present, their `Configure` methods are executed in the order that the assemblies are listed.

#### DOTNET\_ADDITIONAL\_DEPS

The location of the implementation's `*.deps.json` file.

If the file is placed in the user profile's `.dotnet` folder for per-user use:

```
<DRIVE>\Users\<USER>\.dotnet\x64\additionalDeps\
```

If the file is placed in the .NET Core installation for global use, provide the full path to the file:

```
<DRIVE>\Program Files\dotnet\additionalDeps\<ENHANCEMENT_ASSEMBLY_NAME>\shared\Microsoft.NETCore.App\  
<SHARED_FRAMEWORK_VERSION>\<ENHANCEMENT_ASSEMBLY_NAME>.deps.json
```

The sample app sets this value to:

```
%UserProfile%\dotnet\x64\additionalDeps\StartupDiagnostics\
```

For examples of how to set environment variables for various operating systems, see [Use multiple environments](#).

## Sample app

The [sample app \(how to download\)](#) uses `IHostingStartup` to create a diagnostics tool. The tool adds two middlewares to the app at startup that provide diagnostic information:

- Registered services
- Address: scheme, host, path base, path, query string
- Connection: remote IP, remote port, local IP, local port, client certificate

- Request headers
- Environment variables

To run the sample:

1. The Startup Diagnostic project uses [PowerShell](#) to modify its `StartupDiagnostics.deps.json` file. PowerShell is installed by default on Windows OS starting with Windows 7 SP1 and Windows Server 2008 R2 SP1. To obtain PowerShell on other platforms, see [Installing Windows PowerShell](#).
2. Build the Startup Diagnostic project. A build target in the project file:
  - Moves the assembly and symbols files to the user profile's runtime store.
  - Triggers the PowerShell script to modify the `StartupDiagnostics.deps.json` file.
  - Moves the `StartupDiagnostics.deps.json` file to the user profile's `additionalDeps` folder.
3. Set the environment variables:
  - `ASPNETCORE_HOSTINGSTARTUPASSEMBLIES` : `StartupDiagnostics`
  - `DOTNET_ADDITIONAL_DEPS` : `%UserProfile%\dotnet\x64\additionalDeps\StartupDiagnostics\`
4. Run the sample app.
5. Request the `/services` endpoint to see the app's registered services. Request the `/diag` endpoint to see the diagnostic information.

# Logging in ASP.NET Core

7/10/2018 • 23 minutes to read • [Edit Online](#)

By [Steve Smith](#) and [Tom Dykstra](#)

ASP.NET Core supports a logging API that works with a variety of logging providers. Built-in providers let you send logs to one or more destinations, and you can plug in a third-party logging framework. This article shows how to use the built-in logging API and providers in your code.

[View or download sample code \(how to download\)](#)

[View or download sample code \(how to download\)](#)

For information on stdout logging when hosting with IIS, see [Troubleshoot ASP.NET Core on IIS](#). For information on stdout logging with Azure App Service, see [Troubleshoot ASP.NET Core on Azure App Service](#).

## How to create logs

To create logs, implement an [ILogger](#) object from the [dependency injection container](#):

```
public class TodoController : Controller
{
    private readonly ITodoRepository _todoRepository;
    private readonly ILogger _logger;

    public TodoController(ITodoRepository todoRepository,
        ILogger<TodoController> logger)
    {
        _todoRepository = todoRepository;
        _logger = logger;
    }
}
```

Then call logging methods on that logger object:

```
public IActionResult GetById(string id)
{
    _logger.LogInformation(LoggingEvents.GetItem, "Getting item {ID}", id);
    var item = _todoRepository.Find(id);
    if (item == null)
    {
        _logger.LogWarning(LoggingEvents.GetItemNotFound, "GetById({ID}) NOT FOUND", id);
        return NotFound();
    }
    return new ObjectResult(item);
}
```

This example creates logs with the `TodoController` class as the *category*. Categories are explained [later in this article](#).

ASP.NET Core doesn't provide async logger methods because logging should be so fast that it isn't worth the cost of using async. If you're in a situation where that's not true, consider changing the way you log. If your data store is slow, write the log messages to a fast store first, then move them to a slow store later. For example, log to a message queue that's read and persisted to slow storage by another process.

## How to add providers

A logging provider takes the messages that you create with an `ILogger` object and displays or stores them. For example, the Console provider displays messages on the console, and the Azure App Service provider can store them in Azure blob storage.

To use a provider, call the provider's `Add<ProviderName>` extension method in *Program.cs*:

```
public static void Main(string[] args)
{
    var webHost = new WebHostBuilder()
        .UseKestrel()
        .UseContentRoot(Directory.GetCurrentDirectory())
        .ConfigureAppConfiguration((hostingContext, config) =>
    {
        var env = hostingContext.HostingEnvironment;
        config.AddJsonFile("appsettings.json", optional: true, reloadOnChange: true)
            .AddJsonFile($"appsettings.{env.EnvironmentName}.json", optional: true, reloadOnChange:
true);
        config.AddEnvironmentVariables();
    })
        .ConfigureLogging((hostingContext, logging) =>
    {
        logging.AddConfiguration(hostingContext.Configuration.GetSection("Logging"));
        logging.AddConsole();
        logging.AddDebug();
    })
        .UseStartup<Startup_()
        .Build();

    webHost.Run();
}
```

The default project template enables logging with the [CreateDefaultBuilder](#) method:

```
public static void Main(string[] args)
{
    BuildWebHost(args).Run();
}

public static IWebHost BuildWebHost(string[] args) =>
    WebHost.CreateDefaultBuilder(args)
        .UseStartup<Startup_()
        .Build();
```

A logging provider takes the messages that you create with an `ILogger` object and displays or stores them. For example, the Console provider displays messages on the console, and the Azure App Service provider can store them in Azure blob storage.

To use a provider, install its NuGet package and call the provider's extension method on an instance of `ILoggerFactory`, as shown in the following example:

```
public void Configure(IApplicationBuilder app,
    IHostingEnvironment env,
    ILoggerFactory loggerFactory)
{
    loggerFactory
        .AddConsole()
        .AddDebug();
```

ASP.NET Core dependency injection (DI) provides the `I LoggerFactory` instance. The `AddConsole` and `AddDebug` extension methods are defined in the `Microsoft.Extensions.Logging.Console` and `Microsoft.Extensions.Logging.Debug` packages. Each extension method calls the `I LoggerFactory.AddProvider` method, passing in an instance of the provider.

**NOTE**

The [sample app](#) adds logging providers in the `Startup.Configure` method. If you want to obtain log output from code that executes earlier, add logging providers in the `Startup` class constructor.

You'll find information about each [built-in logging provider](#) and links to [third-party logging providers](#) later in the article.

## Settings file configuration

Each of the preceding examples in the [How to add providers](#) section loads logging provider configuration from the `Logging` section of app settings files. The following example shows the contents of a typical `appsettings.Development.json` file:

```
{  
  "Logging": {  
    "LogLevel": {  
      "Default": "Debug",  
      "System": "Information",  
      "Microsoft": "Information"  
    },  
    "Console": {  
      "IncludeScopes": "true"  
    }  
  }  
}
```

`LogLevel` keys represent log names. The `Default` key applies to logs not explicitly listed. The value represents the [log level](#) applied to the given log. Log keys that set `IncludeScopes` (`Console` in the example), specify if [log scopes](#) are enabled for the indicated log.

```
{  
  "Logging": {  
    "LogLevel": {  
      "Default": "Debug",  
      "System": "Information",  
      "Microsoft": "Information"  
    }  
  }  
}
```

`LogLevel` keys represent log names. The `Default` key applies to logs not explicitly listed. The value represents the [log level](#) applied to the given log.

## Sample logging output

With the sample code shown in the preceding section, you'll see logs in the console when you run from the command line. Here's an example of console output:

```
info: Microsoft.AspNetCore.Hosting.Internal.WebHost[1]
      Request starting HTTP/1.1 GET http://localhost:5000/api/todo/0
info: Microsoft.AspNetCore.Mvc.Internal.ControllerActionInvoker[1]
      Executing action method TodoApi.Controllers.TodoController.GetById (TodoApi) with arguments (0) -
ModelState is Valid
info: TodoApi.Controllers.TodoController[1002]
      Getting item 0
warn: TodoApi.Controllers.TodoController[4000]
      GetById(0) NOT FOUND
info: Microsoft.AspNetCore.Mvc.StatusCodeResult[1]
      Executing HttpStatusCodeResult, setting HTTP status code 404
info: Microsoft.AspNetCore.Mvc.Internal.ControllerActionInvoker[2]
      Executed action TodoApi.Controllers.TodoController.GetById (TodoApi) in 42.9286ms
info: Microsoft.AspNetCore.Hosting.Internal.WebHost[2]
      Request finished in 148.889ms 404
```

These logs were created by going to `http://localhost:5000/api/todo/0`, which triggers execution of both `ILogger` calls shown in the preceding section.

Here's an example of the same logs as they appear in the Debug window when you run the sample application in Visual Studio:

```
Microsoft.AspNetCore.Hosting.Internal.WebHost:Information: Request starting HTTP/1.1 GET
http://localhost:53104/api/todo/0
Microsoft.AspNetCore.Mvc.Internal.ControllerActionInvoker:Information: Executing action method
TodoApi.Controllers.TodoController.GetById (TodoApi) with arguments (0) - ModelState is Valid
TodoApi.Controllers.TodoController:Information: Getting item 0
TodoApi.Controllers.TodoController:Warning: GetById(0) NOT FOUND
Microsoft.AspNetCore.Mvc.StatusCodeResult:Information: Executing HttpStatusCodeResult, setting HTTP status
code 404
Microsoft.AspNetCore.Mvc.Internal.ControllerActionInvoker:Information: Executed action
TodoApi.Controllers.TodoController.GetById (TodoApi) in 152.5657ms
Microsoft.AspNetCore.Hosting.Internal.WebHost:Information: Request finished in 316.3195ms 404
```

The logs that were created by the `ILogger` calls shown in the preceding section begin with "TodoApi.Controllers.TodoController". The logs that begin with "Microsoft" categories are from ASP.NET Core. ASP.NET Core itself and your application code are using the same logging API and the same logging providers.

The remainder of this article explains some details and options for logging.

## NuGet packages

The `ILogger` and `ILoggerFactory` interfaces are in [Microsoft.Extensions.Logging.Abstractions](#), and default implementations for them are in [Microsoft.Extensions.Logging](#).

## Log category

A *category* is included with each log that you create. You specify the category when you create an `ILogger` object. The category may be any string, but a convention is to use the fully qualified name of the class from which the logs are written. For example: "TodoApi.Controllers.TodoController".

You can specify the category as a string or use an extension method that derives the category from the type. To specify the category as a string, call `CreateLogger` on an `ILoggerFactory` instance, as shown below.

```

public class TodoController : Controller
{
    private readonly ITodoRepository _todoRepository;
    private readonly ILogger _logger;

    public TodoController(ITodoRepository todoRepository,
        ILoggerFactory logger)
    {
        _todoRepository = todoRepository;
        _logger = logger.CreateLogger("TodoApi.Controllers.TodoController");
    }
}

```

Most of the time, it will be easier to use `ILogger<T>`, as in the following example.

```

public class TodoController : Controller
{
    private readonly ITodoRepository _todoRepository;
    private readonly ILogger _logger;

    public TodoController(ITodoRepository todoRepository,
        ILogger<TodoController> logger)
    {
        _todoRepository = todoRepository;
        _logger = logger;
    }
}

```

This is equivalent to calling `CreateLogger` with the fully qualified type name of `T`.

## Log level

Each time you write a log, you specify its [LogLevel](#). The log level indicates the degree of severity or importance. For example, you might write an `Information` log when a method ends normally, a `Warning` log when a method returns a 404 return code, and an `Error` log when you catch an unexpected exception.

In the following code example, the names of the methods (for example, `LogWarning`) specify the log level. The first parameter is the [Log event ID](#). The second parameter is a [message template](#) with placeholders for argument values provided by the remaining method parameters. The method parameters are explained in more detail later in this article.

```

public IActionResult GetById(string id)
{
    _logger.LogInformation(LoggingEvents.GetItem, "Getting item {ID}", id);
    var item = _todoRepository.Find(id);
    if (item == null)
    {
        _logger.LogWarning(LoggingEvents.GetItemNotFound, "GetById({ID}) NOT FOUND", id);
        return NotFound();
    }
    return new ObjectResult(item);
}

```

Log methods that include the level in the method name are [extension methods for ILogger](#). Behind the scenes, these methods call a `Log` method that takes a `LogLevel` parameter. You can call the `Log` method directly rather than one of these extension methods, but the syntax is relatively complicated. For more information, see the [ILogger interface](#) and the [logger extensions source code](#).

ASP.NET Core defines the following [log levels](#), ordered here from least to highest severity.

- Trace = 0

For information that's valuable only to a developer debugging an issue. These messages may contain sensitive application data and so shouldn't be enabled in a production environment. *Disabled by default*.

Example: `credentials: {"User": "someuser", "Password": "P@ssword"}`

- Debug = 1

For information that has short-term usefulness during development and debugging. Example:

`Entering method Configure with flag set to true.` You typically wouldn't enable `Debug` level logs in production unless you are troubleshooting, due to the high volume of logs.

- Information = 2

For tracking the general flow of the application. These logs typically have some long-term value. Example:

`Request received for path /api/todo`

- Warning = 3

For abnormal or unexpected events in the application flow. These may include errors or other conditions that don't cause the application to stop, but which may need to be investigated. Handled exceptions are a common place to use the `Warning` log level. Example: `FileNotFoundException for file quotes.txt.`

- Error = 4

For errors and exceptions that cannot be handled. These messages indicate a failure in the current activity or operation (such as the current HTTP request), not an application-wide failure. Example log message:

`Cannot insert record due to duplicate key violation.`

- Critical = 5

For failures that require immediate attention. Examples: data loss scenarios, out of disk space.

You can use the log level to control how much log output is written to a particular storage medium or display window. For example, in production you might want all logs of `Information` level and lower to go to a volume data store, and all logs of `Warning` level and higher to go to a value data store. During development, you might normally send logs of `Warning` or higher severity to the console. Then when you need to troubleshoot, you can add `Debug` level. The [Log filtering](#) section later in this article explains how to control which log levels a provider handles.

The ASP.NET Core framework writes `Debug` level logs for framework events. The log examples earlier in this article excluded logs below `Information` level, so no `Debug` level logs were shown. Here's an example of console logs if you run the sample application configured to show `Debug` and higher logs for the console provider.

```

info: Microsoft.AspNetCore.Hosting.Internal.WebHost[1]
      Request starting HTTP/1.1 GET http://localhost:62555/api/todo/0
dbug: Microsoft.AspNetCore.Routing.Tree.TreeRouter[1]
      Request successfully matched the route with name 'GetTodo' and template 'api/Todo/{id}'.
dbug: Microsoft.AspNetCore.Mvc.Internal.ActionSelector[2]
      Action 'TodoApi.Controllers.TodoController.Update (TodoApi)' with id '089d59b6-92ec-472d-b552-
cc613df625d' did not match the constraint 'Microsoft.AspNetCore.Mvc.Internal.HttpMethodActionConstraint'
dbug: Microsoft.AspNetCore.Mvc.Internal.ActionSelector[2]
      Action 'TodoApi.Controllers.TodoController.Delete (TodoApi)' with id 'f3476abe-4bd9-4ad3-9261-
3ead09607366' did not match the constraint 'Microsoft.AspNetCore.Mvc.Internal.HttpMethodActionConstraint'
dbug: Microsoft.AspNetCore.Mvc.Internal.ControllerActionInvoker[1]
      Executing action TodoApi.Controllers.TodoController.GetById (TodoApi)
info: Microsoft.AspNetCore.Mvc.Internal.ControllerActionInvoker[1]
      Executing action method TodoApi.Controllers.TodoController.GetById (TodoApi) with arguments (0) -
ModelState is Valid
info: TodoApi.Controllers.TodoController[1002]
      Getting item 0
warn: TodoApi.Controllers.TodoController[4000]
      GetById(0) NOT FOUND
dbug: Microsoft.AspNetCore.Mvc.Internal.ControllerActionInvoker[2]
      Executed action method TodoApi.Controllers.TodoController.GetById (TodoApi), returned result
Microsoft.AspNetCore.Mvc.NotFoundResult.
info: Microsoft.AspNetCore.Mvc.StatusCodeResult[1]
      Executing HttpStatusCodeResult, setting HTTP status code 404
info: Microsoft.AspNetCore.Mvc.Internal.ControllerActionInvoker[2]
      Executed action TodoApi.Controllers.TodoController.GetById (TodoApi) in 0.8788ms
dbug: Microsoft.AspNetCore.Server.Kestrel[9]
      Connection id "0HL6L7NEFF2QD" completed keep alive response.
info: Microsoft.AspNetCore.Hosting.Internal.WebHost[2]
      Request finished in 2.7286ms 404

```

## Log event ID

Each time you write a log, you can specify an *event ID*. The sample app does this by using a locally-defined `LoggingEvents` class:

```

public IActionResult GetById(string id)
{
    _logger.LogInformation(LoggingEvents.GetItem, "Getting item {ID}", id);
    var item = _todoRepository.Find(id);
    if (item == null)
    {
        _logger.LogWarning(LoggingEvents.GetItemNotFound, ".GetById({ID}) NOT FOUND", id);
        return NotFound();
    }
    return new ObjectResult(item);
}

```

```

public class LoggingEvents
{
    public const int GenerateItems = 1000;
    public const int ListItems = 1001;
    public const int GetItem = 1002;
    public const int InsertItem = 1003;
    public const int UpdateItem = 1004;
    public const int DeleteItem = 1005;

    public const int GetItemNotFound = 4000;
    public const int UpdateItemNotFound = 4001;
}

```

An event ID is an integer value that you can use to associate a set of logged events with one another. For instance, a log for adding an item to a shopping cart could be event ID 1000 and a log for completing a purchase could be event ID 1001.

In logging output, the event ID may be stored in a field or included in the text message, depending on the provider. The Debug provider doesn't show event IDs, but the console provider shows them in brackets after the category:

```
info: TodoApi.Controllers.TodoController[1002]
      Getting item invalidid
warn: TodoApi.Controllers.TodoController[4000]
      GetById(invalidid) NOT FOUND
```

## Log message template

Each time you write a log message, you provide a message template. The message template can be a string or it can contain named placeholders into which argument values are placed. The template isn't a format string, and placeholders should be named, not numbered.

```
public IActionResult GetById(string id)
{
    _logger.LogInformation(LoggingEvents.GetItem, "Getting item {ID}", id);
    var item = _todoRepository.Find(id);
    if (item == null)
    {
        _logger.LogWarning(LoggingEvents.GetItemNotFound, "GetById({ID}) NOT FOUND", id);
        return NotFound();
    }
    return new ObjectResult(item);
}
```

The order of placeholders, not their names, determines which parameters are used to provide their values. If you have the following code:

```
string p1 = "parm1";
string p2 = "parm2";
_logger.LogInformation("Parameter values: {p2}, {p1}", p1, p2);
```

The resulting log message looks like this:

```
Parameter values: parm1, parm2
```

The logging framework does message formatting in this way to make it possible for logging providers to implement [semantic logging, also known as structured logging](#). Because the arguments themselves are passed to the logging system, not just the formatted message template, logging providers can store the parameter values as fields in addition to the message template. If you're directing your log output to Azure Table Storage and your logger method call looks like this:

```
_logger.LogInformation("Getting item {ID} at {RequestTime}", id, DateTime.Now);
```

Each Azure Table entity can have `ID` and `RequestTime` properties, which simplifies queries on log data. You can find all logs within a particular `RequestTime` range without the need to parse the time out of the text message.

# Logging exceptions

The logger methods have overloads that let you pass in an exception, as in the following example:

```
catch (Exception ex)
{
    _logger.LogWarning(LoggingEvents.GetItemNotFound, ex, "GetById({ID}) NOT FOUND", id);
    return NotFound();
}
return new ObjectResult(item);
```

Different providers handle the exception information in different ways. Here's an example of Debug provider output from the code shown above.

```
TodoApi.Controllers.TodoController:Warning: GetById(036dd898-fb01-47e8-9a65-f92eb73cf924) NOT FOUND
System.Exception: Item not found exception.
at TodoApi.Controllers.TodoController.GetById(String id) in
C:\logging\sample\src\TodoApi\Controllers\TodoController.cs:line 226
```

## Log filtering

You can specify a minimum log level for a specific provider and category or for all providers or all categories. Any logs below the minimum level aren't passed to that provider, so they don't get displayed or stored.

If you want to suppress all logs, you can specify `LogLevel.None` as the minimum log level. The integer value of `LogLevel.None` is 6, which is higher than `LogLevel.Critical` (5).

### Create filter rules in configuration

The project templates create code that calls `CreateDefaultBuilder` to set up logging for the Console and Debug providers. The `CreateDefaultBuilder` method also sets up logging to look for configuration in a `Logging` section, using code like the following:

```
public static void Main(string[] args)
{
    var webHost = new WebHostBuilder()
        .UseKestrel()
        .UseContentRoot(Directory.GetCurrentDirectory())
        .ConfigureAppConfiguration((hostingContext, config) =>
    {
        var env = hostingContext.HostingEnvironment;
        config.AddJsonFile("appsettings.json", optional: true, reloadOnChange: true)
            .AddJsonFile($"appsettings.{env.EnvironmentName}.json", optional: true, reloadOnChange:
true);
        config.AddEnvironmentVariables();
    })
    .ConfigureLogging((hostingContext, logging) =>
    {
        logging.AddConfiguration(hostingContext.Configuration.GetSection("Logging"));
        logging.AddConsole();
        logging.AddDebug();
    })
    .UseStartup<Startup>()
    .Build();

    webHost.Run();
}
```

The configuration data specifies minimum log levels by provider and category, as in the following example:

```
{  
    "Logging": {  
        "Debug": {  
            "LogLevel": {  
                "Default": "Information"  
            }  
        },  
        "Console": {  
            "IncludeScopes": false,  
            "LogLevel": {  
                "Microsoft.AspNetCore.Mvc.Razor.Internal": "Warning",  
                "Microsoft.AspNetCore.Mvc.Razor.Razor": "Debug",  
                "Microsoft.AspNetCore.Mvc.Razor": "Error",  
                "Default": "Information"  
            }  
        },  
        "LogLevel": {  
            "Default": "Debug"  
        }  
    }  
}
```

This JSON creates six filter rules, one for the Debug provider, four for the Console provider, and one that applies to all providers. You'll see later how just one of these rules is chosen for each provider when an `ILogger` object is created.

## Filter rules in code

You can register filter rules in code, as shown in the following example:

```
WebHost.CreateDefaultBuilder(args)  
    .UseStartup<Startup>()  
    .ConfigureLogging(logging =>  
        logging.AddFilter("System", LogLevel.Debug)  
            .AddFilter<DebugLoggerProvider>("Microsoft", LogLevel.Trace))  
    .Build();
```

The second `AddFilter` specifies the Debug provider by using its type name. The first `AddFilter` applies to all providers because it doesn't specify a provider type.

## How filtering rules are applied

The configuration data and the `AddFilter` code shown in the preceding examples create the rules shown in the following table. The first six come from the configuration example and the last two come from the code example.

NUMBER	PROVIDER	CATEGORIES THAT BEGIN WITH ...	MINIMUM LOG LEVEL
1	Debug	All categories	Information
2	Console	Microsoft.AspNetCore.Mvc.Razor.Internal	Warning
3	Console	Microsoft.AspNetCore.Mvc.Razor.Razor	Debug

NUMBER	PROVIDER	CATEGORIES THAT BEGIN WITH ...	MINIMUM LOG LEVEL
4	Console	Microsoft.AspNetCore.Mvc.Razor	Error
5	Console	All categories	Information
6	All providers	All categories	Debug
7	All providers	System	Debug
8	Debug	Microsoft	Trace

When you create an `ILogger` object to write logs with, the `ILoggerFactory` object selects a single rule per provider to apply to that logger. All messages written by that `ILogger` object are filtered based on the selected rules. The most specific rule possible for each provider and category pair is selected from the available rules.

The following algorithm is used for each provider when an `ILogger` is created for a given category:

- Select all rules that match the provider or its alias. If none are found, select all rules with an empty provider.
- From the result of the preceding step, select rules with longest matching category prefix. If none are found, select all rules that don't specify a category.
- If multiple rules are selected take the **last** one.
- If no rules are selected, use `MinimumLevel`.

For example, suppose you have the preceding list of rules and you create an `ILogger` object for category "Microsoft.AspNetCore.Mvc.Razor.RazorViewEngine":

- For the Debug provider, rules 1, 6, and 8 apply. Rule 8 is most specific, so that's the one selected.
- For the Console provider, rules 3, 4, 5, and 6 apply. Rule 3 is most specific.

When you create logs with an `ILogger` for category "Microsoft.AspNetCore.Mvc.Razor.RazorViewEngine", logs of `Trace` level and above will go to the Debug provider, and logs of `Debug` level and above will go to the Console provider.

## Provider aliases

You can use the type name to specify a provider in configuration, but each provider defines a shorter *alias* that's easier to use. For the built-in providers, use the following aliases:

- Console
- Debug
- EventLog
- AzureAppServices
- TraceSource
- EventSource

## Default minimum level

There's a minimum level setting that takes effect only if no rules from configuration or code apply for a given provider and category. The following example shows how to set the minimum level:

```
WebHost.CreateDefaultBuilder(args)
    .UseStartup<Startup>()
    .ConfigureLogging(logging => logging.SetMinimumLevel(LogLevel.Warning))
    .Build();
```

If you don't explicitly set the minimum level, the default value is `Information`, which means that `Trace` and `Debug` logs are ignored.

## Filter functions

You can write code in a filter function to apply filtering rules. A filter function is invoked for all providers and categories that don't have rules assigned to them by configuration or code. Code in the function has access to the provider type, category, and log level to decide whether or not a message should be logged. For example:

```
WebHost.CreateDefaultBuilder(args)
    .UseStartup<Startup>()
    .ConfigureLogging(logBuilder =>
{
    logBuilder.AddFilter((provider, category, logLevel) =>
    {
        if (provider == "Microsoft.Extensions.Logging.Console.ConsoleLoggerProvider" &&
            category == "TodoApi.Controllers.TodoController")
        {
            return false;
        }
        return true;
    });
})
.Build();
```

Some logging providers let you specify when logs should be written to a storage medium or ignored based on log level and category.

The `AddConsole` and `AddDebug` extension methods provide overloads that let you pass in filtering criteria. The following sample code causes the console provider to ignore logs below `Warning` level, while the Debug provider ignores logs that the framework creates.

```
public void Configure(IApplicationBuilder app,
    IHostingEnvironment env,
    ILoggerFactory loggerFactory)
{
    loggerFactory
        .AddConsole(LogLevel.Warning)
        .AddDebug((category, logLevel) => (category.Contains("TodoApi") && logLevel >= LogLevel.Trace));
```

The `AddEventLog` method has an overload that takes an `EventLogSettings` instance, which may contain a filtering function in its `Filter` property. The `TraceSource` provider doesn't provide any of those overloads, since its logging level and other parameters are based on the `SourceSwitch` and `TraceListener` it uses.

You can set filtering rules for all providers that are registered with an `ILoggerFactory` instance by using the `WithFilter` extension method. The example below limits framework logs (category begins with "Microsoft" or "System") to warnings while letting the app log at debug level.

```

public void Configure(IApplicationBuilder app,
    IHostingEnvironment env,
    ILoggerFactory loggerFactory)
{
    loggerFactory
        .WithFilter(new FilterLoggerSettings
        {
            { "Microsoft", LogLevel.Warning },
            { "System", LogLevel.Warning },
            { "ToDoApi", LogLevel.Debug }
        })
        .AddConsole()
        .AddDebug();
}

```

If you want to use filtering to prevent all logs from being written for a particular category, you can specify `LogLevel.None` as the minimum log level for that category. The integer value of `LogLevel.None` is 6, which is higher than `LogLevel.Critical` (5).

The `WithFilter` extension method is provided by the [Microsoft.Extensions.Logging.Filter](#) NuGet package. The method returns a new `ILoggerFactory` instance that will filter the log messages passed to all logger providers registered with it. It doesn't affect any other `ILoggerFactory` instances, including the original `ILoggerFactory` instance.

## Log scopes

You can group a set of logical operations within a *scope* in order to attach the same data to each log that's created as part of that set. For example, you might want every log created as part of processing a transaction to include the transaction ID.

A scope is an `IDisposable` type that's returned by the `ILogger.BeginScope<TState>` method and lasts until it's disposed. You use a scope by wrapping your logger calls in a `using` block, as shown here:

```

public IActionResult GetById(string id)
{
    TodoItem item;
    using (_logger.BeginScope("Message attached to logs created in the using block"))
    {
        _logger.LogInformation(LoggingEvents.GetItem, "Getting item {ID}", id);
        item = _todoRepository.Find(id);
        if (item == null)
        {
            _logger.LogWarning(LoggingEvents.GetItemNotFound, ".GetById({ID}) NOT FOUND", id);
            return NotFound();
        }
    }
    return new ObjectResult(item);
}

```

The following code enables scopes for the console provider:

*Program.cs:*

```

.ConfigureLogging((hostingContext, logging) =>
{
    logging.AddConfiguration(hostingContext.Configuration.GetSection("Logging"));
    logging.AddConsole(options => options.IncludeScopes = true);
    logging.AddDebug();
})

```

#### NOTE

Configuring the `IncludeScopes` console logger option is required to enable scope-based logging.

`IncludeScopes` can be configured via *appsettings* configuration files. For more information, see the [Settings file configuration](#) section.

*Program.cs*:

```
.ConfigureLogging((hostingContext, logging) =>
{
    logging.AddConfiguration(hostingContext.Configuration.GetSection("Logging"));
    logging.AddConsole(options => options.IncludeScopes = true);
    logging.AddDebug();
})
```

#### NOTE

Configuring the `IncludeScopes` console logger option is required to enable scope-based logging.

*Startup.cs*:

```
public void Configure(IApplicationBuilder app,
    IHostingEnvironment env,
    ILoggerFactory loggerFactory)
{
    loggerFactory
        .AddConsole(includeScopes: true)
        .AddDebug();
```

Each log message includes the scoped information:

```
info: TodoApi.Controllers.TodoController[1002]
    => RequestId:0HKV9C49II9CK RequestPath:/api/todo/0 => TodoApi.Controllers.TodoController.GetById
(TodoApi) => Message attached to logs created in the using block
    Getting item 0
warn: TodoApi.Controllers.TodoController[4000]
    => RequestId:0HKV9C49II9CK RequestPath:/api/todo/0 => TodoApi.Controllers.TodoController.GetById
(TodoApi) => Message attached to logs created in the using block
    GetById(0) NOT FOUND
```

## Built-in logging providers

ASP.NET Core ships the following providers:

- [Console](#)
- [Debug](#)
- [EventSource](#)
- [EventLog](#)
- [TraceSource](#)
- [Azure App Service](#)

### Console provider

The [Microsoft.Extensions.Logging.Console](#) provider package sends log output to the console.

```
logging.AddConsole()
```

```
loggerFactory.AddConsole()
```

[AddConsole overloads](#) let you pass in an a minimum log level, a filter function, and a boolean that indicates whether scopes are supported. Another option is to pass in an `IConfiguration` object, which can specify scopes support and logging levels.

If you are considering the console provider for use in production, be aware that it has a significant impact on performance.

When you create a new project in Visual Studio, the `AddConsole` method looks like this:

```
loggerFactory.AddConsole(Configuration.GetSection("Logging"));
```

This code refers to the `Logging` section of the `appSettings.json` file:

```
{
  "Logging": {
    "Console": {
      "IncludeScopes": false
    },
    "LogLevel": {
      "Default": "Debug",
      "System": "Information",
      "Microsoft": "Information"
    }
  }
}
```

The settings shown limit framework logs to warnings while allowing the app to log at debug level, as explained in the [Log filtering](#) section. For more information, see [Configuration](#).

## Debug provider

The `Microsoft.Extensions.Logging.Debug` provider package writes log output by using the `System.Diagnostics.Debug` class (`Debug.WriteLine` method calls).

On Linux, this provider writes logs to `/var/log/message`.

```
logging.AddDebug()
```

```
loggerFactory.AddDebug()
```

[AddDebug overloads](#) let you pass in a minimum log level or a filter function.

## EventSource provider

For apps that target ASP.NET Core 1.1.0 or higher, the `Microsoft.Extensions.Logging.EventSource` provider package can implement event tracing. On Windows, it uses [ETW](#). The provider is cross-platform, but there are no event collection and display tools yet for Linux or macOS.

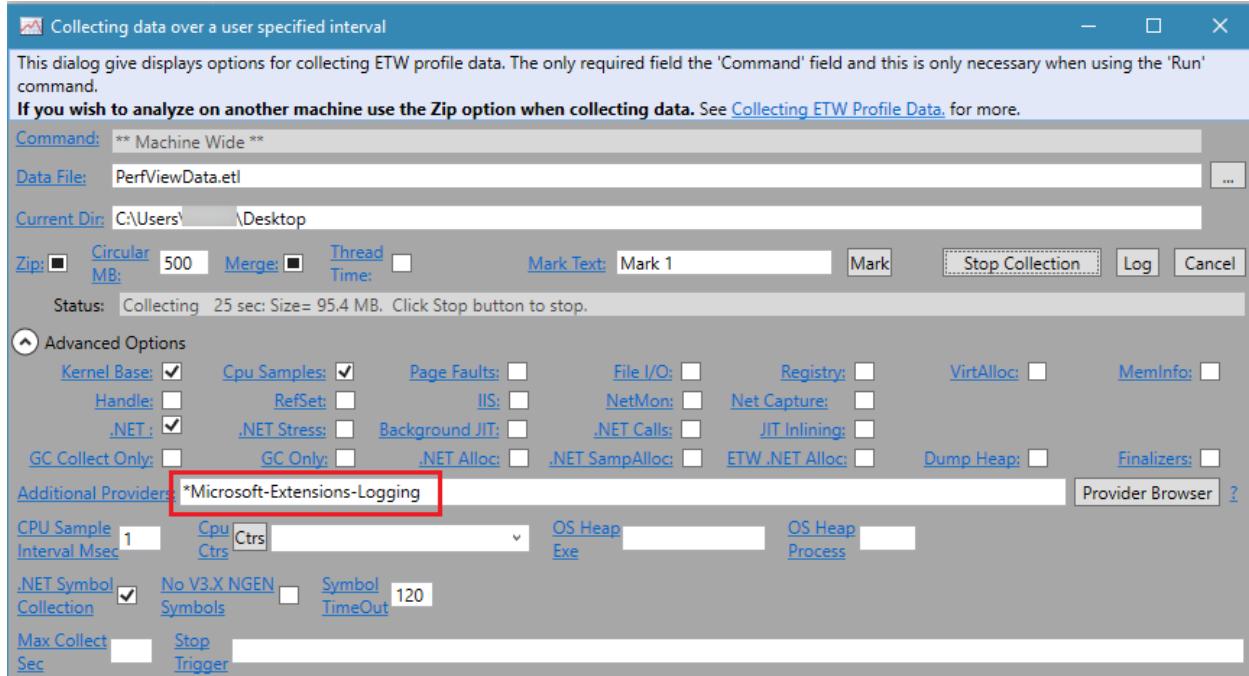
```
logging.AddEventSourceLogger()
```

```
loggerFactory.AddEventSourceLogger()
```

A good way to collect and view logs is to use the [PerfView utility](#). There are other tools for viewing ETW logs, but PerfView provides the best experience for working with the ETW events emitted by ASP.NET.

To configure PerfView for collecting events logged by this provider, add the string

`*Microsoft.Extensions.Logging` to the **Additional Providers** list. (Don't miss the asterisk at the start of the string.)



## Windows EventLog provider

The [Microsoft.Extensions.Logging.EventLog](#) provider package sends log output to the Windows Event Log.

```
logging.AddEventLog()
```

```
loggerFactory.AddEventLog()
```

[AddEventLog](#) overloads let you pass in `EventLogSettings` or a minimum log level.

## TraceSource provider

The [Microsoft.Extensions.Logging.TraceSource](#) provider package uses the [System.Diagnostics.TraceSource](#) libraries and providers.

```
logging.AddTraceSource(sourceSwitchName);
```

```
loggerFactory.AddTraceSource(sourceSwitchName);
```

[AddTraceSource](#) overloads let you pass in a source switch and a trace listener.

To use this provider, an application has to run on the .NET Framework (rather than .NET Core). The provider lets you route messages to a variety of [listeners](#), such as the [TextWriterTraceListener](#) used in the sample application.

The following example configures a `TraceSource` provider that logs `Warning` and higher messages to the

console window.

```
public void Configure(IApplicationBuilder app,
    IHostingEnvironment env,
    ILoggerFactory loggerFactory)
{
    loggerFactory
        .AddDebug();

    // add Trace Source logging
    var testSwitch = new SourceSwitch("sourceSwitch", "Logging Sample");
    testSwitch.Level = SourceLevels.Warning;
    loggerFactory.AddTraceSource(testSwitch,
        new TextWriterTraceListener(writer: Console.Out));
```

## Azure App Service provider

The [Microsoft.Extensions.Logging.AzureAppServices](#) provider package writes logs to text files in an Azure App Service app's file system and to [blob storage](#) in an Azure Storage account. The provider is available only for apps that target ASP.NET Core 1.1 or later.

If targeting .NET Core, don't install the provider package or explicitly call [AddAzureWebAppDiagnostics](#). The provider is automatically available to the app when the app is deployed to Azure App Service.

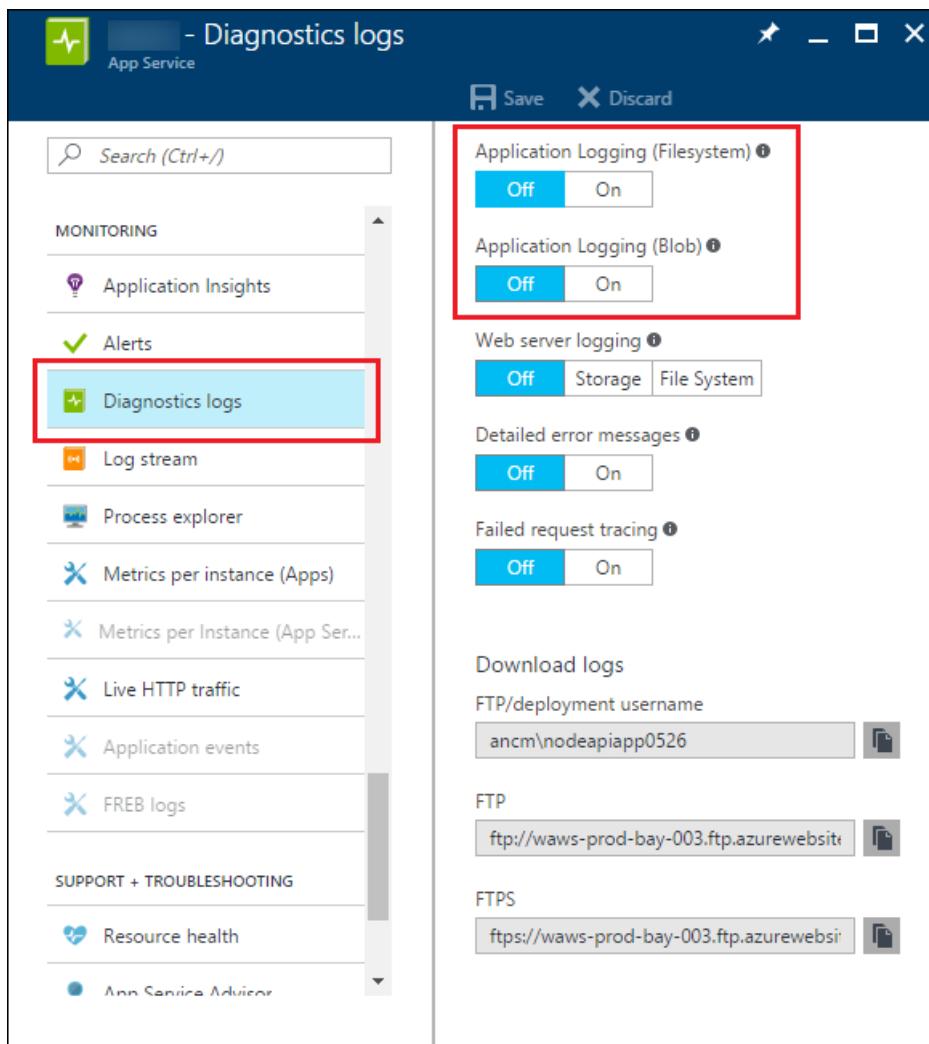
If targeting .NET Framework, add the provider package to the project and invoke [AddAzureWebAppDiagnostics](#):

```
logging.AddAzureWebAppDiagnostics();
```

```
loggerFactory.AddAzureWebAppDiagnostics();
```

An [AddAzureWebAppDiagnostics](#) overload lets you pass in [AzureAppServicesDiagnosticsSettings](#) with which you can override default settings such as the logging output template, blob name, and file size limit. (*Output template* is a message template that's applied to all logs on top of the one that you provide when you call an [ILogger](#) method.)

When you deploy to an App Service app, the app honors the settings in the [Diagnostic Logs](#) section of the **App Service** page of the Azure portal. When these settings are updated, the changes take effect immediately without requiring a restart or redeployment of the app.



The default location for log files is in the `D:\home\LogFiles\Application` folder, and the default file name is `diagnostics-yyyymmdd.txt`. The default file size limit is 10 MB, and the default maximum number of files retained is 2. The default blob name is `{app-name}{timestamp}/yyyy/mm/dd/hh/{guid}-applicationLog.txt`. For more information about default behavior, see [AzureAppServicesDiagnosticsSettings](#).

The provider only works when the project runs in the Azure environment. It has no effect when the project is run locally—it doesn't write to local files or local development storage for blobs.

## Third-party logging providers

Third-party logging frameworks that work with ASP.NET Core:

- [elmah.io \(GitHub repo\)](#)
- [Gelf \(GitHub repo\)](#)
- [JSONLog \(GitHub repo\)](#)
- [Loggr \(GitHub repo\)](#)
- [NLog \(GitHub repo\)](#)
- [Serilog \(GitHub repo\)](#)

Some third-party frameworks can perform [semantic logging](#), also known as structured logging.

Using a third-party framework is similar to using one of the built-in providers:

1. Add a NuGet package to your project.
2. Call an extension method on `ILoggerFactory`.

For more information, see each framework's documentation.

# Azure log streaming

Azure log streaming enables you to view log activity in real time from:

- The application server
- The web server
- Failed request tracing

To configure Azure log streaming:

- Navigate to the **Diagnostics Logs** page from your application's portal page
- Set **Application Logging (Filesystem)** to on.

The screenshot shows the 'Diagnostics logs' configuration page for an Azure App Service. The left sidebar lists various monitoring and troubleshooting tools. The 'Diagnostics logs' section is highlighted with a red box. On the right, the 'Application Logging (Filesystem)' settings are shown, with the 'On' button selected. Below it, the 'Level' is set to 'Warning'. Other sections like 'Application Logging (Blob)', 'Web server logging', and 'Failed request tracing' also have their respective settings visible. At the bottom, there are fields for 'Download logs', 'FTP/deployment username' (set to 'azure-raffle\azure-ftp-deployment-user'), 'FTP' (set to 'ftp://waws-prod-am2-135.ftp.azurewebsites.windows.net'), and 'FTPS' (set to 'ftps://waws-prod-am2-135.ftp.azurewebsites.windows.net').

Navigate to the **Log Streaming** page to view application messages. They're logged by application through the `ILogger` interface.

The screenshot shows the Azure Log stream interface for an App Service. The left sidebar contains a navigation menu with the following items:

- Search (Ctrl+ /)
- Performance test
- Resource explorer
- Testing in production
- Extensions
- MOBILE

  - Easy tables
  - Easy APIs
  - Data connections

- API

  - API definition
  - CORS

- MONITORING

  - Application Insights
  - Alerts
  - Diagnostics logs
  - Log stream** (highlighted with a red box)
  - Process explorer

- SUPPORT + TROUBLESHOOTING

  - Resource health
  - App Service Advisor

The main area displays the log stream with the following content:

```
Connecting...
2017-11-16T18:39:47 Welcome, you are now connected to log-streaming service.
2017-11-16 18:39:04 ~1/ GET /api/vfs/site/wwwroot/_=1510857327404&X-ARR-LOG-ID=36b4e37b-e31e-433d-82dd-(Windows+NT+10.0;+Win64;+x64)+AppleWebKit/537.36+(KHTML,+like+Gecko)+Chrome/62.0.3202.94+Safari/537.36 - https://we
ntent/WebsitesIndex?cacheability=3&region=eastus&cacheVersion=0&defaultCloudName=azure&extensionName=WebsitesExtens
uthority=portal.azure.com .scm.azurewebsites.net 200 0 0 966 1697 156
2017-11-16 18:39:06 GET / X-ARR-LOG-ID=784009e2-cecb-4815-968a-f63b9e8879a6 80 - 73.130.153.74 Mozilla
t/537.36+(KHTML,+like+Gecko)+Chrome/62.0.3202.94+Safari/537.36 ARRAffinity=146838c347f645f6238d55649b145f0b07798967
websites.net 403 14 0 370 943 296
2017-11-16 18:39:11 ~1/ GET /api/siteextensions X-ARR-LOG-ID=7850d378-909d-4b1d-a425-9408dab70910 443 - Mozilla/5.0+(Windows+NT+10.0;+Win64;+x64)+AppleWebKit/537.36+(KHTML,+like+Gecko)+Chrome/62.0.3202.94+Safari/537.36
0 499 1190 703
2017-11-16 18:39:39 GET /ticket.html X-ARR-LOG-ID=b7e33a93-f31e-436f-8214-672dfe954c74 80 - 73.130.153
+AppleWebKit/537.36+(KHTML,+like+Gecko)+Chrome/62.0.3202.94+Safari/537.36 ARRAffinity=146838c347f645f6238d55649b145
affle.azurewebsites.net 304 0 0 314 1087 696
2017-11-16 18:39:40 AZURE-RAFFLE GET /ticket.html X-ARR-LOG-ID=70f2946b-4139-4f65-a936-ba437411cdf9 80 - 73.130.153
+AppleWebKit/537.36+(KHTML,+like+Gecko)+Chrome/62.0.3202.94+Safari/537.36 ARRAffinity=146838c347f645f6238d55649b145
bsites.net 304 0 0 314 1087 218
2017-11-16 18:39:40 AZURE-RAFFLE GET /ticket.html X-ARR-LOG-ID=c5f3593f-4d4b-4811-b150-500d58341622 80 - 73.130.153
+AppleWebKit/537.36+(KHTML,+like+Gecko)+Chrome/62.0.3202.94+Safari/537.36 ARRAffinity=146838c347f645f6238d55649b145
affle.azurewebsites.net 304 0 0 314 1087 0
2017-11-16 18:39:54 AZURE-RAFFLE GET /ticket.html X-ARR-LOG-ID=ae4526f8-c8c7-4399-9f19-9c3fd8e7cdcb 80 - 73.130.153
+AppleWebKit/537.36+(KHTML,+like+Gecko)+Chrome/62.0.3202.94+Safari/537.36 ARRAffinity=146838c347f645f6238d55649b145
bsites.net 304 0 0 314 1087 15
```

## Azure Application Insights trace logging

The [Application Insights SDK](#) is capable of collecting trace telemetry from logs generated via the ASP.NET Core logging infrastructure. For more information, see [Microsoft/ApplicationInsights-aspnetcore Wiki: Logging](#).

## Additional resources

[High-performance logging with LoggerMessage](#)

# High-performance logging with LoggerMessage in ASP.NET Core

6/21/2018 • 7 minutes to read • [Edit Online](#)

By [Luke Latham](#)

`LoggerMessage` features create cacheable delegates that require fewer object allocations and reduced computational overhead compared to `logger extension methods`, such as `LogInformation`, `LogDebug`, and `.LogError`. For high-performance logging scenarios, use the `LoggerMessage` pattern.

`LoggerMessage` provides the following performance advantages over `Logger extension methods`:

- `Logger extension methods` require "boxing" (converting) value types, such as `int`, into `object`. The `LoggerMessage` pattern avoids boxing by using static `Action` fields and extension methods with strongly-typed parameters.
- `Logger extension methods` must parse the message template (named format string) every time a log message is written. `LoggerMessage` only requires parsing a template once when the message is defined.

[View or download sample code \(how to download\)](#)

The sample app demonstrates `LoggerMessage` features with a basic quote tracking system. The app adds and deletes quotes using an in-memory database. As these operations occur, log messages are generated using the `LoggerMessage` pattern.

## LoggerMessage.Define

`Define(LogLevel, EventId, String)` creates an `Action` delegate for logging a message. `Define` overloads permit passing up to six type parameters to a named format string (template).

The string provided to the `Define` method is a template and not an interpolated string. Placeholders are filled in the order that the types are specified. Placeholder names in the template should be descriptive and consistent across templates. They serve as property names within structured log data. We recommend [Pascal casing](#) for placeholder names. For example, `{Count}`, `{FirstName}`.

Each log message is an `Action` held in a static field created by `LoggerMessage.Define`. For example, the sample app creates a field to describe a log message for a GET request for the Index page (*Internal/LoggerExtensions.cs*):

```
private static readonly Action<ILogger, Exception> _indexPageRequested;
```

For the `Action`, specify:

- The log level.
- A unique event identifier (`EventId`) with the name of the static extension method.
- The message template (named format string).

A request for the Index page of the sample app sets the:

- Log level to `Information`.
- Event id to `1` with the name of the `IndexPageRequested` method.
- Message template (named format string) to a string.

```
_indexPageRequested = LoggerMessage.Define(
    LogLevel.Information,
    new EventId(1, nameof(IndexPageRequested)),
    "GET request for Index page");
```

Structured logging stores may use the event name when it's supplied with the event id to enrich logging. For example, [Serilog](#) uses the event name.

The `Action` is invoked through a strongly-typed extension method. The `IndexPageRequested` method logs a message for an Index page GET request in the sample app:

```
public static void IndexPageRequested(this ILogger logger)
{
    _indexPageRequested(logger, null);
}
```

`IndexPageRequested` is called on the logger in the `OnGetAsync` method in *Pages/Index.cshtml.cs*:

```
public async Task OnGetAsync()
{
    _logger.IndexPageRequested();

    Quotes = await _db.Quotes.AsNoTracking().ToListAsync();
}
```

Inspect the app's console output:

```
info: LoggerMessageSample.Pages.IndexModel[1]
      => RequestId:0HL90M6E7PHK4:00000001 RequestPath:/ => /Index
        GET request for Index page
```

To pass parameters to a log message, define up to six types when creating the static field. The sample app logs a string when adding a quote by defining a `string` type for the `Action` field:

```
private static readonly Action<ILogger, string, Exception> _quoteAdded;
```

The delegate's log message template receives its placeholder values from the types provided. The sample app defines a delegate for adding a quote where the quote parameter is a `string`:

```
_quoteAdded = LoggerMessage.Define<string>(
    LogLevel.Information,
    new EventId(2, nameof(QuoteAdded)),
    "Quote added (Quote = '{Quote}')");
```

The static extension method for adding a quote, `QuoteAdded`, receives the quote argument value and passes it to the `Action` delegate:

```
public static void QuoteAdded(this ILogger logger, string quote)
{
    _quoteAdded(logger, quote, null);
}
```

In the Index page's page model (*Pages/Index.cshtml.cs*), `quoteAdded` is called to log the message:

```

public async Task<IActionResult> OnPostAddQuoteAsync()
{
    _db.Quotes.Add(Quote);
    await _db.SaveChangesAsync();

    _logger.QuoteAdded(Quote.Text);

    return RedirectToAction();
}

```

Inspect the app's console output:

```

info: LoggerMessageSample.Pages.IndexModel[2]
      => RequestId:0HL90M6E7PHK5:0000000A RequestPath:/ => /Index
      Quote added (Quote = 'You can avoid reality, but you cannot avoid the consequences of avoiding reality.
      - Ayn Rand')

```

The sample app implements a `try – catch` pattern for quote deletion. An informational message is logged for a successful delete operation. An error message is logged for a delete operation when an exception is thrown. The log message for the unsuccessful delete operation includes the exception stack trace (*Internal/LoggerExtensions.cs*):

```

private static readonly Action<ILogger, string, int, Exception> _quoteDeleted;
private static readonly Action<ILogger, int, Exception> _quoteDeleteFailed;

```

```

_quoteDeleted = LoggerMessage.Define<string, int>(
    LogLevel.Information,
    new EventId(4, nameof(QuoteDeleted)),
    "Quote deleted (Quote = '{Quote}' Id = {Id})");

_quoteDeleteFailed = LoggerMessage.Define<int>(
    LogLevel.Error,
    new EventId(5, nameof(QuoteDeleteFailed)),
    "Quote delete failed (Id = {Id})");

```

Note how the exception is passed to the delegate in `QuoteDeleteFailed`:

```

public static void QuoteDeleted(this ILogger logger, string quote, int id)
{
    _quoteDeleted(logger, quote, id, null);
}

public static void QuoteDeleteFailed(this ILogger logger, int id, Exception ex)
{
    _quoteDeleteFailed(logger, id, ex);
}

```

In the page model for the Index page, a successful quote deletion calls the `QuoteDeleted` method on the logger. When a quote isn't found for deletion, an `ArgumentNullException` is thrown. The exception is trapped by the `try – catch` statement and logged by calling the `QuoteDeleteFailed` method on the logger in the `catch` block (*Pages/Index.cshtml.cs*):

```

public async Task<IActionResult> OnPostDeleteQuoteAsync(int id)
{
    var quote = await _db.Quotes.FindAsync(id);

    // DO NOT use this approach in production code!
    // You should check quote to see if it's null before removing
    // it and saving changes to the database. A try-catch is used
    // here for demonstration purposes of LoggerMessage features.
    try
    {
        _db.Quotes.Remove(quote);
        await _db.SaveChangesAsync();

        _logger.QuoteDeleted(quote.Text, id);
    }
    catch (ArgumentNullException ex)
    {
        _logger.QuoteDeleteFailed(id, ex);
    }

    return RedirectToAction();
}

```

When a quote is successfully deleted, inspect the app's console output:

```

info: LoggerMessageSample.Pages.IndexModel[4]
=> RequestId:0HL90M6E7PHK5:00000016 RequestPath:/ => /Index
    Quote deleted (Quote = 'You can avoid reality, but you cannot avoid the consequences of avoiding
    reality. - Ayn Rand' Id = 1)

```

When quote deletion fails, inspect the app's console output. Note that the exception is included in the log message:

```

fail: LoggerMessageSample.Pages.IndexModel[5]
=> RequestId:0HL90M6E7PHK5:00000010 RequestPath:/ => /Index
    Quote delete failed (Id = 999)
System.ArgumentNullException: Value cannot be null.
Parameter name: entity
    at Microsoft.EntityFrameworkCore.Utilities.Check.NotNull[T](T value, String parameterName)
    at Microsoft.EntityFrameworkCore.DbContext.Remove[TEntity](TEntity entity)
    at Microsoft.EntityFrameworkCore.Internal.InternalDbSet`1.Remove(TEntity entity)
    at LoggerMessageSample.Pages.IndexModel.<OnPostDeleteQuoteAsync>d__14.MoveNext() in
        <PATH>\sample\Pages\Index.cshtml.cs:line 87

```

## LoggerMessage.DefineScope

[DefineScope\(String\)](#) creates a `Func` delegate for defining a [log scope](#). `DefineScope` overloads permit passing up to three type parameters to a named format string (template).

As is the case with the `Define` method, the string provided to the `DefineScope` method is a template and not an interpolated string. Placeholders are filled in the order that the types are specified. Placeholder names in the template should be descriptive and consistent across templates. They serve as property names within structured log data. We recommend [Pascal casing](#) for placeholder names. For example, `{Count}`, `{FirstName}`.

Define a [log scope](#) to apply to a series of log messages using the [DefineScope\(String\)](#) method.

The sample app has a **Clear All** button for deleting all of the quotes in the database. The quotes are deleted by removing them one at a time. Each time a quote is deleted, the `QuoteDeleted` method is called on the logger. A log scope is added to these log messages.

Enable `IncludeScopes` in the console logger section of `appsettings.json`:

```
{  
  "Logging": {  
    "Console": {  
      "IncludeScopes": true  
    },  
    "LogLevel": {  
      "Default": "Warning"  
    }  
  },  
  "AllowedHosts": "*"  
}
```

To create a log scope, add a field to hold a `Func` delegate for the scope. The sample app creates a field called `_allQuotesDeletedScope` (`Internal/LoggerExtensions.cs`):

```
private static Func<ILogger, int, IDisposable> _allQuotesDeletedScope;
```

Use `DefineScope` to create the delegate. Up to three types can be specified for use as template arguments when the delegate is invoked. The sample app uses a message template that includes the number of deleted quotes (an `int` type):

```
_allQuotesDeletedScope = LoggerMessage.DefineScope<int>("All quotes deleted (Count = {Count})");
```

Provide a static extension method for the log message. Include any type parameters for named properties that appear in the message template. The sample app takes in a `count` of quotes to delete and returns

```
_allQuotesDeletedScope :
```

```
public static IDisposable AllQuotesDeletedScope(this ILogger logger, int count)  
{  
    return _allQuotesDeletedScope(logger, count);  
}
```

The scope wraps the logging extension calls in a `using` block:

```
public async Task<IActionResult> OnPostDeleteAllQuotesAsync()  
{  
    var quoteCount = await _db.Quote.CountAsync();  
  
    using (_logger.AllQuotesDeletedScope(quoteCount))  
    {  
        foreach (Quote quote in _db.Quote)  
        {  
            _db.Quote.Remove(quote);  
  
            _logger.QuoteDeleted(quote.Text, quote.Id);  
        }  
        await _db.SaveChangesAsync();  
    }  
  
    return RedirectToPage();  
}
```

Inspect the log messages in the app's console output. The following result shows three quotes deleted with the log scope message included:

```
info: LoggerMessageSample.Pages.IndexModel[4]
=> RequestId:0HL90M6E7PHK5:0000002E RequestPath:/ => /Index => All quotes deleted (Count = 3)
  Quote deleted (Quote = 'Quote 1' Id = 2)
info: LoggerMessageSample.Pages.IndexModel[4]
=> RequestId:0HL90M6E7PHK5:0000002E RequestPath:/ => /Index => All quotes deleted (Count = 3)
  Quote deleted (Quote = 'Quote 2' Id = 3)
info: LoggerMessageSample.Pages.IndexModel[4]
=> RequestId:0HL90M6E7PHK5:0000002E RequestPath:/ => /Index => All quotes deleted (Count = 3)
  Quote deleted (Quote = 'Quote 3' Id = 4)
```

## Additional resources

- [Logging](#)

# Handle errors in ASP.NET Core

7/10/2018 • 6 minutes to read • [Edit Online](#)

By [Steve Smith](#) and [Tom Dykstra](#)

This article covers common approaches to handling errors in ASP.NET Core apps.

[View or download sample code \(how to download\)](#)

## The developer exception page

To configure an app to display a page that shows detailed information about exceptions, use the *developer exception page*. The page made available by the [Microsoft.AspNetCore.Diagnostics](#) package, which is available in the [Microsoft.AspNetCore.App metapackage](#). Add a line to the `Startup.Configure` method:

To configure an app to display a page that shows detailed information about exceptions, use the *developer exception page*. The page is made available by the [Microsoft.AspNetCore.Diagnostics](#) package, which is available in the [Microsoft.AspNetCore.All metapackage](#). Add a line to the `Startup.Configure` method:

To configure an app to display a page that shows detailed information about exceptions, use the *developer exception page*. The page is made available by adding a package reference for the [Microsoft.AspNetCore.Diagnostics](#) package in the project file. Add a line to the `Startup.Configure` method:

```
public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    env.EnvironmentName = EnvironmentName.Production;

    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
    }
    else
    {
        app.UseExceptionHandler("/error");
    }
}
```

Place the call to [UseDeveloperExceptionPage](#) in front of any middleware where you want to catch exceptions, such as `app.UseMvc`.

### WARNING

Enable the developer exception page **only when the app is running in the Development environment**. You don't want to share detailed exception information publicly when the app runs in production. [Learn more about configuring environments](#).

To see the developer exception page, run the sample app with the environment set to `Development`, and add `?throw=true` to the base URL of the app. The page includes several tabs with information about the exception and the request. The first tab includes a stack trace:

An unhandled exception occurred while processing the request.

Exception: Exception triggered!

```
ErrorHandlingSample.Startup+<>c+<<Configure>b__1_4>d.MoveNext() in Startup.cs, line 67
```

Stack    Query    Cookies    Headers

Exception: Exception triggered!

```
ErrorHandlingSample.Startup+<>c+<<Configure>b__1_4>d.MoveNext() in Startup.cs
+   67.           var builder = new StringBuilder();
System.Runtime.ExceptionServices.ExceptionDispatchInfo.Throw()
Syste...[redacted]m.Runtime.CompilerServices.TaskAwaiter.HandleNonSuccessAndDebuggerNotification(Task task)
```

```
Syste...[redacted]m.Runtime.CompilerServices.TaskAwaiter.HandleNonSuccessAndDebuggerNotification(Task task)
Microsoft.AspNetCore.Diagnostics.DeveloperExceptionPageMiddleware+<Invoke>d__7.MoveNext()
```

Show raw exception details

The next tab shows the query string parameters, if any:

An unhandled exception occurred while processing the request.

Exception: Exception triggered!

```
ErrorHandlingSample.Startup+<>c+<<Configure>b__1_4>d.MoveNext() in Startup.cs, line 67
```

Stack    **Query**    Cookies    Headers

Variable	Value
throw	true

If the request has cookies, they appear on the **Cookies** tab. Headers are seen in the last tab:

An unhandled exception occurred while processing the request.

Exception: Exception triggered!

ErrorHandlingSample.Startup+<>c+<<Configure>b\_1\_4>d.MoveNext() in Startup.cs, line 67

Stack	Query	Cookies	Headers
Variable	Value		
Accept	text/html, application/xhtml+xml, image/jxr, */*		
Accept-Encoding	gzip, deflate		
Accept-Language	en-US		
Connection	Keep-Alive		
Host	localhost:13930		
MS-ASPNETCORE-TOKEN	55ddb2cf-3cf5-4734-afa9-7abcbf38839f		
Referer	http://localhost:13930/		
User-Agent	Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/51.0.2704.79 Safari/537.36 Edge/14.14393		
X-Original-For	127.0.0.1:20566		
X-Original-Proto	http		

## Configuring a custom exception handling page

Configure an exception handler page to use when the app isn't running in the `Development` environment:

```
public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    env.EnvironmentName = EnvironmentName.Production;

    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
    }
    else
    {
        app.UseExceptionHandler("/error");
    }
}
```

In a Razor Pages app, the `dotnet new` Razor Pages template provides an Error page and `ErrorModel` page model class in the *Pages* folder.

In an MVC app, don't decorate the error handler action method with HTTP method attributes, such as `HttpGet`. Explicit verbs prevent some requests from reaching the method. Allow anonymous access to the method so that unauthenticated users are able to receive the error view.

For example, the following error handler method is provided by the `dotnet new` MVC template and appears in the Home controller:

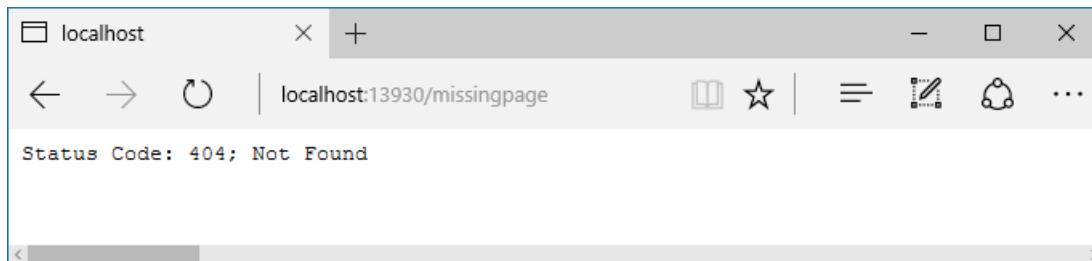
```
[AllowAnonymous]
public IActionResult Error()
{
    return View(new ErrorViewModel
    { RequestId = Activity.Current?.Id ?? HttpContext.TraceIdentifier });
}
```

## Configuring status code pages

By default, an app doesn't provide a rich status code page for HTTP status codes, such as *404 Not Found*. To provide status code pages, configure the Status Code Pages Middleware by adding a line to the `Startup.Configure` method:

```
app.UseStatusCodePages();
```

By default, Status Code Pages Middleware adds text-only handlers for common status codes, such as 404:



The middleware supports several extension methods. One method takes a lambda expression:

```
app.UseStatusCodePages(async context =>
{
    context.HttpContext.Response.ContentType = "text/plain";

    await context.HttpContext.Response.WriteAsync(
        "Status code page, status code: " +
        context.HttpContext.Response.StatusCode);
});
```

Another method takes a content type and format string:

```
app.UseStatusCodePages("text/plain", "Status code page, status code: {0}");
```

There's also redirect and re-execute extension methods. The redirect method sends a *302 Found* status code to the client:

```
app.UseStatusCodePagesWithRedirects("/error/{0}");
```

The re-execute method returns the original status code to the client but also executes the handler for the redirect URL:

```
app.UseStatusCodePagesWithReExecute("/error/{0}");
```

Status code pages can be disabled for specific requests in a Razor Pages handler method or in an MVC controller. To disable status code pages, attempt to retrieve the `IStatusCodePagesFeature` from the request's `HttpContext.Features` collection and disable the feature if it's available:

```

var statusCodePagesFeature = HttpContext.Features.Get<IStatusCodePagesFeature>();

if (statusCodePagesFeature != null)
{
    statusCodePagesFeature.Enabled = false;
}

```

If using a `UseStatusCodePages*` overload that points to an endpoint within the app, create an MVC view or Razor Page for the endpoint. For example, the `dotnet new` template for a Razor Pages app produces the following page and page model class:

*Error.cshtml:*

```

@page
@model ErrorModel
 @{
     ViewData["Title"] = "Error";
 }

<h1 class="text-danger">Error.</h1>
<h2 class="text-danger">An error occurred while processing your request.</h2>

@if (Model.ShowRequestId)
{
    <p>
        <strong>Request ID:</strong> <code>@Model.RequestId</code>
    </p>
}

<h3>Development Mode</h3>
<p>
    Swapping to <strong>Development</strong> environment will display more detailed
    information about the error that occurred.
</p>
<p>
    <strong>Development environment should not be enabled in deployed applications
    </strong>, as it can result in sensitive information from exceptions being
    displayed to end users. For local debugging, development environment can be
    enabled by setting the <strong>ASPNETCORE_ENVIRONMENT</strong> environment
    variable to <strong>Development</strong>, and restarting the application.
</p>

```

*Error.cshtml.cs:*

```

public class ErrorModel : PageModel
{
    public string RequestId { get; set; }

    public bool ShowRequestId => !string.IsNullOrEmpty(RequestId);

    [ResponseCache(Duration = 0, Location = ResponseCacheLocation.None,
        NoStore = true)]
    public void OnGet()
    {
        RequestId = Activity.Current?.Id ?? HttpContext.TraceIdentifier;
    }
}

```

## Exception-handling code

Code in exception handling pages can throw exceptions. It's often a good idea for production error pages to

consist of purely static content.

Also, be aware that once the headers for a response have been sent, you can't change the response's status code, nor can any exception pages or handlers run. The response must be completed or the connection aborted.

## Server exception handling

In addition to the exception handling logic in your app, the [server](#) hosting your app performs some exception handling. If the server catches an exception before the headers are sent, the server sends a *500 Internal Server Error* response with no body. If the server catches an exception after the headers have been sent, the server closes the connection. Requests that aren't handled by your app are handled by the server. Any exception that occurs is handled by the server's exception handling. Any configured custom error pages or exception handling middleware or filters don't affect this behavior.

## Startup exception handling

Only the hosting layer can handle exceptions that take place during app startup. Using the [Web Host](#), you can [configure how the host behaves in response to errors during startup](#) with the `captureStartupErrors` and `detailedErrors` keys.

Hosting can only show an error page for a captured startup error if the error occurs after host address/port binding. If any binding fails for any reason, the hosting layer logs a critical exception, the dotnet process crashes, and no error page is displayed when the app is running on the [Kestrel](#) server.

When running on [IIS](#) or [IIS Express](#), a *502.5 Process Failure* is returned by the [ASP.NET Core Module](#) if the process can't be started. For information on troubleshooting startup issues when hosting with IIS, see [Troubleshoot ASP.NET Core on IIS](#). For information on troubleshooting startup issues with Azure App Service, see [Troubleshoot ASP.NET Core on Azure App Service](#).

## ASP.NET MVC error handling

[MVC](#) apps have some additional options for handling errors, such as configuring exception filters and performing model validation.

### Exception filters

Exception filters can be configured globally or on a per-controller or per-action basis in an MVC app. These filters handle any unhandled exception that occurs during the execution of a controller action or another filter. These filters aren't called otherwise. To learn more, see [Filters](#).

#### TIP

Exception filters are good for trapping exceptions that occur within MVC actions, but they're not as flexible as error handling middleware. Generally prefer the use of middleware, and use filters only where you need to perform error handling *differently* based on which MVC action is chosen.

### Handling model state errors

[Model validation](#) occurs prior to invoking each controller action, and it's the action method's responsibility to inspect `ModelState.IsValid` and react appropriately.

Some apps choose to follow a standard convention for dealing with model validation errors, in which case a [filter](#) may be an appropriate place to implement such a policy. You should test how your actions behave with invalid model states. Learn more in [Test controller logic](#).

## Additional resources

- [Common errors reference for Azure App Service and IIS with ASP.NET Core](#)
- [Troubleshoot ASP.NET Core on IIS](#)
- [Troubleshoot ASP.NET Core on Azure App Service](#)

# File Providers in ASP.NET Core

6/21/2018 • 6 minutes to read • [Edit Online](#)

By [Steve Smith](#)

ASP.NET Core abstracts file system access through the use of File Providers.

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## File Provider abstractions

File Providers are an abstraction over file systems. The main interface is `IFileProvider`. `IFileProvider` exposes methods to get file information (`IFileInfo`), directory information (`IDirectoryContents`), and to set up change notifications (using an `IChangeToken`).

`IFileInfo` provides methods and properties about individual files or directories. It has two boolean properties, `Exists` and `IsDirectory`, as well as properties describing the file's `Name`, `Length` (in bytes), and `LastModified` date. You can read from the file using its `CreateReadStream` method.

## File Provider implementations

Three implementations of `IFileProvider` are available: Physical, Embedded, and Composite. The physical provider is used to access the actual system's files. The embedded provider is used to access files embedded in assemblies. The composite provider is used to provide combined access to files and directories from one or more other providers.

### PhysicalFileProvider

The `PhysicalFileProvider` provides access to the physical file system. It wraps the `System.IO.File` type (for the physical provider), scoping all paths to a directory and its children. This scoping limits access to a certain directory and its children, preventing access to the file system outside of this boundary. When instantiating this provider, you must provide it with a directory path, which serves as the base path for all requests made to this provider (and which restricts access outside of this path). In an ASP.NET Core app, you can instantiate a `PhysicalFileProvider` provider directly, or you can request an `IFileProvider` in a Controller or service's constructor through [dependency injection](#). The latter approach will typically yield a more flexible and testable solution.

The sample below shows how to create a `PhysicalFileProvider`.

```
IFileProvider provider = new PhysicalFileProvider(applicationRoot);
IDirectoryContents contents = provider.GetDirectoryContents(""); // the applicationRoot contents
IFileInfo fileInfo = provider.GetFileInfo("wwwroot/js/site.js"); // a file under applicationRoot
```

You can iterate through its directory contents or get a specific file's information by providing a subpath.

To request a provider from a controller, specify it in the controller's constructor and assign it to a local field. Use the local instance from your action methods:

```

public class HomeController : Controller
{
    private readonly IFileProvider _fileProvider;

    public HomeController(IFileProvider fileProvider)
    {
        _fileProvider = fileProvider;
    }

    public IActionResult Index()
    {
        var contents = _fileProvider.GetDirectoryContents("");
        return View(contents);
    }
}

```

Then, create the provider in the app's `Startup` class:

```

using System.Linq;
using System.Reflection;
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.Configuration;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.FileProviders;
using Microsoft.Extensions.Logging;

namespace FileProviderSample
{
    public class Startup
    {
        private IHostingEnvironment _hostingEnvironment;
        public Startup(IHostingEnvironment env)
        {
            var builder = new ConfigurationBuilder()
                .SetBasePath(env.ContentRootPath)
                .AddJsonFile("appsettings.json", optional: true, reloadOnChange: true)
                .AddJsonFile($"appsettings.{env.EnvironmentName}.json", optional: true)
                .AddEnvironmentVariables();
            Configuration = builder.Build();

            _hostingEnvironment = env;
        }

        public IConfigurationRoot Configuration { get; }

        // This method gets called by the runtime. Use this method to add services to the container.
        public void ConfigureServices(IServiceCollection services)
        {
            // Add framework services.
            services.AddMvc();

            var physicalProvider = _hostingEnvironment.ContentRootFileProvider;
            var embeddedProvider = new EmbeddedFileProvider(Assembly.GetEntryAssembly());
            var compositeProvider = new CompositeFileProvider(physicalProvider, embeddedProvider);

            // choose one provider to use for the app and register it
            //services.AddSingleton<IFileProvider>(physicalProvider);
            //services.AddSingleton<IFileProvider>(embeddedProvider);
            services.AddSingleton<IFileProvider>(compositeProvider);
        }
}

```

In the `/Index.cshtml` view, iterate through the `IDirectoryContents` provided:

```

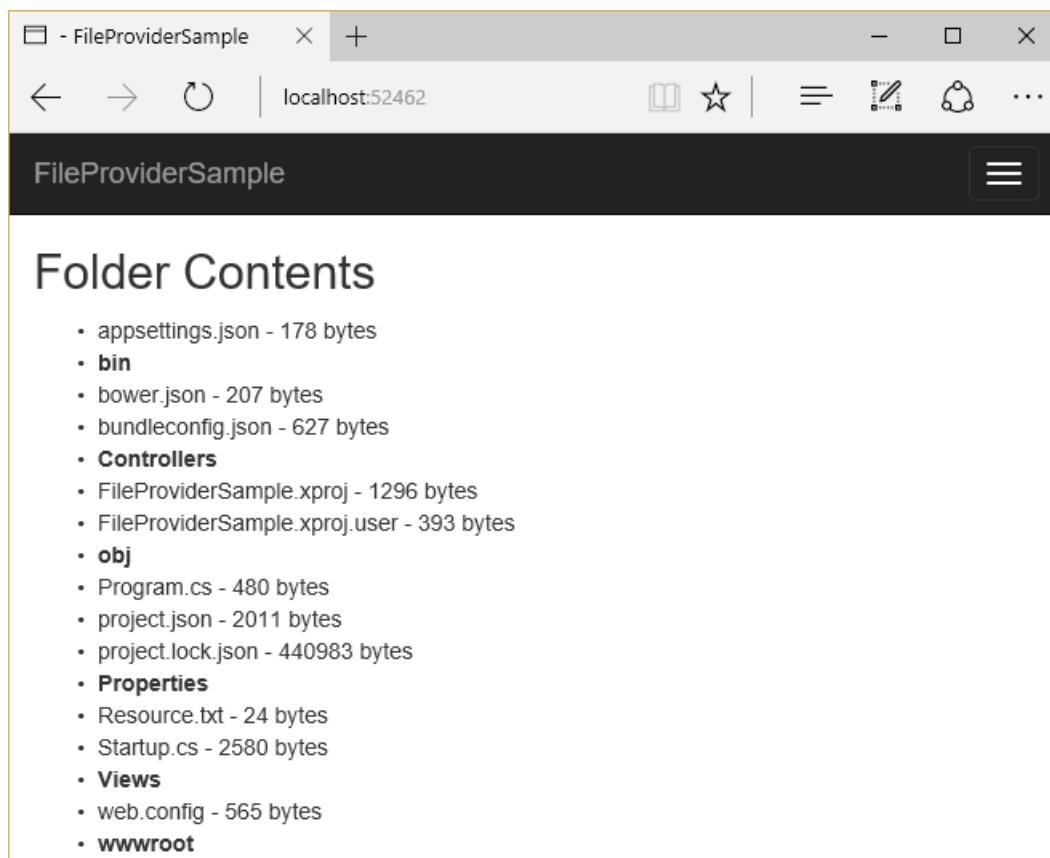
@using Microsoft.Extensions.FileProviders
@model IDirectoryContents

<h2>Folder Contents</h2>

<ul>
    @foreach (IFileInfo item in Model)
    {
        if (item.IsDirectory)
        {
            <li><strong>@item.Name</strong></li>
        }
        else
        {
            <li>@item.Name - @item.Length bytes</li>
        }
    }
</ul>

```

The result:



## EmbeddedFileProvider

The `EmbeddedFileProvider` is used to access files embedded in assemblies. In .NET Core, you embed files in an assembly with the `<EmbeddedResource>` element in the `.csproj` file:

```

<ItemGroup>
    <EmbeddedResource Include="Resource.txt;**\*.js"
        Exclude="bin\**;obj\**;**\*.xproj;packages\**;@(EmbeddedResource)" />
    <Content Update="wwwroot\**\*;Views\**\*;Areas\**\Views;appsettings.json;web.config">
        <CopyToPublishDirectory>PreserveNewest</CopyToPublishDirectory>
    </Content>
</ItemGroup>

```

You can use [globbing patterns](#) when specifying files to embed in the assembly. These patterns can be used to

match one or more files.

#### NOTE

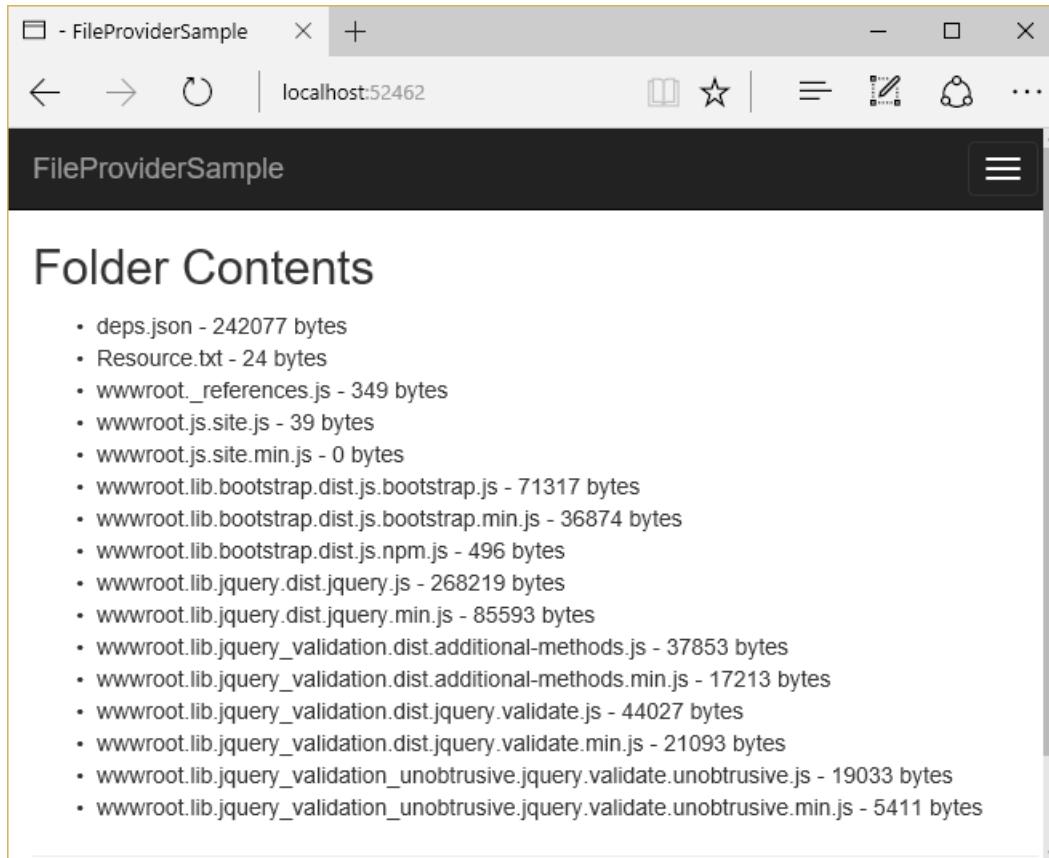
It's unlikely you would ever want to actually embed every .js file in your project in its assembly; the above sample is for demo purposes only.

When creating an `EmbeddedFileProvider`, pass the assembly it will read to its constructor.

```
var embeddedProvider = new EmbeddedFileProvider(Assembly.GetEntryAssembly());
```

The snippet above demonstrates how to create an `EmbeddedFileProvider` with access to the currently executing assembly.

Updating the sample app to use an `EmbeddedFileProvider` results in the following output:



#### NOTE

Embedded resources don't expose directories. Rather, the path to the resource (via its namespace) is embedded in its filename using `.` separators.

#### TIP

The `EmbeddedFileProvider` constructor accepts an optional `baseNamespace` parameter. Specifying this will scope calls to `GetDirectoryContents` to those resources under the provided namespace.

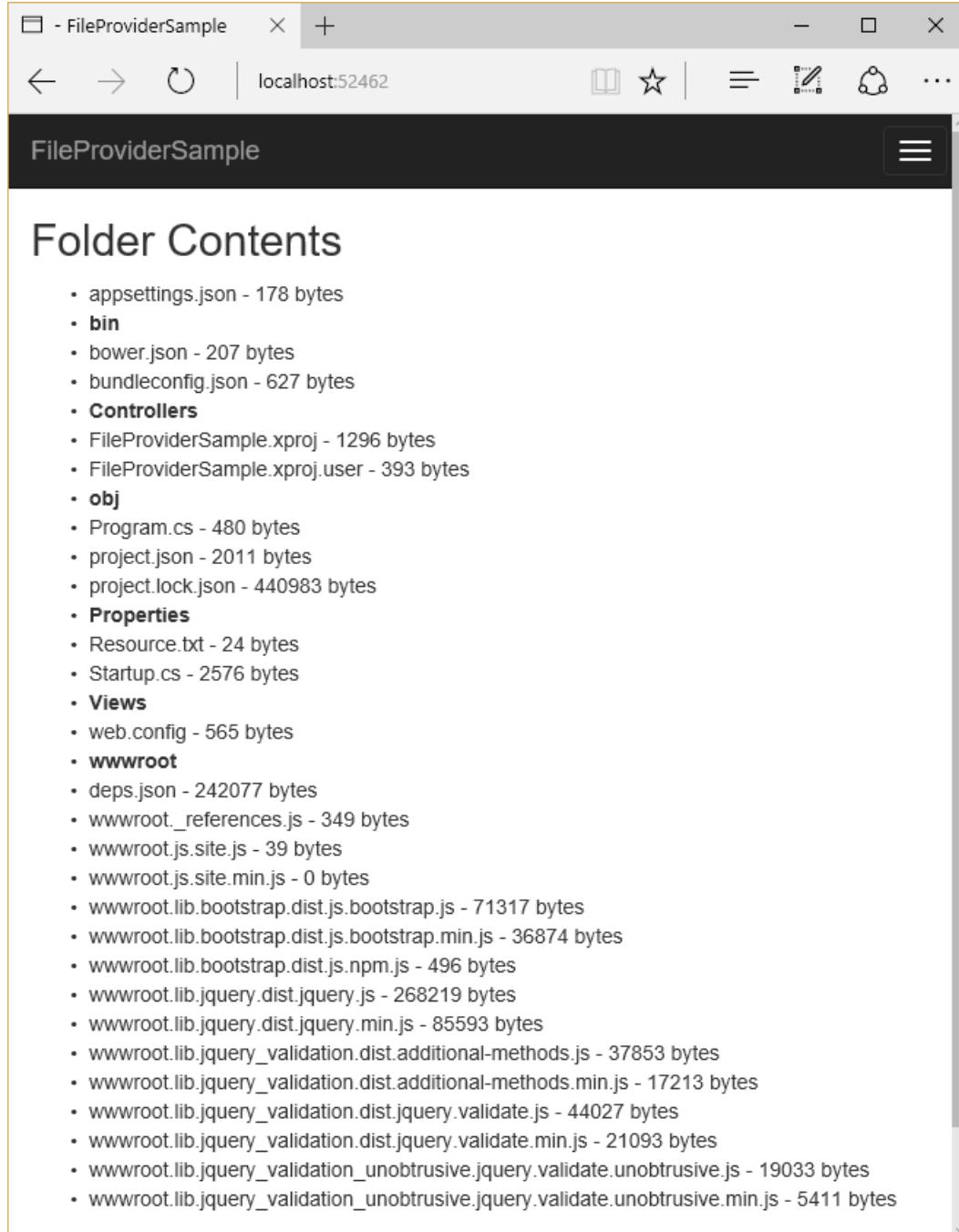
## CompositeFileProvider

The `CompositeFileProvider` combines `IFileProvider` instances, exposing a single interface for working with files from multiple providers. When creating the `CompositeFileProvider`, you pass one or more `IFileProvider`

instances to its constructor:

```
var physicalProvider = _hostingEnvironment.ContentRootFileProvider;
var embeddedProvider = new EmbeddedFileProvider(Assembly.GetEntryAssembly());
var compositeProvider = new CompositeFileProvider(physicalProvider, embeddedProvider);
```

Updating the sample app to use a `CompositeFileProvider` that includes both the physical and embedded providers configured previously, results in the following output:



## Watching for changes

The `IFileProvider` `Watch` method provides a way to watch one or more files or directories for changes. This method accepts a path string, which can use [globbing patterns](#) to specify multiple files, and returns an `IChangeToken`. This token exposes a `HasChanged` property that can be inspected, and a `RegisterChangeCallback` method that's called when changes are detected to the specified path string. Note that each change token only calls its associated callback in response to a single change. To enable constant monitoring, you can use a `TaskCompletionSource` as shown below, or re-create `IChangeToken` instances in response to changes.

In this article's sample, a console application is configured to display a message whenever a text file is modified:

```
private static PhysicalFileProvider _fileProvider =
    new PhysicalFileProvider(Directory.GetCurrentDirectory());

public static void Main(string[] args)
{
    Console.WriteLine("Monitoring quotes.txt for changes (Ctrl-c to quit)...");

    while (true)
    {
        MainAsync().GetAwaiter().GetResult();
    }
}

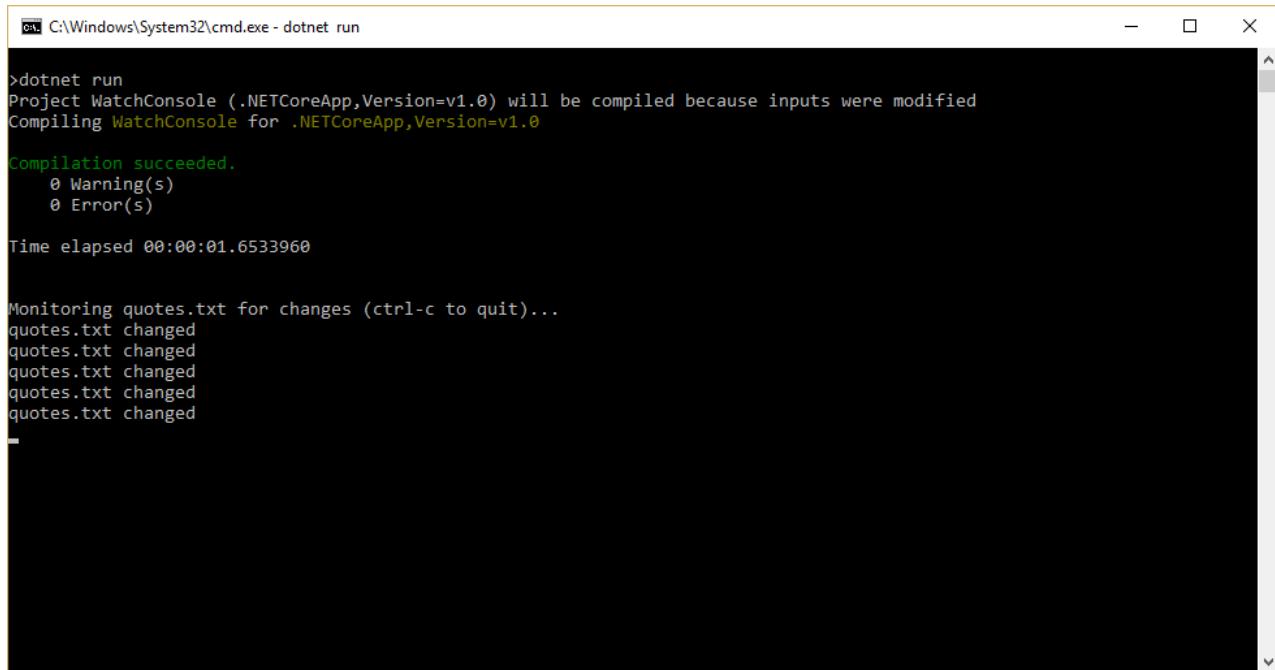
private static async Task MainAsync()
{
    IChangeToken token = _fileProvider.Watch("quotes.txt");
    var tcs = new TaskCompletionSource<object>();

    token.RegisterChangeCallback(state =>
        ((TaskCompletionSource<object>)state).TrySetResult(null), tcs);

    await tcs.Task.ConfigureAwait(false);

    Console.WriteLine("quotes.txt changed");
}
```

The result, after saving the file several times:



```
C:\Windows\System32\cmd.exe - dotnet run

>dotnet run
Project WatchConsole (.NETCoreApp,Version=v1.0) will be compiled because inputs were modified
Compiling WatchConsole for .NETCoreApp,Version=v1.0

Compilation succeeded.
  0 Warning(s)
  0 Error(s)

Time elapsed 00:00:01.6533960

Monitoring quotes.txt for changes (ctrl-c to quit)...
quotes.txt changed
quotes.txt changed
quotes.txt changed
quotes.txt changed
quotes.txt changed
```

#### NOTE

Some file systems, such as Docker containers and network shares, may not reliably send change notifications. Set the `DOTNET_USE_POLLINGFILEWATCHER` environment variable to `1` or `true` to poll the file system for changes every 4 seconds.

## Globbing patterns

File system paths use wildcard patterns called *globbing patterns*. These simple patterns can be used to specify groups of files. The two wildcard characters are `*` and `**`.

\*

Matches anything at the current folder level, or any filename, or any file extension. Matches are terminated by `/` and `.` characters in the file path.

\*\*

Matches anything across multiple directory levels. Can be used to recursively match many files within a directory hierarchy.

## Globbing pattern examples

`directory/file.txt`

Matches a specific file in a specific directory.

`directory/*.txt`

Matches all files with `.txt` extension in a specific directory.

`directory/*bower.json`

Matches all `bower.json` files in directories exactly one level below the `directory` directory.

`directory/**/*.txt`

Matches all files with `.txt` extension found anywhere under the `directory` directory.

## File Provider usage in ASP.NET Core

Several parts of ASP.NET Core utilize file providers. `IHostingEnvironment` exposes the app's content root and web root as `IFileProvider` types. The static files middleware uses file providers to locate static files. Razor makes heavy use of `IFileProvider` in locating views. Dotnet's publish functionality uses file providers and globbing patterns to specify which files should be published.

## Recommendations for use in apps

If your ASP.NET Core app requires file system access, you can request an instance of `IFileProvider` through dependency injection, and then use its methods to perform the access, as shown in this sample. This allows you to configure the provider once, when the app starts up, and reduces the number of implementation types your app instantiates.

# Host in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

.NET apps configure and launch a *host*. The host is responsible for app startup and lifetime management. Two host APIs are available for use:

- [Web Host](#) – Suitable for hosting web apps.
- [Generic Host](#) (ASP.NET Core 2.1 or later) – Suitable for hosting non-web apps (for example, apps that run background tasks). In a future release, the Generic Host will be suitable for hosting any kind of app, including web apps. The Generic Host will eventually replace the Web Host.

For hosting ASP.NET Core *web apps*, developers should use the Web Host based on [IWebHostBuilder](#). For hosting *non-web apps*, developers should use the Generic Host based on [HostBuilder](#).

# ASP.NET Core Web Host

7/6/2018 • 17 minutes to read • [Edit Online](#)

By [Luke Latham](#)

ASP.NET Core apps configure and launch a *host*. The host is responsible for app startup and lifetime management. At a minimum, the host configures a server and a request processing pipeline. This topic covers the ASP.NET Core Web Host ([IWebHostBuilder](#)), which is useful for hosting web apps. For coverage of the .NET Generic Host ([IHostBuilder](#)), see [.NET Generic Host](#).

## Set up a host

Create a host using an instance of [IWebHostBuilder](#). This is typically performed in the app's entry point, the `Main` method. In the project templates, `Main` is located in *Program.cs*. A typical *Program.cs* calls [CreateDefaultBuilder](#) to start setting up a host:

```
public class Program
{
    public static void Main(string[] args)
    {
        CreateWebHostBuilder(args).Build().Run();
    }

    public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
        WebHost.CreateDefaultBuilder(args)
            .UseStartup<Startup>();
}
```

`CreateDefaultBuilder` performs the following tasks:

- Configures [Kestrel](#) as the web server and configures the server using the app's hosting configuration providers. For the Kestrel default options, see [Kestrel web server implementation in ASP.NET Core](#).
- Sets the content root to the path returned by [Directory.GetCurrentDirectory](#).
- Loads [host configuration](#) from:
  - Environment variables prefixed with `ASPNETCORE_` (for example, `ASPNETCORE_ENVIRONMENT`).
  - Command-line arguments.
  - Loads app configuration from:
    - `appsettings.json`.
    - `appsettings.{Environment}.json`.
  - [User secrets](#) when the app runs in the `Development` environment using the entry assembly.
  - Environment variables.
  - Command-line arguments.
- Configures [logging](#) for console and debug output. Logging includes [log filtering](#) rules specified in a Logging configuration section of an `appsettings.json` or `appsettings.{Environment}.json` file.
- When running behind IIS, enables [IIS integration](#). Configures the base path and port the server listens on when using the [ASP.NET Core Module](#). The module creates a reverse proxy between IIS and Kestrel. Also configures the app to [capture startup errors](#). For the IIS default options, see [Host ASP.NET Core on Windows with IIS](#).
- Sets `ServiceProviderOptions.ValidateScopes` to `true` if the app's environment is Development. For more information, see [Scope validation](#).

The configuration defined by `CreateDefaultBuilder` can be overridden and augmented by `ConfigureAppConfiguration`, `ConfigureLogging`, and other methods and extension methods of `IWebHostBuilder`. A few examples follow:

- `ConfigureAppConfiguration` is used to specify additional `IConfiguration` for the app. The following `ConfigureAppConfiguration` call adds a delegate to include app configuration in the `appsettings.xml` file. `ConfigureAppConfiguration` may be called multiple times. Note that this configuration doesn't apply to the host (for example, server URLs or environment). See the [Host configuration values](#) section.

```
WebHost.CreateDefaultBuilder(args)
    .ConfigureAppConfiguration((hostingContext, config) =>
{
    config.AddXmlFile("appsettings.xml", optional: true, reloadOnChange: true);
})
...
...
```

- The following `ConfigureLogging` call adds a delegate to configure the minimum logging level (`SetMinimumLevel`) to `LogLevel.Warning`. This setting overrides the settings in `appsettings.Development.json` (`LogLevel.Debug`) and `appsettings.Production.json` (`LogLevel.Error`) configured by `CreateDefaultBuilder`. `ConfigureLogging` may be called multiple times.

```
WebHost.CreateDefaultBuilder(args)
    .ConfigureLogging(logging =>
{
    logging.SetMinimumLevel(LogLevel.Warning);
})
...
...
```

- The following call to `UseKestrel` overrides the default `Limits.MaxRequestBodySize` of 30,000,000 bytes established when Kestrel was configured by `CreateDefaultBuilder`:

```
WebHost.CreateDefaultBuilder(args)
    .UseKestrel(options =>
{
    options.Limits.MaxRequestBodySize = 20000000;
});
...
...
```

The `content root` determines where the host searches for content files, such as MVC view files. When the app is started from the project's root folder, the project's root folder is used as the content root. This is the default used in [Visual Studio](#) and the [dotnet new templates](#).

For more information on app configuration, see [Configuration in ASP.NET Core](#).

#### NOTE

As an alternative to using the static `CreateDefaultBuilder` method, creating a host from `WebHostBuilder` is a supported approach with ASP.NET Core 2.x. For more information, see the [ASP.NET Core 1.x tab](#).

Create a host using an instance of `WebHostBuilder`. Creating a host is typically performed in the app's entry point, the `Main` method. In the project templates, `Main` is located in `Program.cs`:

```

public class Program
{
    public static void Main(string[] args)
    {
        BuildWebHost(args).Run();
    }

    public static IWebHost BuildWebHost(string[] args) =>
        WebHost.CreateDefaultBuilder(args)
            .UseStartup<Startup>()
            .Build();
}

```

`WebHostBuilder` requires a [server that implements `IHostBuilder`](#). The built-in servers are [Kestrel](#) and [HTTP.sys](#) (prior to the release of ASP.NET Core 2.0, HTTP.sys was called [WebListener](#)). In this example, the [UseKestrel extension method](#) specifies the Kestrel server.

The [content root](#) determines where the host searches for content files, such as MVC view files. The default content root is obtained for `UseContentRoot` by [Directory.GetCurrentDirectory](#). When the app is started from the project's root folder, the project's root folder is used as the content root. This is the default used in [Visual Studio](#) and the [dotnet new templates](#).

To use IIS as a reverse proxy, call [UseIISIntegration](#) as part of building the host. `UseIISIntegration` doesn't configure a [server](#), like [UseKestrel](#) does. `UseIISIntegration` configures the base path and port the server listens on when using the [ASP.NET Core Module](#) to create a reverse proxy between Kestrel and IIS. To use IIS with ASP.NET Core, `UseKestrel` and `UseIISIntegration` must be specified. `UseIISIntegration` only activates when running behind IIS or IIS Express. For more information, see [ASP.NET Core Module](#) and [ASP.NET Core Module configuration reference](#).

A minimal implementation that configures a host (and an ASP.NET Core app) includes specifying a server and configuration of the app's request pipeline:

```

var host = new WebHostBuilder()
    .UseKestrel()
    .Configure(app =>
    {
        app.Run(context => context.Response.WriteAsync("Hello World!"));
    })
    .Build();

host.Run();

```

When setting up a host, [Configure](#) and [ConfigureServices](#) methods can be provided. If a `Startup` class is specified, it must define a `Configure` method. For more information, see [Application startup in ASP.NET Core](#). Multiple calls to `ConfigureServices` append to one another. Multiple calls to `Configure` or `UseStartup` on the `WebHostBuilder` replace previous settings.

## Host configuration values

`WebHostBuilder` relies on the following approaches to set the host configuration values:

- Host builder configuration, which includes environment variables with the format `ASPNETCORE_{configurationKey}`. For example, `ASPNETCORE_ENVIRONMENT`.
- Extensions such as [UseContentRoot](#) and [UseConfiguration](#) (see the [Override configuration](#) section).
- [UseSetting](#) and the associated key. When setting a value with `useSetting`, the value is set as a string regardless of the type.

The host uses whichever option sets a value last. For more information, see [Override configuration](#) in the next section.

### Application Key (Name)

The `IHostingEnvironment.ApplicationName` property is automatically set when `UseStartup` or `Configure` is called during host construction. The value is set to the name of the assembly containing the app's entry point. To set the value explicitly, use the `WebHostDefaults.ApplicationKey`:

**Key:** `applicationName`

**Type:** `string`

**Default:** The name of the assembly containing the app's entry point.

**Set using:** `UseSetting`

**Environment variable:** `ASPNETCORE_APPLICATIONKEY`

```
WebHost.CreateDefaultBuilder(args)
    .UseSetting(WebHostDefaults.ApplicationKey, "CustomApplicationName")
```

```
var host = new WebHostBuilder()
    .UseSetting("applicationName", "CustomApplicationName")
```

### Capture Startup Errors

This setting controls the capture of startup errors.

**Key:** `captureStartupErrors`

**Type:** `bool` (`true` or `1`)

**Default:** Defaults to `false` unless the app runs with Kestrel behind IIS, where the default is `true`.

**Set using:** `CaptureStartupErrors`

**Environment variable:** `ASPNETCORE_CAPTURESTARTUPERRORS`

When `false`, errors during startup result in the host exiting. When `true`, the host captures exceptions during startup and attempts to start the server.

```
WebHost.CreateDefaultBuilder(args)
    .CaptureStartupErrors(true)
```

```
var host = new WebHostBuilder()
    .CaptureStartupErrors(true)
```

### Content Root

This setting determines where ASP.NET Core begins searching for content files, such as MVC views.

**Key:** `contentRoot`

**Type:** `string`

**Default:** Defaults to the folder where the app assembly resides.

**Set using:** `UseContentRoot`

**Environment variable:** `ASPNETCORE_CONTENTROOT`

The content root is also used as the base path for the [Web Root setting](#). If the path doesn't exist, the host fails to start.

```
WebHost.CreateDefaultBuilder(args)
    .UseContentRoot("c:\\<content-root>")
```

```
var host = new WebHostBuilder()
    .UseContentRoot("c:\\<content-root>")
```

## Detailed Errors

Determines if detailed errors should be captured.

**Key:** detailedErrors

**Type:** bool (`true` or `1`)

**Default:** false

**Set using:** `UseSetting`

**Environment variable:** `ASPNETCORE_DETAILEDERRORS`

When enabled (or when the [Environment](#) is set to `Development`), the app captures detailed exceptions.

```
WebHost.CreateDefaultBuilder(args)
    .UseSetting(WebHostDefaults.DetailedErrorsKey, "true")
```

```
var host = new WebHostBuilder()
    .UseSetting(WebHostDefaults.DetailedErrorsKey, "true")
```

## Environment

Sets the app's environment.

**Key:** environment

**Type:** string

**Default:** Production

**Set using:** `UseEnvironment`

**Environment variable:** `ASPNETCORE_ENVIRONMENT`

The environment can be set to any value. Framework-defined values include `Development`, `Staging`, and `Production`. Values aren't case sensitive. By default, the *Environment* is read from the `ASPNETCORE_ENVIRONMENT` environment variable. When using [Visual Studio](#), environment variables may be set in the *launchSettings.json* file. For more information, see [Use multiple environments in ASP.NET Core](#).

```
WebHost.CreateDefaultBuilder(args)
    .UseEnvironment(EnvironmentName.Development)
```

```
var host = new WebHostBuilder()
    .UseEnvironment(EnvironmentName.Development)
```

## Hosting Startup Assemblies

Sets the app's hosting startup assemblies.

**Key:** hostingStartupAssemblies

**Type:** string

**Default:** Empty string

**Set using:** `UseSetting`

## **Environment variable:** ASPNETCORE\_HOSTINGSTARTUPASSEMBLIES

A semicolon-delimited string of hosting startup assemblies to load on startup.

Although the configuration value defaults to an empty string, the hosting startup assemblies always include the app's assembly. When hosting startup assemblies are provided, they're added to the app's assembly for loading when the app builds its common services during startup.

```
WebHost.CreateDefaultBuilder(args)
    .UseSetting(WebHostDefaults.HostingStartupAssembliesKey, "assembly1;assembly2")
```

## Prefer Hosting URLs

Indicates whether the host should listen on the URLs configured with the `WebHostBuilder` instead of those configured with the `IIServer` implementation.

**Key:** preferHostingUrls

**Type:** `bool` (`true` or `1`)

**Default:** true

**Set using:** `PreferHostingUrls`

**Environment variable:** ASPNETCORE\_PREFERHOSTINGURLS

```
WebHost.CreateDefaultBuilder(args)
    .PreferHostingUrls(false)
```

## Prevent Hosting Startup

Prevents the automatic loading of hosting startup assemblies, including hosting startup assemblies configured by the app's assembly. For more information, see [Enhance an app from an external assembly in ASP.NET Core with IHostingStartup](#).

**Key:** preventHostingStartup

**Type:** `bool` (`true` or `1`)

**Default:** false

**Set using:** `UseSetting`

**Environment variable:** ASPNETCORE\_PREVENTHOSTINGSTARTUP

```
WebHost.CreateDefaultBuilder(args)
    .UseSetting(WebHostDefaults.PreventHostingStartupKey, "true")
```

## Server URLs

Indicates the IP addresses or host addresses with ports and protocols that the server should listen on for requests.

**Key:** urls

**Type:** `string`

**Default:** `http://localhost:5000`

**Set using:** `UseUrls`

**Environment variable:** ASPNETCORE\_URLS

Set to a semicolon-separated (;) list of URL prefixes to which the server should respond. For example, `http://localhost:123`. Use "\*" to indicate that the server should listen for requests on any IP address or hostname using the specified port and protocol (for example, `http://*:5000`). The protocol (`http://` or `https://`) must be included with each URL. Supported formats vary between servers.

```
WebHost.CreateDefaultBuilder(args)
    .UseUrls("http://*:5000;http://localhost:5001;https://hostname:5002")
```

Kestrel has its own endpoint configuration API. For more information, see [Kestrel web server implementation in ASP.NET Core](#).

```
var host = new WebHostBuilder()
    .UseUrls("http://*:5000;http://localhost:5001;https://hostname:5002")
```

## Shutdown Timeout

Specifies the amount of time to wait for the web host to shut down.

**Key:** shutdownTimeoutSeconds

**Type:** *int*

**Default:** 5

**Set using:** `UseShutdownTimeout`

**Environment variable:** `ASPNETCORE_SHUTDOWNTIMEOUTSECONDS`

Although the key accepts an *int* with `UseSetting` (for example,

```
.UseSetting(WebHostDefaults.ShutdownTimeoutKey, "10"))
```

, the `UseShutdownTimeout` extension method takes a `TimeSpan`.

During the timeout period, hosting:

- Triggers [IApplicationLifetime.ApplicationStopping](#).
- Attempts to stop hosted services, logging any errors for services that fail to stop.

If the timeout period expires before all of the hosted services stop, any remaining active services are stopped when the app shuts down. The services stop even if they haven't finished processing. If services require additional time to stop, increase the timeout.

```
WebHost.CreateDefaultBuilder(args)
    .UseShutdownTimeout(TimeSpan.FromSeconds(10))
```

## Startup Assembly

Determines the assembly to search for the `Startup` class.

**Key:** startupAssembly

**Type:** *string*

**Default:** The app's assembly

**Set using:** `UseStartup`

**Environment variable:** `ASPNETCORE_STARTUPASSEMBLY`

The assembly by name (`string`) or type (`TStartup`) can be referenced. If multiple `useStartup` methods are called, the last one takes precedence.

```
WebHost.CreateDefaultBuilder(args)
    .UseStartup("StartupAssemblyName")
```

```
WebHost.CreateDefaultBuilder(args)
    .UseStartup<TStartup>()
```

```
var host = new WebHostBuilder()
    .UseStartup("StartupAssemblyName")
```

```
var host = new WebHostBuilder()
    .UseStartup<Startup>()
```

## Web Root

Sets the relative path to the app's static assets.

**Key:** webroot

**Type:** string

**Default:** If not specified, the default is "(Content Root)/wwwroot", if the path exists. If the path doesn't exist, then a no-op file provider is used.

**Set using:** `UseWebRoot`

**Environment variable:** `ASPNETCORE_WEBROOT`

```
WebHost.CreateDefaultBuilder(args)
    .UseWebRoot("public")
```

```
var host = new WebHostBuilder()
    .UseWebRoot("public")
```

## Override configuration

Use [Configuration](#) to configure the web host. In the following example, host configuration is optionally specified in a `hostsettings.json` file. Any configuration loaded from the `hostsettings.json` file may be overridden by command-line arguments. The built configuration (in `config`) is used to configure the host with [UseConfiguration](#).

`IWebHostBuilder` configuration is added to the app's configuration, but the converse isn't true—

`ConfigureAppConfiguration` doesn't affect the `IWebHostBuilder` configuration.

Overriding the configuration provided by `useUrls` with `hostsettings.json` config first, command-line argument config second:

```

public class Program
{
    public static void Main(string[] args)
    {
        CreateWebHostBuilder(args).Build().Run();
    }

    public static IWebHostBuilder CreateWebHostBuilder(string[] args)
    {
        var config = new ConfigurationBuilder()
            .SetBasePath(Directory.GetCurrentDirectory())
            .AddJsonFile("hostsettings.json", optional: true)
            .AddCommandLine(args)
            .Build();

        return WebHost.CreateDefaultBuilder(args)
            .UseUrls("http://*:5000")
            .UseConfiguration(config)
            .Configure(app =>
        {
            app.Run(context =>
                context.Response.WriteAsync("Hello, World!"));
        })
            .Build();
    }
}

```

*hostsettings.json:*

```
{
  urls: "http://*:5005"
}
```

Overriding the configuration provided by `useUrls` with *hostsettings.json* config first, command-line argument config second:

```

public class Program
{
    public static void Main(string[] args)
    {
        var config = new ConfigurationBuilder()
            .SetBasePath(Directory.GetCurrentDirectory())
            .AddJsonFile("hostsettings.json", optional: true)
            .AddCommandLine(args)
            .Build();

        var host = new WebHostBuilder()
            .UseUrls("http://*:5000")
            .UseConfiguration(config)
            .UseKestrel()
            .Configure(app =>
        {
            app.Run(context =>
                context.Response.WriteAsync("Hello, World!"));
        })
            .Build();

        host.Run();
    }
}

```

*hostsettings.json:*

```
{  
  urls: "http://*:5005"  
}
```

## NOTE

The `UseConfiguration` extension method isn't currently capable of parsing a configuration section returned by `GetSection` (for example, `.UseConfiguration(Configuration.GetSection("section"))`). The `GetSection` method filters the configuration keys to the section requested but leaves the section name on the keys (for example, `section:urls`, `section:environment`). The `UseConfiguration` method expects the keys to match the `WebHostBuilder` keys (for example, `urls`, `environment`). The presence of the section name on the keys prevents the section's values from configuring the host. This issue will be addressed in an upcoming release. For more information and workarounds, see [Passing configuration section into WebHostBuilder.UseConfiguration uses full keys](#).

`UseConfiguration` only copies keys from the provided `IConfiguration` to the host builder configuration. Therefore, setting `reloadOnChange: true` for JSON, INI, and XML settings files has no effect.

To specify the host run on a particular URL, the desired value can be passed in from a command prompt when executing `dotnet run`. The command-line argument overrides the `urls` value from the `hostsettings.json` file, and the server listens on port 8080:

```
dotnet run --urls "http://*:8080"
```

## Manage the host

### Run

The `Run` method starts the web app and blocks the calling thread until the host is shut down:

```
host.Run();
```

### Start

Run the host in a non-blocking manner by calling its `Start` method:

```
using (host)  
{  
  host.Start();  
  Console.ReadLine();  
}
```

If a list of URLs is passed to the `Start` method, it listens on the URLs specified:

```

var urls = new List<string>()
{
    "http://*:5000",
    "http://localhost:5001"
};

var host = new WebHostBuilder()
    .UseKestrel()
    .UseStartup<Startup>()
    .Start(urls.ToArray());

using (host)
{
    Console.ReadLine();
}

```

The app can initialize and start a new host using the pre-configured defaults of `CreateDefaultBuilder` using a static convenience method. These methods start the server without console output and with `WaitForShutdown` wait for a break (Ctrl-C/SIGINT or SIGTERM):

### **Start(RequestDelegate app)**

Start with a `RequestDelegate` :

```

using (var host = WebHost.Start(app => app.Response.WriteAsync("Hello, World!")))
{
    Console.WriteLine("Use Ctrl-C to shutdown the host...");
    host.WaitForShutdown();
}

```

Make a request in the browser to `http://localhost:5000` to receive the response "Hello World!" `WaitForShutdown` blocks until a break (Ctrl-C/SIGINT or SIGTERM) is issued. The app displays the `Console.WriteLine` message and waits for a keypress to exit.

### **Start(string url, RequestDelegate app)**

Start with a URL and `RequestDelegate` :

```

using (var host = WebHost.Start("http://localhost:8080", app => app.Response.WriteAsync("Hello, World!")))
{
    Console.WriteLine("Use Ctrl-C to shutdown the host...");
    host.WaitForShutdown();
}

```

Produces the same result as **Start(RequestDelegate app)**, except the app responds on `http://localhost:8080`.

### **Start(Action<IRouteBuilder> routeBuilder)**

Use an instance of `IRouteBuilder` ([Microsoft.AspNetCore.Routing](#)) to use routing middleware:

```

using (var host = WebHost.Start(router => router
    .MapGet("hello/{name}", (req, res, data) =>
        res.WriteAsync($"Hello, {data.Values["name"]}!"))
    .MapGet("buenosdias/{name}", (req, res, data) =>
        res.WriteAsync($"Buenos dias, {data.Values["name"]}!"))
    .MapGet("throw/{message?}", (req, res, data) =>
        throw new Exception((string)data.Values["message"] ?? "Uh oh!"))
    .MapGet("{greeting}/{name}", (req, res, data) =>
        res.WriteAsync($"{data.Values["greeting"]}, {data.Values["name"]}!"))
    .MapGet("", (req, res, data) => res.WriteAsync("Hello, World!"))))
{
    Console.WriteLine("Use Ctrl-C to shutdown the host...");
    host.WaitForShutdown();
}

```

Use the following browser requests with the example:

REQUEST	RESPONSE
<code>http://localhost:5000/hello/Martin</code>	Hello, Martin!
<code>http://localhost:5000/buenosdias/Catrina</code>	Buenos dias, Catrina!
<code>http://localhost:5000/throw/ooops!</code>	Throws an exception with string "ooops!"
<code>http://localhost:5000/throw</code>	Throws an exception with string "Uh oh!"
<code>http://localhost:5000/Sante/Kevin</code>	Sante, Kevin!
<code>http://localhost:5000</code>	Hello World!

`WaitForShutdown` blocks until a break (Ctrl-C/SIGINT or SIGTERM) is issued. The app displays the `Console.WriteLine` message and waits for a keypress to exit.

### **Start(string url, Action<IRouteBuilder> routeBuilder)**

Use a URL and an instance of `IRouteBuilder`:

```

using (var host = WebHost.Start("http://localhost:8080", router => router
    .MapGet("hello/{name}", (req, res, data) =>
        res.WriteAsync($"Hello, {data.Values["name"]}!"))
    .MapGet("buenosdias/{name}", (req, res, data) =>
        res.WriteAsync($"Buenos dias, {data.Values["name"]}!"))
    .MapGet("throw/{message?}", (req, res, data) =>
        throw new Exception((string)data.Values["message"] ?? "Uh oh!"))
    .MapGet("{greeting}/{name}", (req, res, data) =>
        res.WriteAsync($"{data.Values["greeting"]}, {data.Values["name"]}!"))
    .MapGet("", (req, res, data) => res.WriteAsync("Hello, World!"))))
{
    Console.WriteLine("Use Ctrl-C to shut down the host...");
    host.WaitForShutdown();
}

```

Produces the same result as **Start(Action<IRouteBuilder> routeBuilder)**, except the app responds at `http://localhost:8080`.

### **StartWith(Action<IApplicationBuilder> app)**

Provide a delegate to configure an `IApplicationBuilder`:

```
using (var host = WebHost.StartWith(app =>
    app.Use(next =>
    {
        return async context =>
        {
            await context.Response.WriteAsync("Hello World!");
        };
    }));
{
    Console.WriteLine("Use Ctrl-C to shut down the host...");
    host.WaitForShutdown();
}
```

Make a request in the browser to `http://localhost:5000` to receive the response "Hello World!" `WaitForShutdown` blocks until a break (Ctrl-C/SIGINT or SIGTERM) is issued. The app displays the `Console.WriteLine` message and waits for a keypress to exit.

### **StartWith(string url, Action<IApplicationBuilder> app)**

Provide a URL and a delegate to configure an `IApplicationBuilder`:

```
using (var host = WebHost.StartWith("http://localhost:8080", app =>
    app.Use(next =>
    {
        return async context =>
        {
            await context.Response.WriteAsync("Hello World!");
        };
    }));
{
    Console.WriteLine("Use Ctrl-C to shut down the host...");
    host.WaitForShutdown();
}
```

Produces the same result as **StartWith(Action<IApplicationBuilder> app)**, except the app responds on `http://localhost:8080`.

### **Run**

The `Run` method starts the web app and blocks the calling thread until the host is shut down:

```
host.Run();
```

### **Start**

Run the host in a non-blocking manner by calling its `Start` method:

```
using (host)
{
    host.Start();
    Console.ReadLine();
}
```

If a list of URLs is passed to the `Start` method, it listens on the URLs specified:

```
var urls = new List<string>()
{
    "http://*:5000",
    "http://localhost:5001"
};

var host = new WebHostBuilder()
    .UseKestrel()
    .UseStartup<Startup>()
    .Start(urls.ToArray());

using (host)
{
    Console.ReadLine();
}
```

## IHostingEnvironment interface

The [IHostingEnvironment interface](#) provides information about the app's web hosting environment. Use [constructor injection](#) to obtain the `IHostingEnvironment` in order to use its properties and extension methods:

```
public class CustomFileReader
{
    private readonly IHostingEnvironment _env;

    public CustomFileReader(IHostingEnvironment env)
    {
        _env = env;
    }

    public string ReadFile(string filePath)
    {
        var fileProvider = _env.WebRootFileProvider;
        // Process the file here
    }
}
```

A [convention-based approach](#) can be used to configure the app at startup based on the environment. Alternatively, inject the `IHostingEnvironment` into the `Startup` constructor for use in `ConfigureServices`:

```

public class Startup
{
    public Startup(IHostingEnvironment env)
    {
        HostingEnvironment = env;
    }

    public IHostingEnvironment HostingEnvironment { get; }

    public void ConfigureServices(IServiceCollection services)
    {
        if (HostingEnvironment.IsDevelopment())
        {
            // Development configuration
        }
        else
        {
            // Staging/Production configuration
        }
    }

    var contentRootPath = HostingEnvironment.ContentRootPath;
}
}

```

#### NOTE

In addition to the `IsDevelopment` extension method, `IHostingEnvironment` offers `IsStaging`, `IsProduction`, and `IsEnvironment(string environmentName)` methods. For more information, see [Use multiple environments in ASP.NET Core](#).

The `IHostingEnvironment` service can also be injected directly into the `Configure` method for setting up the processing pipeline:

```

public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    if (env.IsDevelopment())
    {
        // In Development, use the developer exception page
        app.UseDeveloperExceptionPage();
    }
    else
    {
        // In Staging/Production, route exceptions to /error
        app.UseExceptionHandler("/error");
    }

    var contentRootPath = env.ContentRootPath;
}

```

`IHostingEnvironment` can be injected into the `Invoke` method when creating custom [middleware](#):

```

public async Task Invoke(HttpContext context, IHostingEnvironment env)
{
    if (env.IsDevelopment())
    {
        // Configure middleware for Development
    }
    else
    {
        // Configure middleware for Staging/Production
    }

    var contentRootPath = env.ContentRootPath;
}

```

## IApplicationLifetime interface

[IApplicationLifetime](#) allows for post-startup and shutdown activities. Three properties on the interface are cancellation tokens used to register `Action` methods that define startup and shutdown events.

CANCELLATION TOKEN	TRIGGERED WHEN...
<a href="#">ApplicationStarted</a>	The host has fully started.
<a href="#">ApplicationStopped</a>	The host is completing a graceful shutdown. All requests should be processed. Shutdown blocks until this event completes.
<a href="#">ApplicationStopping</a>	The host is performing a graceful shutdown. Requests may still be processing. Shutdown blocks until this event completes.

```

public class Startup
{
    public void Configure(IApplicationBuilder app, IApplicationLifetime appLifetime)
    {
        appLifetime.ApplicationStarted.Register(OnStarted);
        appLifetime.ApplicationStopping.Register(OnStopping);
        appLifetime.ApplicationStopped.Register(OnStopped);

        Console.CancelKeyPress += (sender, eventArgs) =>
        {
            appLifetime.StopApplication();
            // Don't terminate the process immediately, wait for the Main thread to exit gracefully.
            eventArgs.Cancel = true;
        };
    }

    private void OnStarted()
    {
        // Perform post-startup activities here
    }

    private void OnStopping()
    {
        // Perform on-stopping activities here
    }

    private void OnStopped()
    {
        // Perform post-stopped activities here
    }
}

```

[StopApplication](#) requests termination of the app. The following class uses [StopApplication](#) to gracefully shut down an app when the class's [Shutdown](#) method is called:

```

public class MyClass
{
    private readonly IApplicationLifetime _appLifetime;

    public MyClass(IApplicationLifetime appLifetime)
    {
        _appLifetime = appLifetime;
    }

    public void Shutdown()
    {
        _appLifetime.StopApplication();
    }
}

```

## Scope validation

[CreateDefaultBuilder](#) sets [ServiceProviderOptions.ValidateScopes](#) to [true](#) if the app's environment is Development.

When [ValidateScopes](#) is set to [true](#), the default service provider performs checks to verify that:

- Scoped services aren't directly or indirectly resolved from the root service provider.
- Scoped services aren't directly or indirectly injected into singletons.

The root service provider is created when [BuildServiceProvider](#) is called. The root service provider's lifetime corresponds to the app/server's lifetime when the provider starts with the app and is disposed when the app shuts

down.

Scoped services are disposed by the container that created them. If a scoped service is created in the root container, the service's lifetime is effectively promoted to singleton because it's only disposed by the root container when app/server is shut down. Validating service scopes catches these situations when `BuildServiceProvider` is called.

To always validate scopes, including in the Production environment, configure the `ServiceProviderOptions` with `UseDefaultServiceProvider` on the host builder:

```
WebHost.CreateDefaultBuilder(args)
    .UseDefaultServiceProvider((context, options) => {
        options.ValidateScopes = true;
    })
```

## Troubleshooting System.ArgumentException

The following only applies to ASP.NET Core 2.0 apps when the app doesn't call `UseStartup` or `Configure`.

A host may be built by injecting `IStartup` directly into the dependency injection container rather than calling `UseStartup` or `Configure`:

```
services.AddSingleton<IStartup, Startup>();
```

If the host is built this way, the following error may occur:

```
Unhandled Exception: System.ArgumentException: A valid non-empty application name must be provided.
```

This occurs because the app name (the name of the current assembly) is required to scan for `HostingStartupAttributes`. If the app manually injects `IStartup` into the dependency injection container, add the following call to `WebHostBuilder` with the assembly name specified:

```
WebHost.CreateDefaultBuilder(args)
    .UseSetting("applicationName", "AssemblyName")
```

Alternatively, add a dummy `Configure` to the `WebHostBuilder`, which sets the app name automatically:

```
WebHost.CreateDefaultBuilder(args)
    .Configure(_ => { })
```

For more information, see [Announcements: Microsoft.Extensions.PlatformAbstractions has been removed \(comment\)](#) and the [StartupInjection sample](#).

## Additional resources

- [Host ASP.NET Core on Windows with IIS](#)
- [Host ASP.NET Core on Linux with Nginx](#)
- [Host ASP.NET Core on Linux with Apache](#)
- [Host ASP.NET Core in a Windows Service](#)

# .NET Generic Host

7/6/2018 • 10 minutes to read • [Edit Online](#)

By [Luke Latham](#)

.NET apps configure and launch a *host*. The host is responsible for app startup and lifetime management. This topic covers the ASP.NET Core Generic Host ([HostBuilder](#)), which is useful for hosting apps that don't process HTTP requests. For coverage of the Web Host ([WebHostBuilder](#)), see [ASP.NET Core Web Host](#).

The goal of the Generic Host is to decouple the HTTP pipeline from the Web Host API to enable a wider array of host scenarios. Messaging, background tasks, and other non-HTTP workloads based on the Generic Host benefit from cross-cutting capabilities, such as configuration, dependency injection (DI), and logging.

The Generic Host is new in ASP.NET Core 2.1 and isn't suitable for web hosting scenarios. For web hosting scenarios, use the [Web Host](#). The Generic Host is under development to replace the Web Host in a future release and act as the primary host API in both HTTP and non-HTTP scenarios.

[View or download sample code \(how to download\)](#)

When running the sample app in [Visual Studio Code](#), use an *external or integrated terminal*. Don't run the sample in an `internalConsole`.

To set the console in Visual Studio Code:

1. Open the `.vscode/launch.json` file.
2. In the **.NET Core Launch (console)** configuration, locate the **console** entry. Set the value to either `externalTerminal` or `integratedTerminal`.

## Introduction

The Generic Host library is available in the [Microsoft.Extensions.Hosting namespace](#) and provided by the [Microsoft.Extensions.Hosting package](#). The `Microsoft.Extensions.Hosting` package is included in the [Microsoft.AspNetCore.App metapackage](#) (ASP.NET Core 2.1 or later).

`IHostedService` is the entry point to code execution. Each `IHostedService` implementation is executed in the order of [service registration in ConfigureServices](#). `StartAsync` is called on each `IHostedService` when the host starts, and `StopAsync` is called in reverse registration order when the host shuts down gracefully.

## Set up a host

`IHostBuilder` is the main component that libraries and apps use to initialize, build, and run the host:

```
public static async Task Main(string[] args)
{
    var host = new HostBuilder()
        .Build();

    await host.RunAsync();
}
```

## Host configuration

`HostBuilder` relies on the following approaches to set the host configuration values:

- Configuration builder
- Extension method configuration

## Configuration builder

Host builder configuration is created by calling [ConfigureHostConfiguration](#) on the [IHostBuilder](#) implementation.

`ConfigureHostConfiguration` uses an  [IConfigurationBuilder](#) to create an  [IConfiguration](#) for the host. The configuration builder initializes the [IHostingEnvironment](#) for use in the app's build process.

Environment variable configuration isn't added by default. Call [AddEnvironmentVariables](#) on the host builder to configure the host from environment variables. `AddEnvironmentVariables` accepts an optional user-defined prefix. The sample app uses a prefix of `PREFIX_`. The prefix is removed when the environment variables are read. When the sample app's host is configured, the environment variable value for `PREFIX_ENVIRONMENT` becomes the host configuration value for the `environment` key.

During development when using [Visual Studio](#) or running an app with `dotnet run`, environment variables may be set in the *Properties/launchSettings.json* file. In [Visual Studio Code](#), environment variables may be set in the *.vscode/launch.json* file during development. For more information, see [Use multiple environments in ASP.NET Core](#).

`ConfigureHostConfiguration` can be called multiple times with additive results. The host uses whichever option sets a value last.

*hostsettings.json*:

```
{
  "environment": "Development"
}
```

Example `HostBuilder` configuration using `ConfigureHostConfiguration`:

```
var host = new HostBuilder()
    .ConfigureHostConfiguration(configHost =>
    {
        configHost.SetBasePath(Directory.GetCurrentDirectory());
        configHost.AddJsonFile("hostsettings.json", optional: true);
        configHost.AddEnvironmentVariables(prefix: "PREFIX_");
        configHost.AddCommandLine(args);
    })
}
```

### NOTE

The [AddConfiguration](#) extension method isn't currently capable of parsing a configuration section returned by [GetSection](#) (for example, `.AddConfiguration(Configuration.GetSection("section"))`). The `GetSection` method filters the configuration keys to the section requested but leaves the section name on the keys (for example, `section:environment`). The `AddConfiguration` method expects the keys to match the `HostBuilder` keys (for example, `environment`). The presence of the section name on the keys prevents the section's values from configuring the host. This issue will be addressed in an upcoming release. For more information and workarounds, see [Passing configuration section into WebHostBuilder.UseConfiguration uses full keys](#).

## Extension method configuration

Extension methods are called on the `IHostBuilder` implementation to configure the content root and the environment.

### Application Key (Name)

The [IHostingEnvironment.ApplicationName](#) property is set from host configuration during host construction. To

set the value explicitly, use the [HostDefaults.ApplicationKey](#):

**Key:** applicationName

**Type:** string

**Default:** The name of the assembly containing the app's entry point.

**Set using:** [UseSetting](#)

**Environment variable:** <PREFIX>APPLICATIONKEY ( <PREFIX> is [optional and user-defined](#))

```
WebHost.CreateDefaultBuilder(args)
    .UseSetting(WebHostDefaults.ApplicationKey, "CustomApplicationName")
```

#### Content Root

This setting determines where the host begins searching for content files.

**Key:** contentRoot

**Type:** string

**Default:** Defaults to the folder where the app assembly resides.

**Set using:** [UseContentRoot](#)

**Environment variable:** <PREFIX>CONTENTROOT ( <PREFIX> is [optional and user-defined](#))

If the path doesn't exist, the host fails to start.

```
var host = new HostBuilder()
    .UseContentRoot("c:\\<content-root>")
```

#### Environment

Sets the app's [environment](#).

**Key:** environment

**Type:** string

**Default:** Production

**Set using:** [UseEnvironment](#)

**Environment variable:** <PREFIX>ENVIRONMENT ( <PREFIX> is [optional and user-defined](#))

The environment can be set to any value. Framework-defined values include [Development](#), [Staging](#), and [Production](#). Values aren't case sensitive.

```
var host = new HostBuilder()
    .UseEnvironment(EnvironmentName.Development)
```

## ConfigureAppConfiguration

App builder configuration is created by calling [ConfigureAppConfiguration](#) on the [IHostBuilder](#) implementation.

[ConfigureAppConfiguration](#) uses an [IConfigurationBuilder](#) to create an [IConfiguration](#) for the app.

[ConfigureAppConfiguration](#) can be called multiple times with additive results. The app uses whichever option sets a value last. The configuration created by [ConfigureAppConfiguration](#) is available at [HostBuilderContext.Configuration](#) for subsequent operations and in [Services](#).

Example app configuration using [ConfigureAppConfiguration](#):

```

var host = new HostBuilder()
    .ConfigureAppConfiguration((hostContext, configApp) =>
{
    configApp.SetBasePath(Directory.GetCurrentDirectory());
    configApp.AddJsonFile("appsettings.json", optional: true);
    configApp.AddJsonFile(
        $"appsettings.{hostContext.HostingEnvironment.EnvironmentName}.json",
        optional: true);
    configApp.AddEnvironmentVariables(prefix: "PREFIX_");
    configApp.AddCommandLine(args);
})

```

*appsettings.json:*

```
{
    "Logging": {
        "LogLevel": {
            "Default": "Warning"
        }
    },
    "AllowedHosts": "*"
}
```

*appsettings.Development.json:*

```
{
    "Logging": {
        "LogLevel": {
            "Default": "Debug",
            "System": "Information",
            "Microsoft": "Information"
        }
    }
}
```

*appsettings.Production.json:*

```
{
    "Logging": {
        "LogLevel": {
            "Default": "Error",
            "System": "Information",
            "Microsoft": "Information"
        }
    }
}
```

#### NOTE

The [AddConfiguration](#) extension method isn't currently capable of parsing a configuration section returned by [GetSection](#) (for example, `.AddConfiguration(Configuration.GetSection("section"))`). The [GetSection](#) method filters the configuration keys to the section requested but leaves the section name on the keys (for example, `section:Logging:LogLevel:Default`). The [AddConfiguration](#) method expects an exact match to configuration keys (for example, `Logging:LogLevel:Default`). The presence of the section name on the keys prevents the section's values from configuring the app. This issue will be addressed in an upcoming release. For more information and workarounds, see [Passing configuration section into WebHostBuilder.UseConfiguration uses full keys](#).

To move settings files to the output directory, specify the settings files as [MSBuild project items](#) in the project file.

The sample app moves its JSON app settings files and `hostsettings.json` with the following <Content> item:

```
<ItemGroup>
<Content Include="**\*.json" CopyToOutputDirectory="PreserveNewest" />
</ItemGroup>
```

## ConfigureServices

[ConfigureServices](#) adds services to the app's dependency injection container. `ConfigureServices` can be called multiple times with additive results.

A hosted service is a class with background task logic that implements the [IHostedService](#) interface. For more information, see [Background tasks with hosted services in ASP.NET Core](#).

The [sample app](#) uses the `AddHostedService` extension method to add a service for lifetime events, `LifetimeEventsHostedService`, and a timed background task, `TimedHostedService`, to the app:

```
var host = new HostBuilder()
    .ConfigureServices((hostContext, services) =>
{
    services.AddLogging();
    services.AddHostedService<LifetimeEventsHostedService>();
    services.AddHostedService<TimedHostedService>();
})
```

## ConfigureLogging

[ConfigureLogging](#) adds a delegate for configuring the provided [ILoggingBuilder](#). `ConfigureLogging` may be called multiple times with additive results.

```
var host = new HostBuilder()
    .ConfigureLogging((hostContext, configLogging) =>
{
    configLogging.AddConsole();
    configLogging.AddDebug();
})
```

### UseConsoleLifetime

[UseConsoleLifetime](#) listens for `ctrl+c` /SIGINT or SIGTERM and calls [StopApplication](#) to start the shutdown process. `UseConsoleLifetime` unblocks extensions such as [RunAsync](#) and [WaitForShutdownAsync](#).

[ConsoleLifetime](#) is pre-registered as the default lifetime implementation. The last lifetime registered is used.

```
var host = new HostBuilder()
    .UseConsoleLifetime()
```

## Container configuration

To support plugging in other containers, the host can accept an [IServiceProviderFactory](#). Providing a factory isn't part of the DI container registration but is instead a host intrinsic used to create the concrete DI container.

[UseServiceProviderFactory\(IServiceProviderFactory<TContainerBuilder>\)](#) overrides the default factory used to create the app's service provider.

Custom container configuration is managed by the [ConfigureContainer](#) method. `ConfigureContainer` provides a

strongly-typed experience for configuring the container on top of the underlying host API. `ConfigureContainer` can be called multiple times with additive results.

Create a service container for the app:

```
namespace GenericHostSample
{
    internal class ServiceContainer
    {
    }
}
```

Provide a service container factory:

```
using System;
using Microsoft.Extensions.DependencyInjection;

namespace GenericHostSample
{
    internal class ServiceContainerFactory : IServiceProviderFactory<MyContainer>
    {
        public ServiceContainer CreateBuilder(IServiceCollection services)
        {
            return new ServiceContainer();
        }

        public IServiceProvider CreateServiceProvider(ServiceContainer containerBuilder)
        {
            throw new NotImplementedException();
        }
    }
}
```

Use the factory and configure the custom service container for the app:

```
var host = new HostBuilder()
    .UseServiceProviderFactory<ServiceContainer>(new ServiceContainerFactory())
    .ConfigureContainer<ServiceContainer>((hostContext, container) =>
{
})
```

## Extensibility

Host extensibility is performed with extension methods on `IHostBuilder`. The following example shows how an extension method extends an `IHostBuilder` implementation with [RabbitMQ](#). The extension method (elsewhere in the app) registers a RabbitMQ `IHostedService`:

```
// UseRabbitMq is an extension method that sets up RabbitMQ to handle incoming
// messages.
var host = new HostBuilder()
    .UseRabbitMq<MyMessageHandler>()
    .Build();

await host.StartAsync();
```

## Manage the host

The `IHost` implementation is responsible for starting and stopping the `IHostedService` implementations that are

registered in the service container.

## Run

[Run](#) runs the app and blocks the calling thread until the host is shut down:

```
public class Program
{
    public void Main(string[] args)
    {
        var host = new HostBuilder()
            .Build();

        host.Run();
    }
}
```

## RunAsync

[RunAsync](#) runs the app and returns a `Task` that completes when the cancellation token or shutdown is triggered:

```
public class Program
{
    public static async Task Main(string[] args)
    {
        var host = new HostBuilder()
            .Build();

        await host.RunAsync();
    }
}
```

## RunConsoleAsync

[RunConsoleAsync](#) enables console support, builds and starts the host, and waits for `Ctrl+C` /SIGINT or SIGTERM to shut down.

```
public class Program
{
    public static async Task Main(string[] args)
    {
        var hostBuilder = new HostBuilder();

        await hostBuilder.RunConsoleAsync();
    }
}
```

## Start and StopAsync

[Start](#) starts the host synchronously.

[StopAsync\(TimeSpan\)](#) attempts to stop the host within the provided timeout.

```

public class Program
{
    public static async Task Main(string[] args)
    {
        var host = new HostBuilder()
            .Build();

        using (host)
        {
            host.Start();

            await host.StopAsync(TimeSpan.FromSeconds(5));
        }
    }
}

```

## StartAsync and StopAsync

[StartAsync](#) starts the app.

[StopAsync](#) stops the app.

```

public class Program
{
    public static async Task Main(string[] args)
    {
        var host = new HostBuilder()
            .Build();

        using (host)
        {
            await host.StartAsync();

            await host.StopAsync();
        }
    }
}

```

## WaitForShutdown

[WaitForShutdown](#) is triggered via the [IHostLifetime](#), such as [ConsoleLifetime](#) (listens for [Ctrl+C](#) /SIGINT or SIGTERM). [WaitForShutdown](#) calls [StopAsync](#).

```

public class Program
{
    public void Main(string[] args)
    {
        var host = new HostBuilder()
            .Build();

        using (host)
        {
            host.Start();

            host.WaitForShutdown();
        }
    }
}

```

## WaitForShutdownAsync

[WaitForShutdownAsync](#) returns a [Task](#) that completes when shutdown is triggered via the given token and calls [StopAsync](#).

```
public class Program
{
    public static async Task Main(string[] args)
    {
        var host = new HostBuilder()
            .Build();

        using (host)
        {
            await host.StartAsync();

            await host.WaitForShutdownAsync();
        }
    }
}
```

## External control

External control of the host can be achieved using methods that can be called externally:

```
public class Program
{
    private IHost _host;

    public Program()
    {
        _host = new HostBuilder()
            .Build();
    }

    public async Task StartAsync()
    {
        _host.StartAsync();
    }

    public async Task StopAsync()
    {
        using (_host)
        {
            await _host.StopAsync(TimeSpan.FromSeconds(5));
        }
    }
}
```

`IHostLifetime.WaitForStartAsync` is called at the start of `StartAsync`, which waits until it's complete before continuing. This can be used to delay startup until signaled by an external event.

## IHostingEnvironment interface

`IHostingEnvironment` provides information about the app's hosting environment. Use [constructor injection](#) to obtain the `IHostingEnvironment` in order to use its properties and extension methods:

```

public class MyClass
{
    private readonly IHostingEnvironment _env;

    public MyClass(IHostingEnvironment env)
    {
        _env = env;
    }

    public void DoSomething()
    {
        var environmentName = _env.EnvironmentName;
    }
}

```

For more information, see [Use multiple environments in ASP.NET Core](#).

## IApplicationLifetime interface

[IApplicationLifetime](#) allows for post-startup and shutdown activities, including graceful shutdown requests. Three properties on the interface are cancellation tokens used to register `Action` methods that define startup and shutdown events.

CANCELLATION TOKEN	TRIGGERED WHEN...
<a href="#">ApplicationStarted</a>	The host has fully started.
<a href="#">ApplicationStopped</a>	The host is completing a graceful shutdown. All requests should be processed. Shutdown blocks until this event completes.
<a href="#">ApplicationStopping</a>	The host is performing a graceful shutdown. Requests may still be processing. Shutdown blocks until this event completes.

Constructor-inject the `IApplicationLifetime` service into any class. The [sample app](#) uses constructor injection into a `LifetimeEventsHostedService` class (an `IHostedService` implementation) to register the events.

*LifetimeEventsHostedService.cs:*

```

internal class LifetimeEventsHostedService : IHostedService
{
    private readonly ILogger _logger;
    private readonly IApplicationLifetime _appLifetime;

    public LifetimeEventsHostedService(
        ILogger<LifetimeEventsHostedService> logger, IApplicationLifetime appLifetime)
    {
        _logger = logger;
        _appLifetime = appLifetime;
    }

    public Task StartAsync(CancellationToken cancellationToken)
    {
        _appLifetime.ApplicationStarted.Register(OnStarted);
        _appLifetime.ApplicationStopping.Register(OnStopping);
        _appLifetime.ApplicationStopped.Register(OnStopped);

        return Task.CompletedTask;
    }

    public Task StopAsync(CancellationToken cancellationToken)
    {
        return Task.CompletedTask;
    }

    private void OnStarted()
    {
        _logger.LogInformation("OnStarted has been called.");

        // Perform post-startup activities here
    }

    private void OnStopping()
    {
        _logger.LogInformation("OnStopping has been called.");

        // Perform on-stopping activities here
    }

    private void OnStopped()
    {
        _logger.LogInformation("OnStopped has been called.");

        // Perform post-stopped activities here
    }
}

```

[StopApplication](#) requests termination of the app. The following class uses `StopApplication` to gracefully shut down an app when the class's `Shutdown` method is called:

```
public class MyClass
{
    private readonly IApplicationLifetime _appLifetime;

    public MyClass(IApplicationLifetime appLifetime)
    {
        _appLifetime = appLifetime;
    }

    public void Shutdown()
    {
        _appLifetime.StopApplication();
    }
}
```

## Additional resources

- [Background tasks with hosted services in ASP.NET Core](#)
- [Hosting repo samples on GitHub](#)

# Background tasks with hosted services in ASP.NET Core

6/21/2018 • 4 minutes to read • [Edit Online](#)

By [Luke Latham](#)

In ASP.NET Core, background tasks can be implemented as *hosted services*. A hosted service is a class with background task logic that implements the [IHostedService](#) interface. This topic provides three hosted service examples:

- Background task that runs on a timer.
- Hosted service that activates a scoped service. The scoped service can use dependency injection.
- Queued background tasks that run sequentially.

[View or download sample code \(how to download\)](#)

The sample app is provided in two versions:

- Web Host – The Web Host is useful for hosting web apps. The example code shown in this topic is from the Web Host version of the sample. For more information, see the [Web Host](#) topic.
- Generic Host – The Generic Host is new in ASP.NET Core 2.1. For more information, see the [Generic Host](#) topic.

## IHostedService interface

Hosted services implement the [IHostedService](#) interface. The interface defines two methods for objects that are managed by the host:

- [StartAsync\(CancellationToken\)](#) - Called after the server has started and [IAplicationLifetime.ApplicationStarted](#) is triggered. `StartAsync` contains the logic to start the background task.
- [StopAsync\(CancellationToken\)](#) - Triggered when the host is performing a graceful shutdown. `StopAsync` contains the logic to end the background task and dispose of any unmanaged resources. If the app shuts down unexpectedly (for example, the app's process fails), `StopAsync` might not be called.

The hosted service is activated once at app startup and gracefully shutdown at app shutdown. When [IDisposable](#) is implemented, resources can be disposed when the service container is disposed. If an error is thrown during background task execution, `Dispose` should be called even if `StopAsync` isn't called.

## Timed background tasks

A timed background task makes use of the [System.Threading.Timer](#) class. The timer triggers the task's `Dowork` method. The timer is disabled on `StopAsync` and disposed when the service container is disposed on `Dispose`:

```

internal class TimedHostedService : IHostedService, IDisposable
{
    private readonly ILogger _logger;
    private Timer _timer;

    public TimedHostedService(ILogger<TimedHostedService> logger)
    {
        _logger = logger;
    }

    public Task StartAsync(CancellationToken cancellationToken)
    {
        _logger.LogInformation("Timed Background Service is starting.");

        _timer = new Timer(DoWork, null, TimeSpan.Zero,
            TimeSpan.FromSeconds(5));

        return Task.CompletedTask;
    }

    private void DoWork(object state)
    {
        _logger.LogInformation("Timed Background Service is working.");
    }

    public Task StopAsync(CancellationToken cancellationToken)
    {
        _logger.LogInformation("Timed Background Service is stopping.");

        _timer?.Change(Timeout.Infinite, 0);

        return Task.CompletedTask;
    }

    public void Dispose()
    {
        _timer?.Dispose();
    }
}

```

The service is registered in `Startup.ConfigureServices` with the `AddHostedService` extension method:

```
services.AddHostedService<TimedHostedService>();
```

The service is registered in `Startup.ConfigureServices`:

```
services.AddSingleton<IHostedService, TimedHostedService>();
```

## Consuming a scoped service in a background task

To use scoped services within an `IHostedService`, create a scope. No scope is created for a hosted service by default.

The scoped background task service contains the background task's logic. In the following example, `ILogger` is injected into the service:

```
internal interface IScopedProcessingService
{
    void DoWork();
}

internal class ScopedProcessingService : IScopedProcessingService
{
    private readonly ILogger _logger;

    public ScopedProcessingService(ILogger<ScopedProcessingService> logger)
    {
        _logger = logger;
    }

    public void DoWork()
    {
        _logger.LogInformation("Scoped Processing Service is working.");
    }
}
```

The hosted service creates a scope to resolve the scoped background task service to call its `DoWork` method:

```

internal class ConsumeScopedServiceHostedService : IHostedService
{
    private readonly ILogger _logger;

    public ConsumeScopedServiceHostedService(IServiceProvider services,
        ILogger<ConsumeScopedServiceHostedService> logger)
    {
        Services = services;
        _logger = logger;
    }

    public IServiceProvider Services { get; }

    public Task StartAsync(CancellationToken cancellationToken)
    {
        _logger.LogInformation(
            "Consume Scoped Service Hosted Service is starting.");

        DoWork();

        return Task.CompletedTask;
    }

    private void DoWork()
    {
        _logger.LogInformation(
            "Consume Scoped Service Hosted Service is working.");

        using (var scope = Services.CreateScope())
        {
            var scopedProcessingService =
                scope.ServiceProvider
                    .GetRequiredService<IScopedProcessingService>();

            scopedProcessingService.DoWork();
        }
    }

    public Task StopAsync(CancellationToken cancellationToken)
    {
        _logger.LogInformation(
            "Consume Scoped Service Hosted Service is stopping.");

        return Task.CompletedTask;
    }
}

```

The services are registered in `Startup.ConfigureServices`. The `IHostedService` implementation is registered with the `AddHostedService` extension method:

```

services.AddHostedService<ConsumeScopedServiceHostedService>();
services.AddScoped<IScopedProcessingService, ScopedProcessingService>();

```

The services are registered in `Startup.ConfigureServices`:

```

services.AddSingleton<IHostedService, ConsumeScopedServiceHostedService>();
services.AddScoped<IScopedProcessingService, ScopedProcessingService>();

```

## Queued background tasks

A background task queue is based on the .NET 4.x `QueueBackgroundWorkItem` (tentatively scheduled to be built-

in for ASP.NET Core 3.0):

```
public interface IBackgroundTaskQueue
{
    void QueueBackgroundWorkItem(Func< CancellationToken, Task> workItem);

    Task<Func< CancellationToken, Task>> DequeueAsync(
        CancellationToken cancellationToken);
}

public class BackgroundTaskQueue : IBackgroundTaskQueue
{
    private ConcurrentQueue<Func< CancellationToken, Task>> _workItems =
        new ConcurrentQueue<Func< CancellationToken, Task>>();
    private SemaphoreSlim _signal = new SemaphoreSlim(0);

    public void QueueBackgroundWorkItem(
        Func< CancellationToken, Task> workItem)
    {
        if (workItem == null)
        {
            throw new ArgumentNullException(nameof(workItem));
        }

        _workItems.Enqueue(workItem);
        _signal.Release();
    }

    public async Task<Func< CancellationToken, Task>> DequeueAsync(
        CancellationToken cancellationToken)
    {
        await _signal.WaitAsync(cancellationToken);
        _workItems.TryDequeue(out var workItem);

        return workItem;
    }
}
```

In `QueueHostedService`, background tasks (`workItem`) in the queue are dequeued and executed:

```

public class QueuedHostedService : IHostedService
{
    private CancellationTokenSource _shutdown =
        new CancellationTokenSource();
    private Task _backgroundTask;
    private readonly ILogger _logger;

    public QueuedHostedService(IBackgroundTaskQueue taskQueue,
        ILoggerFactory loggerFactory)
    {
        TaskQueue = taskQueue;
        _logger = loggerFactory.CreateLogger<QueuedHostedService>();
    }

    public IBackgroundTaskQueue TaskQueue { get; }

    public Task StartAsync(CancellationToken cancellationToken)
    {
        _logger.LogInformation("Queued Hosted Service is starting.");
        _backgroundTask = Task.Run(BackgroundProceessing);

        return Task.CompletedTask;
    }

    private async Task BackgroundProceessing()
    {
        while (!_shutdown.IsCancellationRequested)
        {
            var workItem =
                await TaskQueue.DequeueAsync(_shutdown.Token);

            try
            {
                await workItem(_shutdown.Token);
            }
            catch (Exception ex)
            {
                _logger.LogError(ex,
                    $"Error occurred executing {nameof(workItem)}.");
            }
        }
    }

    public Task StopAsync(CancellationToken cancellationToken)
    {
        _logger.LogInformation("Queued Hosted Service is stopping.");

        _shutdown.Cancel();

        return Task.WhenAny(_backgroundTask,
            Task.Delay(Timeout.Infinite, cancellationToken));
    }
}

```

The services are registered in `Startup.ConfigureServices`. The `IHostedService` implementation is registered with the `AddHostedService` extension method:

```

services.AddHostedService<QueuedHostedService>();
services.AddSingleton<IBackgroundTaskQueue, BackgroundTaskQueue>();

```

The services are registered in `Startup.ConfigureServices`:

```
services.AddSingleton<IHostedService, QueuedHostedService>();
services.AddSingleton<IBackgroundTaskQueue, BackgroundTaskQueue>();
```

In the Index page model class, the `IBackgroundTaskQueue` is injected into the constructor and assigned to `Queue`:

```
public IndexModel(IBackgroundTaskQueue queue,
    IApplicationLifetime appLifetime,
    ILogger<IndexModel> logger)
{
    Queue = queue;
    _appLifetime = appLifetime;
    _logger = logger;
}

public IBackgroundTaskQueue Queue { get; }
```

When the **Add Task** button is selected on the Index page, the `OnPostAddTask` method is executed.

`QueueBackgroundWorkItem` is called to enqueue the work item:

```
public IActionResult OnPostAddTask()
{
    Queue.QueueBackgroundWorkItem(async token =>
    {
        var guid = Guid.NewGuid().ToString();

        for (int delayLoop = 0; delayLoop < 3; delayLoop++)
        {
            _logger.LogInformation(
                $"Queued Background Task {guid} is running. {delayLoop}/3");
            await Task.Delay(TimeSpan.FromSeconds(5), token);
        }

        _logger.LogInformation(
            $"Queued Background Task {guid} is complete. 3/3");
    });

    return RedirectToPage();
}
```

## Additional resources

- [Implement background tasks in microservices with `IHostedService` and the `BackgroundService` class](#)
- [System.Threading.Timer](#)

# Session and app state in ASP.NET Core

6/21/2018 • 17 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [Steve Smith](#), [Diana LaRose](#), and [Luke Latham](#)

HTTP is a stateless protocol. Without taking additional steps, HTTP requests are independent messages that don't retain user values or app state. This article describes several approaches to preserve user data and app state between requests.

[View or download sample code \(how to download\)](#)

## State management

State can be stored using several approaches. Each approach is described later in this topic.

STORAGE APPROACH	STORAGE MECHANISM
<a href="#">Cookies</a>	HTTP cookies (may include data stored using server-side app code)
<a href="#">Session state</a>	HTTP cookies and server-side app code
<a href="#">TempData</a>	HTTP cookies or session state
<a href="#">Query strings</a>	HTTP query strings
<a href="#">Hidden fields</a>	HTTP form fields
<a href="#">HttpContext.Items</a>	Server-side app code
<a href="#">Cache</a>	Server-side app code
<a href="#">Dependency Injection</a>	Server-side app code

## Cookies

Cookies store data across requests. Because cookies are sent with every request, their size should be kept to a minimum. Ideally, only an identifier should be stored in a cookie with the data stored by the app. Most browsers restrict cookie size to 4096 bytes. Only a limited number of cookies are available for each domain.

Because cookies are subject to tampering, they must be validated by the app. Cookies can be deleted by users and expire on clients. However, cookies are generally the most durable form of data persistence on the client.

Cookies are often used for personalization, where content is customized for a known user. The user is only identified and not authenticated in most cases. The cookie can store the user's name, account name, or unique user ID (such as a GUID). You can then use the cookie to access the user's personalized settings, such as their preferred website background color.

Be mindful of the [European Union General Data Protection Regulations \(GDPR\)](#) when issuing cookies and dealing with privacy concerns. For more information, see [General Data Protection Regulation \(GDPR\) support in ASP.NET Core](#).

# Session state

Session state is an ASP.NET Core scenario for storage of user data while the user browses a web app. Session state uses a store maintained by the app to persist data across requests from a client. The session data is backed by a cache and considered ephemeral data—the site should continue to function without the session data.

## NOTE

Session isn't supported in [SignalR](#) apps because a [SignalR Hub](#) may execute independent of an HTTP context. For example, this can occur when a long polling request is held open by a hub beyond the lifetime of the request's HTTP context.

ASP.NET Core maintains session state by providing a cookie to the client that contains a session ID, which is sent to the app with each request. The app uses the session ID to fetch the session data.

Session state exhibits the following behaviors:

- Because the session cookie is specific to the browser, sessions aren't shared across browsers.
- Session cookies are deleted when the browser session ends.
- If a cookie is received for an expired session, a new session is created that uses the same session cookie.
- Empty sessions aren't retained—the session must have at least one value set into it to persist the session across requests. When a session isn't retained, a new session ID is generated for each new request.
- The app retains a session for a limited time after the last request. The app either sets the session timeout or uses the default value of 20 minutes. Session state is ideal for storing user data that's specific to a particular session but where the data doesn't require permanent storage across sessions.
- Session data is deleted either when the [ISession.Clear](#) implementation is called or when the session expires.
- There's no default mechanism to inform app code that a client browser has been closed or when the session cookie is deleted or expired on the client.

## WARNING

Don't store sensitive data in session state. The user might not close the browser and clear the session cookie. Some browsers maintain valid session cookies across browser windows. A session might not be restricted to a single user—the next user might continue to browse the app with the same session cookie.

The in-memory cache provider stores session data in the memory of the server where the app resides. In a server farm scenario:

- Use *sticky sessions* to tie each session to a specific app instance on an individual server. [Azure App Service](#) uses [Application Request Routing \(ARR\)](#) to enforce sticky sessions by default. However, sticky sessions can affect scalability and complicate web app updates. A better approach is to use a Redis or SQL Server distributed cache, which doesn't require sticky sessions. For more information, see [Work with a distributed cache](#).
- The session cookie is encrypted via [IDataProtector](#). Data Protection must be properly configured to read session cookies on each machine. For more information, see [Data Protection in ASP.NET Core](#) and [Key storage providers](#).

## Configure session state

The [Microsoft.AspNetCore.Session](#) package, which is included in the [Microsoft.AspNetCore.App metapackage](#), provides middleware for managing session state. To enable the session middleware, `Startup` must contain:

The [Microsoft.AspNetCore.Session](#) package provides middleware for managing session state. To enable the session middleware, `Startup` must contain:

- Any of the [IDistributedCache](#) memory caches. The `IDistributedCache` implementation is used as a backing

store for session. For more information, see [Work with a distributed cache](#).

- A call to [AddSession](#) in `ConfigureServices`.
- A call to [UseSession](#) in `Configure`.

The following code shows how to set up the in-memory session provider with a default in-memory implementation of `IDistributedCache`:

```
public class Startup
{
    public void ConfigureServices(IServiceCollection services)
    {
        services.Configure<CookiePolicyOptions>(options =>
        {
            options.CheckConsentNeeded = context => true;
            options.MinimumSameSitePolicy = SameSiteMode.None;
        });

        services.AddDistributedMemoryCache();

        services.AddSession(options =>
        {
            // Set a short timeout for easy testing.
            options.IdleTimeout = TimeSpan.FromSeconds(10);
            options.Cookie.HttpOnly = true;
        });

        services.AddMvc()
            .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
    }

    public void Configure(IApplicationBuilder app, IHostingEnvironment env)
    {
        if (env.IsDevelopment())
        {
            app.UseDeveloperExceptionPage();
        }
        else
        {
            app.UseExceptionHandler("/Error");
            app.UseHsts();
        }

        app.UseHttpsRedirection();
        app.UseStaticFiles();
        app.UseCookiePolicy();
        app.UseSession();
        app.UseHttpContextItemsMiddleware();
        app.UseMvc();
    }
}
```

```

public class Startup
{
    public void ConfigureServices(IServiceCollection services)
    {
        services.AddDistributedMemoryCache();

        services.AddSession(options =>
        {
            // Set a short timeout for easy testing.
            options.IdleTimeout = TimeSpan.FromSeconds(10);
            options.CookieHttpOnly = true;
        });
    }

    services.AddMvc();
}

public void Configure(IApplicationBuilder app)
{
    app.UseSession();
    app.UseHttpContextItemsMiddleware();
    app.UseMvc(routes =>
    {
        routes.MapRoute(
            name: "default",
            template: "{controller=Home}/{action=Index}/{id?}");
    });
}
}

```

The order of middleware is important. In the preceding example, an `InvalidOperationException` exception occurs when `UseSession` is invoked after `UseMvc`. For more information, see [Middleware Ordering](#).

`HttpContext.Session` is available after session state is configured.

`HttpContext.Session` can't be accessed before `UseSession` has been called.

A new session with a new session cookie can't be created after the app has begun writing to the response stream. The exception is recorded in the web server log and not displayed in the browser.

### Load session state asynchronously

The default session provider in ASP.NET Core loads session records from the underlying `IDistributedCache` backing store asynchronously only if the `ISession.LoadAsync` method is explicitly called before the `TryGetValue`, `Set`, or `Remove` methods. If `LoadAsync` isn't called first, the underlying session record is loaded synchronously, which can incur a performance penalty at scale.

To have apps enforce this pattern, wrap the `DistributedSessionStore` and `DistributedSession` implementations with versions that throw an exception if the `LoadAsync` method isn't called before `TryGetValue`, `Set`, or `Remove`. Register the wrapped versions in the services container.

### Session options

To override session defaults, use `SessionOptions`.

OPTION	DESCRIPTION
<code>Cookie</code>	Determines the settings used to create the cookie. <code>Name</code> defaults to <code>SessionDefaults.CookieName</code> ( <code>.AspNetCore.Session</code> ). <code>Path</code> defaults to <code>SessionDefaults.CookiePath</code> ( <code>/</code> ). <code>SameSite</code> defaults to <code>SameSiteMode.Lax</code> ( <code>1</code> ). <code>HttpOnly</code> defaults to <code>true</code> . <code>IsEssential</code> defaults to <code>false</code> .

OPTION	DESCRIPTION
IdleTimeout	The <code>IdleTimeout</code> indicates how long the session can be idle before its contents are abandoned. Each session access resets the timeout. Note this only applies to the content of the session, not the cookie. The default is 20 minutes.
IOTimeout	The maximum amount of time allowed to load a session from the store or to commit it back to the store. Note this may only apply to asynchronous operations. This timeout can be disabled using <code>InfiniteTimeSpan</code> . The default is 1 minute.

Session uses a cookie to track and identify requests from a single browser. By default, this cookie is named `.AspNetCore.Session`, and it uses a path of `/`. Because the cookie default doesn't specify a domain, it isn't made available to the client-side script on the page (because `HttpOnly` defaults to `true`).

OPTION	DESCRIPTION
CookieDomain	Determines the domain used to create the cookie. <code>CookieDomain</code> isn't set by default.
CookieHttpOnly	Determines if the browser should allow the cookie to be accessed by client-side JavaScript. The default is <code>true</code> , which means the cookie is only passed to HTTP requests and isn't made available to script on the page.
CookieName	Determines the cookie name used to persist the session ID. The default is <code>SessionDefaults.CookieName</code> ( <code>.AspNetCore.Session</code> ).
CookiePath	Determines the path used to create the cookie. Defaults to <code>SessionDefaults.CookiePath</code> ( <code>/</code> ).
CookieSecure	Determines if the cookie should only be transmitted on HTTPS requests. The default is <code>CookieSecurePolicy.None</code> (2).
IdleTimeout	The <code>IdleTimeout</code> indicates how long the session can be idle before its contents are abandoned. Each session access resets the timeout. Note this only applies to the content of the session, not the cookie. The default is 20 minutes.

Session uses a cookie to track and identify requests from a single browser. By default, this cookie is named `.AspNet.Session`, and it uses a path of `/`.

To override cookie session defaults, use `SessionOptions`:

```

public void ConfigureServices(IServiceCollection services)
{
    services.Configure<CookiePolicyOptions>(options =>
    {
        options.CheckConsentNeeded = context => true;
        options.MinimumSameSitePolicy = SameSiteMode.None;
    });

    services.AddDistributedMemoryCache();

    services.AddMvc()
        .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);

    services.AddSession(options =>
    {
        options.Cookie.Name = ".AdventureWorks.Session";
        options.IdleTimeout = TimeSpan.FromSeconds(10);
    });
}

```

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddDistributedMemoryCache();

    services.AddSession(options =>
    {
        options.CookieName = ".AdventureWorks.Session";
        options.IdleTimeout = TimeSpan.FromSeconds(10);
    });

    services.AddMvc();
}

```

The app uses the [IdleTimeout](#) property to determine how long a session can be idle before its contents in the server's cache are abandoned. This property is independent of the cookie expiration. Each request that passes through the [Session Middleware](#) resets the timeout.

Session state is *non-locking*. If two requests simultaneously attempt to modify the contents of a session, the last request overrides the first. `Session` is implemented as a *coherent session*, which means that all the contents are stored together. When two requests seek to modify different session values, the last request may override session changes made by the first.

## Set and get Session values

Session state is accessed from a Razor Pages [PageModel](#) class or MVC [Controller](#) class with [HttpContext.Session](#). This property is an [ISession](#) implementation.

The `ISession` implementation provides several extension methods to set and retrieve integer and string values.

The extension methods are in the [Microsoft.AspNetCore.Http](#) namespace (add a

`using Microsoft.AspNetCore.Http;` statement to gain access to the extension methods) when the

[Microsoft.AspNetCore.Http.Extensions](#) package is referenced by the project. Both packages are included in the [Microsoft.AspNetCore.App](#) metapackage.

The `ISession` implementation provides several extension methods to set and retrieve integer and string values.

The extension methods are in the [Microsoft.AspNetCore.Http](#) namespace (add a

`using Microsoft.AspNetCore.Http;` statement to gain access to the extension methods) when the

[Microsoft.AspNetCore.Http.Extensions](#) package is referenced by the project.

`ISession` extension methods:

- [Get\(I Session, String\)](#)
- [GetInt32\(I Session, String\)](#)
- [GetString\(I Session, String\)](#)
- [SetInt32\(I Session, String, Int32\)](#)
- [SetString\(I Session, String, String\)](#)

The following example retrieves the session value for the `IndexModel.SessionKeyName` key (`_Name` in the sample app) in a Razor Pages page:

```
@page
@using Microsoft.AspNetCore.Http
@model IndexModel

...
Name: @HttpContext.Session.GetString(IndexModel.SessionKeyName)
```

The following example shows how to set and get an integer and a string:

```
public class IndexModel : PageModel
{
    public const string SessionKeyName = "_Name";
    public const string SessionKeyAge = "_Age";
    const string SessionKeyTime = "_Time";

    public string SessionInfo_Name { get; private set; }
    public string SessionInfo_Age { get; private set; }
    public string SessionInfo_CurrentTime { get; private set; }
    public string SessionInfo_SessionTime { get; private set; }
    public string SessionInfo_MiddlewareValue { get; private set; }

    public void OnGet()
    {
        // Requires: using Microsoft.AspNetCore.Http;
        if (string.IsNullOrEmpty(HttpContext.Session.GetString(SessionKeyName)))
        {
            HttpContext.Session.SetString(SessionKeyName, "The Doctor");
            HttpContext.Session.SetInt32(SessionKeyAge, 773);
        }
    }

    var name = HttpContext.Session.GetString(SessionKeyName);
    var age = HttpContext.Session.GetInt32(SessionKeyAge);
```

```

public class HomeController : Controller
{
    const string SessionKeyName = "_Name";
    const string SessionKeyYearsMember = "_YearsMember";
    const string SessionKeyDate = "_Date";

    public IActionResult Index()
    {
        // Requires using Microsoft.AspNetCore.Http;
        HttpContext.Session.SetString(SessionKeyName, "Rick");
        HttpContext.Session.SetInt32(SessionKeyYearsMember, 3);

        return RedirectToAction("SessionNameYears");
    }

    public IActionResult SessionNameYears()
    {
        var name = HttpContext.Session.GetString(SessionKeyName);
        var yearsMember = HttpContext.Session.GetInt32(SessionKeyYearsMember);

        return Content($"Name: \"{name}\", Membership years: \"{yearsMember}\"");
    }
}

```

All session data must be serialized to enable a distributed cache scenario, even when using the in-memory cache. Minimal string and number serializers are provided (see the methods and extension methods of [ISession](#)). Complex types must be serialized by the user using another mechanism, such as JSON.

Add the following extension methods to set and get serializable objects:

```

public static class SessionExtensions
{
    public static void Set<T>(this ISession session, string key, T value)
    {
        session.SetString(key, JsonConvert.SerializeObject(value));
    }

    public static T Get<T>(this ISession session, string key)
    {
        var value = session.GetString(key);

        return value == null ? default(T) :
            JsonConvert.DeserializeObject<T>(value);
    }
}

```

```

public static class SessionExtensions
{
    public static void Set<T>(this ISession session, string key, T value)
    {
        session.SetString(key, JsonConvert.SerializeObject(value));
    }

    public static T Get<T>(this ISession session, string key)
    {
        var value = session.GetString(key);
        return value == null ? default(T) :
            JsonConvert.DeserializeObject<T>(value);
    }
}

```

The following example shows how to set and get a serializable object with the extension methods:

```
// Requires you add the Set and Get extension method mentioned in the topic.  
if (HttpContext.Session.Get<DateTime>(SessionKeyTime) == default(DateTime))  
{  
    HttpContext.Session.Set<DateTime>(SessionKeyTime, currentTime);  
}
```

```
public IActionResult SetDate()  
{  
    // Requires you add the Set extension method mentioned in the topic.  
    HttpContext.Session.Set<DateTime>(SessionKeyDate, DateTime.Now);  
  
    return RedirectToAction("GetDate");  
}  
  
public IActionResult GetDate()  
{  
    // Requires you add the Get extension method mentioned in the topic.  
    var date = HttpContext.Session.Get<DateTime>(SessionKeyDate);  
    var sessionTime = date.TimeOfDay.ToString();  
    var currentTime = DateTime.Now.TimeOfDay.ToString();  
  
    return Content($"Current time: {currentTime} - "  
        + $"session time: {sessionTime}");  
}
```

## TempData

ASP.NET Core exposes the [TempData property of a Razor Pages page model](#) or [TempData of an MVC controller](#). This property stores data until it's read. The [Keep](#) and [Peek](#) methods can be used to examine the data without deletion. TempData is particularly useful for redirection when data is required for more than a single request. TempData is implemented by TempData providers using either cookies or session state.

### TempData providers

In ASP.NET Core 2.0 or later, the cookie-based TempData provider is used by default to store TempData in cookies.

The cookie data is encrypted using [IDataProtector](#), encoded with [Base64UrlTextEncoder](#), then chunked. Because the cookie is chunked, the single cookie size limit found in ASP.NET Core 1.x doesn't apply. The cookie data isn't compressed because compressing encrypted data can lead to security problems such as the [CRIME](#) and [BREACH](#) attacks. For more information on the cookie-based TempData provider, see [CookieTempDataProvider](#).

In ASP.NET Core 1.0 and 1.1, the session state TempData provider is the default provider.

### Choose a TempData provider

Choosing a TempData provider involves several considerations, such as:

1. Does the app already use session state? If so, using the session state TempData provider has no additional cost to the app (aside from the size of the data).
2. Does the app use TempData only sparingly for relatively small amounts of data (up to 500 bytes)? If so, the cookie TempData provider adds a small cost to each request that carries TempData. If not, the session state TempData provider can be beneficial to avoid round-tripping a large amount of data in each request until the TempData is consumed.
3. Does the app run in a server farm on multiple servers? If so, there's no additional configuration required to use the cookie TempData provider outside of Data Protection (see [Data Protection](#) and [Key storage providers](#)).

#### NOTE

Most web clients (such as web browsers) enforce limits on the maximum size of each cookie, the total number of cookies, or both. When using the cookie TempData provider, verify the app won't exceed these limits. Consider the total size of the data. Account for increases in cookie size due to encryption and chunking.

## Configure the TempData provider

The cookie-based TempData provider is enabled by default.

To enable the session-based TempData provider, use the [AddSessionStateTempDataProvider](#) extension method:

```
public void ConfigureServices(IServiceCollection services)
{
    services.Configure<CookiePolicyOptions>(options =>
    {
        options.CheckConsentNeeded = context => true;
        options.MinimumSameSitePolicy = SameSiteMode.None;
    });

    services.AddMvc()
        .SetCompatibilityVersion(CompatibilityVersion.Version_2_1)
        .AddSessionStateTempDataProvider();

    services.AddSession();
}

public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
        app.UseDatabaseErrorPage();
    }
    else
    {
        app.UseExceptionHandler("/Error");
        app.UseHsts();
    }

    app.UseHttpsRedirection();
    app.UseStaticFiles();
    app.UseCookiePolicy();
    app.UseSession();
    app.UseMvc();
}
```

The following `Startup` class code configures the session-based TempData provider:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc();
    services.AddSession();
}

public void Configure(IApplicationBuilder app, IHostingEnvironment env, ILoggerFactory loggerFactory)
{
    app.UseSession();
    app.UseMvc(routes =>
    {
        routes.MapRoute(
            name: "default",
            template: "{controller=Home}/{action=Index}/{id?}");
    });
}
```

The order of middleware is important. In the preceding example, an `InvalidOperationException` exception occurs when `UseSession` is invoked after `UseMvc`. For more information, see [Middleware Ordering](#).

#### IMPORTANT

If targeting .NET Framework and using the session-based `TempData` provider, add the [Microsoft.AspNetCore.Session](#) package to the project.

## Query strings

A limited amount of data can be passed from one request to another by adding it to the new request's query string. This is useful for capturing state in a persistent manner that allows links with embedded state to be shared through email or social networks. Because URL query strings are public, never use query strings for sensitive data.

In addition to unintended sharing, including data in query strings can create opportunities for [Cross-Site Request Forgery \(CSRF\)](#) attacks, which can trick users into visiting malicious sites while authenticated. Attackers can then steal user data from the app or take malicious actions on behalf of the user. Any preserved app or session state must protect against CSRF attacks. For more information, see [Prevent Cross-Site Request Forgery \(XSRF/CSRF\) attacks](#).

## Hidden fields

Data can be saved in hidden form fields and posted back on the next request. This is common in multi-page forms. Because the client can potentially tamper with the data, the app must always revalidate the data stored in hidden fields.

## HttpContext.Items

The `HttpContext.Items` collection is used to store data while processing a single request. The collection's contents are discarded after a request is processed. The `Items` collection is often used to allow components or middleware to communicate when they operate at different points in time during a request and have no direct way to pass parameters.

In the following example, `middleware` adds `isVerified` to the `Items` collection.

```
app.Use(async (context, next) =>
{
    // perform some verification
    context.Items["isVerified"] = true;
    await next.Invoke();
});
```

Later in the pipeline, another middleware can access the value of `isVerified`:

```
app.Run(async (context) =>
{
    await context.Response.WriteAsync($"Verified: {context.Items["isVerified"]}");
});
```

For middleware that's only used by a single app, `string` keys are acceptable. Middleware shared between app instances should use unique object keys to avoid key collisions. The following example shows how to use a unique object key defined in a middleware class:

```
public class HttpContextItemsMiddleware
{
    private readonly RequestDelegate _next;
    public static readonly object HttpContextItemsMiddlewareKey = new Object();

    public HttpContextItemsMiddleware(RequestDelegate next)
    {
        _next = next;
    }

    public async Task Invoke(HttpContext httpContext)
    {
        httpContext.Items[HttpContextItemsMiddlewareKey] = "K-9";

        await _next(httpContext);
    }
}

public static class HttpContextItemsMiddlewareExtensions
{
    public static IApplicationBuilder
        UseHttpContextItemsMiddleware(this IApplicationBuilder builder)
    {
        return builder.UseMiddleware<HttpContextItemsMiddleware>();
    }
}
```

```
// You may need to install the Microsoft.AspNetCore.Http.Abstractions package
public class HttpContextItemsMiddleware
{
    private readonly RequestDelegate _next;
    public static readonly object HttpContextItemsMiddlewareKey = new Object();

    public HttpContextItemsMiddleware(RequestDelegate next)
    {
        _next = next;
    }

    public async Task Invoke(HttpContext httpContext)
    {
        httpContext.Items[HttpContextItemsMiddlewareKey] = "K-9";

        await _next(httpContext);
    }
}

public static class HttpContextItemsMiddlewareExtensions
{
    public static IApplicationBuilder
        UseHttpContextItemsMiddleware(this IApplicationBuilder builder)
    {
        return builder.UseMiddleware<HttpContextItemsMiddleware>();
    }
}
```

Other code can access the value stored in `HttpContext.Items` using the key exposed by the middleware class:

```
HttpContext.Items
    .TryGetValue(HttpContextItemsMiddleware.HttpContextItemsMiddlewareKey,
        out var middlewareSetValue);
SessionInfo_MiddlewareValue =
    middlewareSetValue?.ToString() ?? "Middleware value not set!";
```

```
public IActionResult GetMiddlewareValue()
{
    var middlewareSetValue =
        HttpContext.Items[HttpContextItemsMiddleware.HttpContextItemsMiddlewareKey];

    return Content($"Value: {middlewareSetValue}");
}
```

This approach also has the advantage of eliminating the use of key strings in the code.

## Cache

Caching is an efficient way to store and retrieve data. The app can control the lifetime of cached items.

Cached data isn't associated with a specific request, user, or session. **Be careful not to cache user-specific data that may be retrieved by other users' requests.**

For more information, see the [Cache responses](#) topic.

## Dependency Injection

Use [Dependency Injection](#) to make data available to all users:

1. Define a service containing the data. For example, a class named `MyAppData` is defined:

```
public class MyAppData
{
    // Declare properties and methods
}
```

2. Add the service class to `Startup.ConfigureServices`:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddSingleton<MyAppData>();
}
```

3. Consume the data service class:

```
public class IndexModel : PageModel
{
    public IndexModel(MyAppData myService)
    {
        // Do something with the service
        // Examples: Read data, store in a field or property
    }
}
```

```
public class HomeController : Controller
{
    public HomeController(MyAppData myService)
    {
        // Do something with the service
        // Examples: Read data, store in a field or property
    }
}
```

## Common errors

- "Unable to resolve service for type 'Microsoft.Extensions.Caching.Distributed.IDistributedCache' while attempting to activate 'Microsoft.AspNetCore.Session.DistributedSessionStore'."

This is usually caused by failing to configure at least one `IDistributedCache` implementation. For more information, see [Work with a distributed cache](#) and [Cache in-memory](#).

- In the event that the session middleware fails to persist a session (for example, if the backing store isn't available), the middleware logs the exception and the request continues normally. This leads to unpredictable behavior.

For example, a user stores a shopping cart in session. The user adds an item to the cart but the commit fails. The app doesn't know about the failure so it reports to the user that the item was added to their cart, which isn't true.

The recommended approach to check for errors is to call `await feature.Session.CommitAsync();` from app code when the app is done writing to the session. `CommitAsync` throws an exception if the backing store is unavailable. If `CommitAsync` fails, the app can process the exception. `LoadAsync` throws under the same conditions where the data store is unavailable.

# Web server implementations in ASP.NET Core

6/21/2018 • 4 minutes to read • [Edit Online](#)

By [Tom Dykstra](#), [Steve Smith](#), [Stephen Halter](#), and [Chris Ross](#)

An ASP.NET Core app runs with an in-process HTTP server implementation. The server implementation listens for HTTP requests and surfaces them to the app as sets of [request features](#) composed into an [HttpContext](#).

ASP.NET Core ships two server implementations:

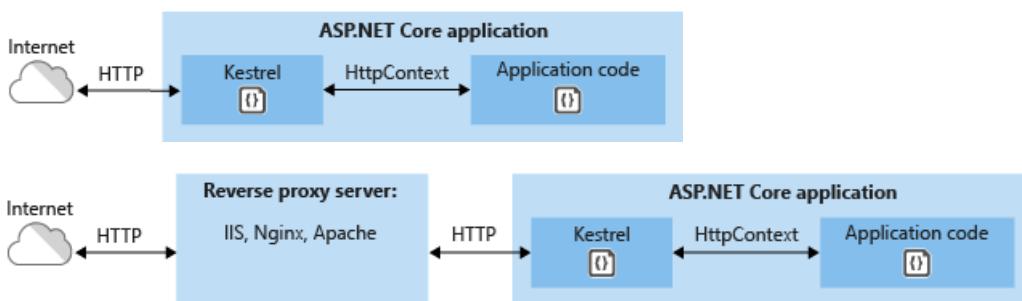
- [Kestrel](#) is the default, cross-platform HTTP server for ASP.NET Core.
- [HTTP.sys](#) is a Windows-only HTTP server based on the [HTTP.sys kernel driver](#) and [HTTP Server API](#).  
(HTTP.sys is called [WebListener](#) in ASP.NET Core 1.x.)

## Kestrel

Kestrel is the default web server included in ASP.NET Core project templates.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

Kestrel can be used by itself or with a *reverse proxy server*, such as IIS, Nginx, or Apache. A reverse proxy server receives HTTP requests from the Internet and forwards them to Kestrel after some preliminary handling.



Either configuration—with or without a reverse proxy server—is a valid and supported hosting configuration for ASP.NET Core 2.0 or later apps. For more information, see [When to use Kestrel with a reverse proxy](#).

IIS, Nginx, and Apache can't be used without Kestrel or a [custom server implementation](#). ASP.NET Core was designed to run in its own process so that it can behave consistently across platforms. IIS, Nginx, and Apache dictate their own startup procedure and environment. To use these server technologies directly, ASP.NET Core would need to adapt to the requirements of each server. Using a web server implementation, such as Kestrel, ASP.NET Core has control over the startup process and environment when hosted on different server technologies.

### IIS with Kestrel

When using [IIS](#) or [IIS Express](#) as a reverse proxy for ASP.NET Core, the ASP.NET Core app runs in a process separate from the IIS worker process. In the IIS process, the [ASP.NET Core Module](#) coordinates the reverse proxy relationship. The primary functions of the ASP.NET Core Module are to start the ASP.NET Core app, restart the app when it crashes, and forward HTTP traffic to the app. For more information, see [ASP.NET Core Module](#).

### Nginx with Kestrel

For information on how to use Nginx on Linux as a reverse proxy server for Kestrel, see [Host on Linux with Nginx](#).

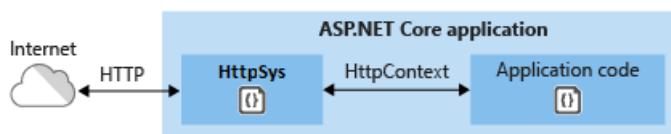
## Apache with Kestrel

For information on how to use Apache on Linux as a reverse proxy server for Kestrel, see [Host on Linux with Apache](#).

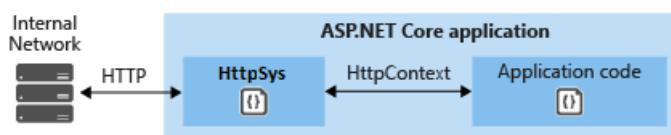
## HTTP.sys

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

If ASP.NET Core apps are run on Windows, HTTP.sys is an alternative to Kestrel. Kestrel is generally recommended for best performance. HTTP.sys can be used in scenarios where the app is exposed to the Internet and required features are supported by HTTP.sys but not Kestrel. For information on HTTP.sys features, see [HTTP.sys](#).



HTTP.sys can also be used for apps that are only exposed to an internal network.



## ASP.NET Core server infrastructure

The [IApplicationBuilder](#) available in the `Startup.Configure` method exposes the [ServerFeatures](#) property of type [IFeatureCollection](#). Kestrel and HTTP.sys (WebListener in ASP.NET Core 1.x) only expose a single feature each, [IServerAddressesFeature](#), but different server implementations may expose additional functionality.

[IServerAddressesFeature](#) can be used to find out which port the server implementation has bound at runtime.

## Custom servers

If the built-in servers don't meet the app's requirements, a custom server implementation can be created. The [Open Web Interface for .NET \(OWIN\) guide](#) demonstrates how to write a [Nowin](#)-based [IServer](#) implementation. Only the feature interfaces that the app uses require implementation, though at a minimum [IHttpRequestFeature](#) and [IHttpResponseFeature](#) must be supported.

## Server startup

When using [Visual Studio](#), [Visual Studio for Mac](#), or [Visual Studio Code](#), the server is launched when the app is started by the Integrated Development Environment (IDE). In Visual Studio on Windows, launch profiles can be used to start the app and server with either [IIS Express/ASP.NET Core Module](#) or the console. In Visual Studio Code, the app and server are started by [Omnisharp](#), which activates the CoreCLR debugger. Using Visual Studio for Mac, the app and server are started by the [Mono Soft-Mode Debugger](#).

When launching an app from a command prompt in the project's folder, `dotnet run` launches the app and server (Kestrel and HTTP.sys only). The configuration is specified by the `-c|--configuration` option, which is set to either `Debug` (default) or `Release`. If launch profiles are present in a `launchSettings.json` file, use the `--launch-profile <NAME>` option to set the launch profile (for example, `Development` or `Production`). For more information, see the [dotnet run](#) and [.NET Core distribution packaging](#) topics.

## Additional resources

- [Kestrel](#)
- [Kestrel with IIS](#)
- [Host on Linux with Nginx](#)
- [Host on Linux with Apache](#)
- [HTTP.sys](#) (for ASP.NET Core 1.x, see [WebListener](#))

# Kestrel web server implementation in ASP.NET Core

6/21/2018 • 22 minutes to read • [Edit Online](#)

By Tom Dykstra, Chris Ross, and Stephen Halter

Kestrel is a cross-platform [web server for ASP.NET Core](#). Kestrel is the web server that's included by default in ASP.NET Core project templates.

Kestrel supports the following features:

- HTTPS
- Opaque upgrade used to enable [WebSockets](#)
- Unix sockets for high performance behind Nginx

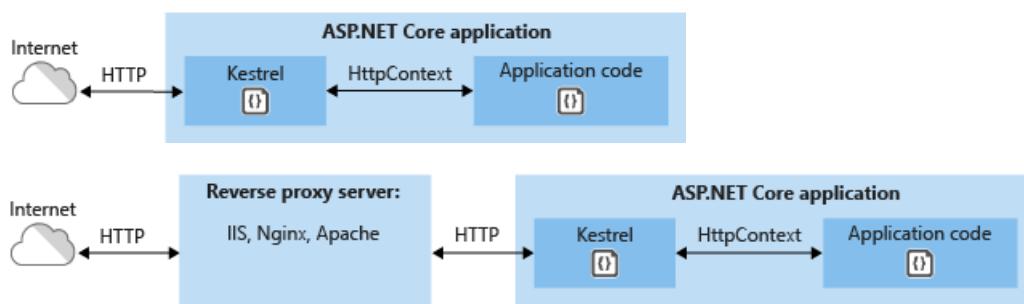
Kestrel is supported on all platforms and versions that .NET Core supports.

[View or download sample code \(how to download\)](#)

## When to use Kestrel with a reverse proxy

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

You can use Kestrel by itself or with a *reverse proxy server*, such as IIS, Nginx, or Apache. A reverse proxy server receives HTTP requests from the Internet and forwards them to Kestrel after some preliminary handling.



Either configuration—with or without a reverse proxy server—is a valid and supported hosting configuration for ASP.NET Core 2.0 or later apps.

A reverse proxy scenario exists when there are multiple apps that share the same IP and port running on a single server. Kestrel doesn't support this scenario because Kestrel doesn't support sharing the same IP and port among multiple processes. When Kestrel is configured to listen on a port, Kestrel handles all of the traffic for that port regardless of requests' host header. A reverse proxy that can share ports has the ability to forward requests to Kestrel on a unique IP and port.

Even if a reverse proxy server isn't required, using a reverse proxy server might be a good choice:

- It can limit the exposed public surface area of the apps that it hosts.
- It provides an additional layer of configuration and defense.
- It might integrate better with existing infrastructure.
- It simplifies load balancing and SSL configuration. Only the reverse proxy server requires an SSL certificate, and that server can communicate with your app servers on the internal network using plain HTTP.

## WARNING

If not using a reverse proxy with host filtering enabled, [host filtering](#) must be enabled.

# How to use Kestrel in ASP.NET Core apps

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

The [Microsoft.AspNetCore.Server.Kestrel](#) package is included in the [Microsoft.AspNetCore.App metapackage] (xref:fundamentals/metapackage-app) (ASP.NET Core 2.1 or later).

ASP.NET Core project templates use Kestrel by default. In *Program.cs*, the template code calls [CreateDefaultBuilder](#), which calls [UseKestrel](#) behind the scenes.

```
public static void Main(string[] args)
{
    CreateWebHostBuilder(args).Build().Run();
}

public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
    WebHost.CreateDefaultBuilder(args)
        .UseStartup<Startup>();
```

## Kestrel options

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

The Kestrel web server has constraint configuration options that are especially useful in Internet-facing deployments. A few important limits that can be customized:

- Maximum client connections
- Maximum request body size
- Minimum request body data rate

Set these and other constraints on the [Limits](#) property of the [KestrelServerOptions](#) class. The `Limits` property holds an instance of the [KestrelServerLimits](#) class.

### Maximum client connections

[MaxConcurrentConnections](#)

[MaxConcurrentUpgradedConnections](#)

The maximum number of concurrent open TCP connections can be set for the entire app with the following code:

```
.UseKestrel(options =>
{
    options.Limits.MaxConcurrentConnections = 100;
    options.Limits.MaxConcurrentUpgradedConnections = 100;
    options.Limits.MaxRequestBodySize = 10 * 1024;
    options.Limits.MinRequestBodyDataRate =
        new MinDataRate(bytesPerSecond: 100, gracePeriod: TimeSpan.FromSeconds(10));
    options.Limits.MinResponseDataRate =
        new MinDataRate(bytesPerSecond: 100, gracePeriod: TimeSpan.FromSeconds(10));
    options.Listen(IPAddress.Loopback, 5000);
    options.Listen(IPAddress.Loopback, 5001, listenOptions =>
    {
        listenOptions.UseHttps("testCert.pfx", "testPassword");
    });
});
```

There's a separate limit for connections that have been upgraded from HTTP or HTTPS to another protocol (for example, on a WebSockets request). After a connection is upgraded, it isn't counted against the `MaxConcurrentConnections` limit.

```
.UseKestrel(options =>
{
    options.Limits.MaxConcurrentConnections = 100;
    options.Limits.MaxConcurrentUpgradedConnections = 100;
    options.Limits.MaxRequestBodySize = 10 * 1024;
    options.Limits.MinRequestBodyDataRate =
        new MinDataRate(bytesPerSecond: 100, gracePeriod: TimeSpan.FromSeconds(10));
    options.Limits.MinResponseDataRate =
        new MinDataRate(bytesPerSecond: 100, gracePeriod: TimeSpan.FromSeconds(10));
    options.Listen(IPAddress.Loopback, 5000);
    options.Listen(IPAddress.Loopback, 5001, listenOptions =>
    {
        listenOptions.UseHttps("testCert.pfx", "testPassword");
    });
});
```

The maximum number of connections is unlimited (null) by default.

## Maximum request body size

### MaxRequestBodySize

The default maximum request body size is 30,000,000 bytes, which is approximately 28.6 MB.

The recommended approach to override the limit in an ASP.NET Core MVC app is to use the [RequestSizeLimit](#) attribute on an action method:

```
[RequestSizeLimit(100000000)]
public IActionResult MyActionMethod()
```

Here's an example that shows how to configure the constraint for the app on every request:

```

.UseKestrel(options =>
{
    options.Limits.MaxConcurrentConnections = 100;
    options.Limits.MaxConcurrentUpgradedConnections = 100;
    options.Limits.MaxRequestBodySize = 10 * 1024;
    options.Limits.MinRequestBodyDataRate =
        new MinDataRate(bytesPerSecond: 100, gracePeriod: TimeSpan.FromSeconds(10));
    options.Limits.MinResponseDataRate =
        new MinDataRate(bytesPerSecond: 100, gracePeriod: TimeSpan.FromSeconds(10));
    options.Listen(IPAddress.Loopback, 5000);
    options.Listen(IPAddress.Loopback, 5001, listenOptions =>
    {
        listenOptions.UseHttps("testCert.pfx", "testPassword");
    });
});

```

You can override the setting on a specific request in middleware:

```

app.Run(async (context) =>
{
    context.Features.Get< IHttpMaxRequestBodySizeFeature>()
        .MaxRequestBodySize = 10 * 1024;
    context.Features.Get< IHttpMinRequestBodyDataRateFeature>()
        .MinDataRate = new MinDataRate(bytesPerSecond: 100,
            gracePeriod: TimeSpan.FromSeconds(10));
    context.Features.Get< IHttpMinResponseDataRateFeature>()
        .MinDataRate = new MinDataRate(bytesPerSecond: 100,
            gracePeriod: TimeSpan.FromSeconds(10));
}

```

An exception is thrown if you attempt to configure the limit on a request after the app has started to read the request. There's an `IsReadOnly` property that indicates if the `MaxRequestBodySize` property is in read-only state, meaning it's too late to configure the limit.

## Minimum request body data rate

[MinRequestBodyDataRate](#)

[MinResponseDataRate](#)

Kestrel checks every second if data is arriving at the specified rate in bytes/second. If the rate drops below the minimum, the connection is timed out. The grace period is the amount of time that Kestrel gives the client to increase its send rate up to the minimum; the rate isn't checked during that time. The grace period helps avoid dropping connections that are initially sending data at a slow rate due to TCP slow-start.

The default minimum rate is 240 bytes/second with a 5 second grace period.

A minimum rate also applies to the response. The code to set the request limit and the response limit is the same except for having `RequestBody` or `Response` in the property and interface names.

Here's an example that shows how to configure the minimum data rates in *Program.cs*:

```

.UseKestrel(options =>
{
    options.Limits.MaxConcurrentConnections = 100;
    options.Limits.MaxConcurrentUpgradedConnections = 100;
    options.Limits.MaxRequestBodySize = 10 * 1024;
    options.Limits.MinRequestBodyDataRate =
        new MinDataRate(bytesPerSecond: 100, gracePeriod: TimeSpan.FromSeconds(10));
    options.Limits.MinResponseDataRate =
        new MinDataRate(bytesPerSecond: 100, gracePeriod: TimeSpan.FromSeconds(10));
    options.Listen(IPAddress.Loopback, 5000);
    options.Listen(IPAddress.Loopback, 5001, listenOptions =>
    {
        listenOptions.UseHttps("testCert.pfx", "testPassword");
    });
});

```

You can configure the rates per request in middleware:

```

app.Run(async (context) =>
{
    context.Features.Get< IHttpMaxRequestBodySizeFeature>()
        .MaxRequestBodySize = 10 * 1024;
    context.Features.Get< IHttpMinRequestBodyDataRateFeature>()
        .MinDataRate = new MinDataRate(bytesPerSecond: 100,
            gracePeriod: TimeSpan.FromSeconds(10));
    context.Features.Get< IHttpMinResponseDataRateFeature>()
        .MinDataRate = new MinDataRate(bytesPerSecond: 100,
            gracePeriod: TimeSpan.FromSeconds(10));
}

```

For information about other Kestrel options and limits, see:

- [KestrelServerOptions](#)
- [KestrelServerLimits](#)
- [ListenOptions](#)

## Endpoint configuration

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

By default, ASP.NET Core binds to `http://localhost:5000`. Call [Listen](#) or [ListenUnixSocket](#) methods on [KestrelServerOptions](#) to configure URL prefixes and ports for Kestrel. `useUrls`, the `--urls` command-line argument, `urls` host configuration key, and the `ASPNETCORE_URLS` environment variable also work but have the limitations noted later in this section.

The `urls` host configuration key must come from the host configuration, not the app configuration. Adding a `urls` key and value to `appsettings.json` doesn't affect host configuration because the host is completely initialized by the time the configuration is read from the configuration file. However, a `urls` key in `appsettings.json` can be used with [UseConfiguration](#) on the host builder to configure the host:

```

var config = new ConfigurationBuilder()
    .SetBasePath(Directory.GetCurrentDirectory())
    .AddJsonFile("appSettings.json", optional: true, reloadOnChange: true)
    .Build();

var host = new WebHostBuilder()
    .UseKestrel()
    .UseConfiguration(config)
    .UseContentRoot(Directory.GetCurrentDirectory())
    .UseStartup<Startup>()
    .Build();

```

By default, ASP.NET Core binds to:

- `http://localhost:5000`
- `https://localhost:5001` (when a local development certificate is present)

A development certificate is created:

- When the [.NET Core SDK](#) is installed.
- The [dev-certs tool](#) is used to create a certificate.

Some browsers require that you grant explicit permission to the browser to trust the local development certificate.

ASP.NET Core 2.1 and later project templates configure apps to run on HTTPS by default and include [HTTPS redirection and HSTS support](#).

Call [Listen](#) or [ListenUnixSocket](#) methods on [KestrelServerOptions](#) to configure URL prefixes and ports for Kestrel.

`UseUrls`, the `--urls` command-line argument, `urls` host configuration key, and the `ASPNETCORE_URLS` environment variable also work but have the limitations noted later in this section (a default certificate must be available for HTTPS endpoint configuration).

ASP.NET Core 2.1 `KestrelServerOptions` configuration:

#### **ConfigureEndpointDefaults(Action<ListenOptions>)**

Specifies a configuration `Action` to run for each specified endpoint. Calling `ConfigureEndpointDefaults` multiple times replaces prior `Action`s with the last `Action` specified.

#### **ConfigureHttpsDefaults(Action<HttpsConnectionAdapterOptions>)**

Specifies a configuration `Action` to run for each HTTPS endpoint. Calling `ConfigureHttpsDefaults` multiple times replaces prior `Action`s with the last `Action` specified.

#### **Configure(IConfiguration)**

Creates a configuration loader for setting up Kestrel that takes an [IConfiguration](#) as input. The configuration must be scoped to the configuration section for Kestrel.

#### **ListenOptions.UseHttps**

Configure Kestrel to use HTTPS.

`ListenOptions.UseHttps` extensions:

- `UseHttps` – Configure Kestrel to use HTTPS with the default certificate. Throws an exception if no default certificate is configured.
- `UseHttps(string fileName)`
- `UseHttps(string fileName, string password)`

- `UseHttps(string fileName, string password, Action<HttpsConnectionAdapterOptions> configureOptions)`
- `UseHttps(StoreName storeName, string subject)`
- `UseHttps(StoreName storeName, string subject, bool allowInvalid)`
- `UseHttps(StoreName storeName, string subject, bool allowInvalid, StoreLocation location)`
- `UseHttps(StoreName storeName, string subject, bool allowInvalid, StoreLocation location, Action<HttpsConnectionAdapterOptions> configureOptions)`
- `UseHttps(X509Certificate2 serverCertificate)`
- `UseHttps(X509Certificate2 serverCertificate, Action<HttpsConnectionAdapterOptions> configureOptions)`
- `UseHttps(Action<HttpsConnectionAdapterOptions> configureOptions)`

`ListenOptions.UseHttps` parameters:

- `filename` is the path and file name of a certificate file, relative to the directory that contains the app's content files.
- `password` is the password required to access the X.509 certificate data.
- `configureOptions` is an `Action` to configure the `HttpsConnectionAdapterOptions`. Returns the `ListenOptions`.
- `storeName` is the certificate store from which to load the certificate.
- `subject` is the subject name for the certificate.
- `allowInvalid` indicates if invalid certificates should be considered, such as self-signed certificates.
- `location` is the store location to load the certificate from.
- `serverCertificate` is the X.509 certificate.

In production, HTTPS must be explicitly configured. At a minimum, a default certificate must be provided.

Supported configurations described next:

- No configuration
- Replace the default certificate from configuration
- Change the defaults in code

*No configuration*

Kestrel listens on `http://localhost:5000` and `https://localhost:5001` (if a default cert is available).

Specify URLs using the:

- `ASPNETCORE_URLS` environment variable.
- `--urls` command-line argument.
- `urls` host configuration key.
- `UseUrls` extension method.

For more information, see [Server URLs](#) and [Override configuration](#).

The value provided using these approaches can be one or more HTTP and HTTPS endpoints (HTTPS if a default cert is available). Configure the value as a semicolon-separated list (for example,

```
"Urls": "http://localhost:8000;http://localhost:8001" ).
```

*Replace the default certificate from configuration*

`WebHost.CreateDefaultBuilder` calls `serverOptions.Configure(context.Configuration.GetSection("Kestrel"))` by default to load Kestrel configuration. A default HTTPS app settings configuration schema is available for Kestrel. Configure multiple endpoints, including the URLs and the certificates to use, either from a file on disk or from a certificate store.

In the following *appsettings.json* example:

- Set **AllowInvalid** to `true` to permit the use of invalid certificates (for example, self-signed certificates).
- Any HTTPS endpoint that doesn't specify a certificate (**HttpsDefaultCert** in the example that follows) falls back to the cert defined under **Certificates > Default** or the development certificate.

```
{  
  "Kestrel": {  
    "EndPoints": {  
      "Http": {  
        "Url": "http://localhost:5000"  
      },  
  
      "HttpsInlineCertFile": {  
        "Url": "https://localhost:5001",  
        "Certificate": {  
          "Path": "<path to .pfx file>",  
          "Password": "<certificate password>"  
        }  
      },  
  
      "HttpsInlineCertStore": {  
        "Url": "https://localhost:5002",  
        "Certificate": {  
          "Subject": "<subject; required>",  
          "Store": "<certificate store; defaults to My>",  
          "Location": "<location; defaults to CurrentUser>",  
          "AllowInvalid": "<true or false; defaults to false>"  
        }  
      },  
  
      "HttpsDefaultCert": {  
        "Url": "https://localhost:5003"  
      },  
  
      "Https": {  
        "Url": "https://*:5004",  
        "Certificate": {  
          "Path": "<path to .pfx file>",  
          "Password": "<certificate password>"  
        }  
      }  
    },  
    "Certificates": {  
      "Default": {  
        "Path": "<path to .pfx file>",  
        "Password": "<certificate password>"  
      }  
    }  
  }  
}
```

An alternative to using **Path** and **Password** for any certificate node is to specify the certificate using certificate store fields. For example, the **Certificates > Default** certificate can be specified as:

```
"Default": {  
  "Subject": "<subject; required>",  
  "Store": "<cert store; defaults to My>",  
  "Location": "<location; defaults to CurrentUser>",  
  "AllowInvalid": "<true or false; defaults to false>"  
}
```

Schema notes:

- Endpoints names are case-insensitive. For example, `HTTPS` and `Https` are valid.
- The `Url` parameter is required for each endpoint. The format for this parameter is the same as the top-level `Urls` configuration parameter except that it's limited to a single value.
- These endpoints replace those defined in the top-level `Urls` configuration rather than adding to them. Endpoints defined in code via `Listen` are cumulative with the endpoints defined in the configuration section.
- The `Certificate` section is optional. If the `Certificate` section isn't specified, the defaults defined in earlier scenarios are used. If no defaults are available, the server throws an exception and fails to start.
- The `Certificate` section supports both **Path–Password** and **Subject–Store** certificates.
- Any number of endpoints may be defined in this way so long as they don't cause port conflicts.
- `serverOptions.Configure(context.Configuration.GetSection("Kestrel"))` returns a `KestrelConfigurationLoader` with an `.Endpoint(string name, options => { })` method that can be used to supplement a configured endpoint's settings:

```
serverOptions.Configure(context.Configuration.GetSection("Kestrel"))
    .Endpoint("HTTPS", opt =>
{
    opt.HttpsOptions.SslProtocols = SslProtocols.Tls12;
});
```

You can also directly access `KestrelServerOptions.ConfigurationLoader` to keep iterating on the existing loader, such as the one provided by [WebHost.CreateDefaultBuilder](#).

- The configuration section for each endpoint is available on the options in the `Endpoint` method so that custom settings may be read.
- Multiple configurations may be loaded by calling `serverOptions.Configure(context.Configuration.GetSection("Kestrel"))` again with another section. Only the last configuration is used, unless `Load` is explicitly called on prior instances. The metapackage doesn't call `Load` so that its default configuration section may be replaced.
- `KestrelConfigurationLoader` mirrors the `Listen` family of APIs from `KestrelServerOptions` as `Endpoint` overloads, so code and config endpoints may be configured in the same place. These overloads don't use names and only consume default settings from configuration.

*Change the defaults in code*

`ConfigureEndpointDefaults` and `ConfigureHttpsDefaults` can be used to change default settings for `ListenOptions` and `HttpsConnectionAdapterOptions`, including overriding the default certificate specified in the prior scenario. `ConfigureEndpointDefaults` and `ConfigureHttpsDefaults` should be called before any endpoints are configured.

```
options.ConfigureEndpointDefaults(opt =>
{
    opt.NoDelay = true;
});

options.ConfigureHttpsDefaults(httpsOptions =>
{
    httpsOptions.SslProtocols = SslProtocols.Tls12;
});
```

*Kestrel support for SNI*

[Server Name Indication \(SNI\)](#) can be used to host multiple domains on the same IP address and port. For SNI to function, the client sends the host name for the secure session to the server during the TLS handshake so

that the server can provide the correct certificate. The client uses the furnished certificate for encrypted communication with the server during the secure session that follows the TLS handshake.

Kestrel supports SNI via the `ServerCertificateSelector` callback. The callback is invoked once per connection to allow the app to inspect the host name and select the appropriate certificate.

SNI support requires:

- Running on target framework `netcoreapp2.1`. On `netcoreapp2.0` and `net461`, the callback is invoked but the `name` is always `null`. The `name` is also `null` if the client doesn't provide the host name parameter in the TLS handshake.
- All websites run on the same Kestrel instance. Kestrel doesn't support sharing an IP address and port across multiple instances without a reverse proxy.

```
WebHost.CreateDefaultBuilder()
    .UseKestrel((context, options) =>
{
    options.ListenAnyIP(5005, listenOptions =>
{
    listenOptions.UseHttps(httpsOptions =>
{
    var localhostCert = CertificateLoader.LoadFromStoreCert(
        "localhost", "My", StoreLocation.CurrentUser,
        allowInvalid: true);
    var exampleCert = CertificateLoader.LoadFromStoreCert(
        "example.com", "My", StoreLocation.CurrentUser,
        allowInvalid: true);
    var subExampleCert = CertificateLoader.LoadFromStoreCert(
        "sub.example.com", "My", StoreLocation.CurrentUser,
        allowInvalid: true);
    var certs = new Dictionary(StringComparer.OrdinalIgnoreCase);
    certs["localhost"] = localhostCert;
    certs["example.com"] = exampleCert;
    certs["sub.example.com"] = subExampleCert;

    httpsOptions.ServerCertificateSelector = (connectionContext, name) =>
{
    if (name != null && certs.TryGetValue(name, out var cert))
    {
        return cert;
    }

    return exampleCert;
};
});
});
});
});
```

## Bind to a TCP socket

The [Listen](#) method binds to a TCP socket, and an options lambda permits SSL certificate configuration:

```
public static void Main(string[] args)
{
    CreateWebHostBuilder(args).Build().Run();
}

public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
    WebHost.CreateDefaultBuilder(args)
        .UseStartup<Startup>()
        .UseKestrel(options =>
    {
        options.Listen(IPAddress.Loopback, 8000);
        options.Listen(IPAddress.Loopback, 8001, listenOptions =>
        {
            listenOptions.UseHttps("testCert.pfx", "testPassword");
        });
    });
}
```

The example configures SSL for an endpoint with [ListenOptions](#). Use the same API to configure other Kestrel settings for specific endpoints.

On Windows, self-signed certificates can be created using the [New-SelfSignedCertificate PowerShell cmdlet](#). For an unsupported example, see [UpdateIISExpressSSLForChrome.ps1](#).

On macOS, Linux, and Windows, certificates can be created using [OpenSSL](#).

## Bind to a Unix socket

Listen on a Unix socket with [ListenUnixSocket](#) for improved performance with Nginx, as shown in this example:

```
.UseKestrel(options =>
{
    options.ListenUnixSocket("/tmp/kestrel-test.sock");
    options.ListenUnixSocket("/tmp/kestrel-test.sock", listenOptions =>
    {
        listenOptions.UseHttps("testCert.pfx", "testpassword");
    });
});
```

## Port 0

When the port number `0` is specified, Kestrel dynamically binds to an available port. The following example shows how to determine which port Kestrel actually bound at runtime:

```

public void Configure(IApplicationBuilder app)
{
    var serverAddressesFeature =
        app.ServerFeatures.Get<IServerAddressesFeature>();

    app.UseStaticFiles();

    app.Run(async (context) =>
    {
        context.Response.ContentType = "text/html";
        await context.Response
            .WriteAsync("<!DOCTYPE html><html lang=\"en\"><head>" +
            "<title></title></head><body><p>Hosted by Kestrel</p>");

        if (serverAddressesFeature != null)
        {
            await context.Response
                .WriteAsync("<p>Listening on the following addresses: " +
                    string.Join(", ", serverAddressesFeature.Addresses) +
                    "</p>");
        }

        await context.Response.WriteAsync("<p>Request URL: " +
            $"{context.Request.GetDisplayUrl()}</p>");
    });
}

```

When the app is run, the console window output indicates the dynamic port where the app can be reached:

```
Listening on the following addresses: http://127.0.0.1:48508
```

## **UseUrls, --urls command-line argument, urls host configuration key, and ASPNETCORE\_URLS environment variable limitations**

Configure endpoints with the following approaches:

- `UseUrls`
- `--urls` command-line argument
- `urls` host configuration key
- `ASPNETCORE_URLS` environment variable

These methods are useful for making code work with servers other than Kestrel. However, be aware of these limitations:

- SSL can't be used with these approaches unless a default certificate is provided in the HTTPS endpoint configuration (for example, using `KestrelServerOptions` configuration or a configuration file as shown earlier in this topic).
- When both the `Listen` and `useUrls` approaches are used simultaneously, the `Listen` endpoints override the `useUrls` endpoints.

### **IIS endpoint configuration**

When using IIS, the URL bindings for IIS override bindings are set by either `Listen` or `UseUrls`. For more information, see the [ASP.NET Core Module](#) topic.

## **Transport configuration**

With the release of ASP.NET Core 2.1, Kestrel's default transport is no longer based on Libuv but instead based on managed sockets. This is a breaking change for ASP.NET Core 2.0 apps upgrading to 2.1 that call

`WebHostBuilderExtensions.UseLibuv` and depend on either of the following packages:

- `Microsoft.AspNetCore.Server.Kestrel` (direct package reference)
- `Microsoft.AspNetCore.App`

For ASP.NET Core 2.1 or later projects that use the `Microsoft.AspNetCore.App metapackage` and require the use of Libuv:

- Add a dependency for the `Microsoft.AspNetCore.Server.Kestrel.Transport.Libuv` package to the app's project file:

```
<PackageReference Include="Microsoft.AspNetCore.Server.Kestrel.Transport.Libuv"
Version="2.1.0" />
```

- Call `WebHostBuilderExtensions.UseLibuv`:

```
public class Program
{
    public static void Main(string[] args)
    {
        CreateWebHostBuilder(args).Build().Run();
    }

    public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
        WebHost.CreateDefaultBuilder(args)
            .UseLibuv()
            .UseStartup<Startup>();
}
```

## URL prefixes

When using `UseUrls`, `--urls` command-line argument, `urls` host configuration key, or `ASPNETCORE_URLS` environment variable, the URL prefixes can be in any of the following formats.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

Only HTTP URL prefixes are valid. Kestrel doesn't support SSL when configuring URL bindings using `UseUrls`.

- IPv4 address with port number

```
http://65.55.39.10:80/
```

`0.0.0.0` is a special case that binds to all IPv4 addresses.

- IPv6 address with port number

```
http://[0:0:0:0:0:ffff:4137:270a]:80/
```

`[::]` is the IPv6 equivalent of IPv4 `0.0.0.0`.

- Host name with port number

```
http://contoso.com:80/
http://*:80/
```

Host names, `*`, and `+`, aren't special. Anything not recognized as a valid IP address or `localhost` binds to all IPv4 and IPv6 IPs. To bind different host names to different ASP.NET Core apps on the same port, use [HTTP.sys](#) or a reverse proxy server, such as IIS, Nginx, or Apache.

#### WARNING

If not using a reverse proxy with host filtering enabled, enable [host filtering](#).

- Host `localhost` name with port number or loopback IP with port number

```
http://localhost:5000/  
http://127.0.0.1:5000/  
http://[::1]:5000/
```

When `localhost` is specified, Kestrel attempts to bind to both IPv4 and IPv6 loopback interfaces. If the requested port is in use by another service on either loopback interface, Kestrel fails to start. If either loopback interface is unavailable for any other reason (most commonly because IPv6 isn't supported), Kestrel logs a warning.

## Host filtering

While Kestrel supports configuration based on prefixes such as `http://example.com:5000`, Kestrel largely ignores the host name. Host `localhost` is a special case used for binding to loopback addresses. Any host other than an explicit IP address binds to all public IP addresses. None of this information is used to validate request `Host` headers.

As a workaround, host behind a reverse proxy with host header filtering. This is the only supported scenario for Kestrel in ASP.NET Core 1.x.

As a workaround, use middleware to filter requests by the `Host` header:

```
using Microsoft.AspNetCore.Http;  
using Microsoft.Extensions.Configuration;  
using Microsoft.Extensions.Logging;  
using Microsoft.Extensions.Primitives;  
using Microsoft.Net.Http.Headers;  
using System;  
using System.Collections.Generic;  
using System.Threading.Tasks;  
  
// A normal middleware would provide an options type, config binding, extension methods, etc..  
// This intentionally does all of the work inside of the middleware so it can be  
// easily copy-pasted into docs and other projects.  
public class HostFilteringMiddleware  
{  
    private readonly RequestDelegate _next;  
    private readonly IList<string> _hosts;  
    private readonly ILogger<HostFilteringMiddleware> _logger;  
  
    public HostFilteringMiddleware(RequestDelegate next, IConfiguration config,  
        ILogger<HostFilteringMiddleware> logger)  
    {  
        if (config == null)  
        {  
            throw new ArgumentNullException(nameof(config));  
        }  
  
        _next = next ?? throw new ArgumentNullException(nameof(next));  
        _logger = logger ?? throw new ArgumentNullException(nameof(logger));  
    }
```

```

// A semicolon separated list of host names without the port numbers.
// IPv6 addresses must use the bounding brackets and be in their normalized form.
_hosts = config["AllowedHosts"]?.Split(new[] { ';' }, StringSplitOptions.RemoveEmptyEntries);
if (_hosts == null || _hosts.Count == 0)
{
    throw new InvalidOperationException("No configuration entry found for AllowedHosts.");
}

public Task Invoke(HttpContext context)
{
    if (!ValidateHost(context))
    {
        context.Response.StatusCode = 400;
        _logger.LogDebug("Request rejected due to incorrect Host header.");
        return Task.CompletedTask;
    }

    return _next(context);
}

// This does not duplicate format validations that are expected to be performed by the host.
private bool ValidateHost(HttpContext context)
{
    StringSegment host = context.Request.Headers[HeaderNames.Host].ToString().Trim();

    if (StringSegment.IsNullOrEmpty(host))
    {
        // Http/1.0 does not require the Host header.
        // Http/1.1 requires the header but the value may be empty.
        return true;
    }

    // Drop the port

    var colonIndex = host.LastIndexOf(':');

    // IPv6 special case
    if (host.StartsWith("[", StringComparison.OrdinalIgnoreCase))
    {
        var endBracketIndex = host.IndexOf(']');
        if (endBracketIndex < 0)
        {
            // Invalid format
            return false;
        }
        if (colonIndex < endBracketIndex)
        {
            // No port, just the IPv6 Host
            colonIndex = -1;
        }
    }

    if (colonIndex > 0)
    {
        host = host.Subsegment(0, colonIndex);
    }

    foreach (var allowedHost in _hosts)
    {
        if (StringSegment.Equals(allowedHost, host, StringComparison.OrdinalIgnoreCase))
        {
            return true;
        }
    }

    // Sub-domain wildcards: *.example.com
    if (allowedHost.StartsWith("*.", StringComparison.OrdinalIgnoreCase) && host.Length >= allowedHost.Length)
    {
        return true;
    }
}

```

```
// .example.com
var allowedRoot = new StringSegment(allowedHost, 1, allowedHost.Length - 1);

var hostRoot = host.Subsegment(host.Length - allowedRoot.Length, allowedRoot.Length);
if (hostRoot.Equals(allowedRoot, StringComparison.OrdinalIgnoreCase))
{
    return true;
}
}

return false;
}
}
```

Register the preceding `HostFilteringMiddleware` in `Startup.Configure`. Note that the [ordering of middleware registration](#) is important. Registration should occur immediately after Diagnostic Middleware registration (for example, `app.UseExceptionHandler`).

```
public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
        app.UseBrowserLink();
    }
    else
    {
        app.UseExceptionHandler("/Home/Error");
    }

    app.UseMiddleware<HostFilteringMiddleware>();

    app.UseMvcWithDefaultRoute();
}
```

The middleware expects an `AllowedHosts` key in `appsettings.json/appsettings.<EnvironmentName>.json`. The value is a semicolon-delimited list of host names without port numbers:

As a workaround, use Host Filtering Middleware. Host Filtering Middleware is provided by the [Microsoft.AspNetCore.HostFiltering](#) package, which is included in the [Microsoft.AspNetCore.App](#) metapackage (ASP.NET Core 2.1 or later). The middleware is added by `CreateDefaultBuilder`, which calls `AddHostFiltering`:

```
public class Program
{
    public static void Main(string[] args)
    {
        CreateWebHostBuilder(args).Build().Run();
    }

    public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
        WebHost.CreateDefaultBuilder(args)
            .UseStartup<Startup>();
}
```

Host Filtering Middleware is disabled by default. To enable the middleware, define an `AllowedHosts` key in `appsettings.json/appsettings.<EnvironmentName>.json`. The value is a semicolon-delimited list of host names without port numbers:

`appsettings.json`:

```
{  
  "AllowedHosts": "example.com;localhost"  
}
```

#### NOTE

Forwarded Headers Middleware also has an `ForwardedHeadersOptions.AllowedHosts` option. Forwarded Headers Middleware and Host Filtering Middleware have similar functionality for different scenarios. Setting `AllowedHosts` with Forwarded Headers Middleware is appropriate when the Host header isn't preserved while forwarding requests with a reverse proxy server or load balancer. Setting `AllowedHosts` with Host Filtering Middleware is appropriate when Kestrel is used as an edge server or when the Host header is directly forwarded.

For more information on Forwarded Headers Middleware, see [Configure ASP.NET Core to work with proxy servers and load balancers](#).

## Additional resources

- [Enforce HTTPS](#)
- [Kestrel source code](#)
- [RFC 7230: Message Syntax and Routing \(Section 5.4: Host\)](#)
- [Configure ASP.NET Core to work with proxy servers and load balancers](#)

# ASP.NET Core Module

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Tom Dykstra](#), [Rick Strahl](#), and [Chris Ross](#)

The ASP.NET Core Module allows ASP.NET Core apps to run behind IIS in a reverse proxy configuration. IIS provides advanced web app security and manageability features.

Supported Windows versions:

- Windows 7 or later
- Windows Server 2008 R2 or later

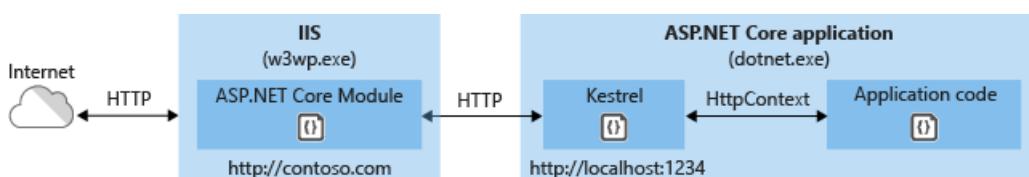
The ASP.NET Core Module only works with Kestrel. The module is incompatible with [HTTP.sys](#) (formerly called [WebListener](#)).

## ASP.NET Core Module description

The ASP.NET Core Module is a native IIS module that plugs into the IIS pipeline to redirect web requests to backend ASP.NET Core apps. Many native modules, such as Windows Authentication, remain active. To learn more about IIS modules active with the module, see [IIS modules](#).

Because ASP.NET Core apps run in a process separate from the IIS worker process, the module also handles process management. The module starts the process for the ASP.NET Core app when the first request arrives and restarts the app if it crashes. This is essentially the same behavior as seen with ASP.NET 4.x apps that run in-process in IIS that are managed by the [Windows Process Activation Service \(WAS\)](#).

The following diagram illustrates the relationship between IIS, the ASP.NET Core Module, and ASP.NET Core apps:



Requests arrive from the web to the kernel-mode HTTP.sys driver. The driver routes the requests to IIS on the website's configured port, usually 80 (HTTP) or 443 (HTTPS). The module forwards the requests to Kestrel on a random port for the app, which isn't port 80/443.

The module specifies the port via an environment variable at startup, and the IIS Integration Middleware configures the server to listen on `http://localhost:{port}`. Additional checks are performed, and requests that don't originate from the module are rejected. The module doesn't support HTTPS forwarding, so requests are forwarded over HTTP even if received by IIS over HTTPS.

After Kestrel picks up a request from the module, the request is pushed into the ASP.NET Core middleware pipeline. The middleware pipeline handles the request and passes it on as an `HttpContext` instance to the app's logic. The app's response is passed back to IIS, which pushes it back out to the HTTP client that initiated the request.

The ASP.NET Core Module has a few other functions. The module can:

- Set environment variables for the worker process.
- Log stdout output to file storage for troubleshooting startup issues.

- Forward Windows authentication tokens.

## How to install and use the ASP.NET Core Module

For detailed instructions on how to install and use the ASP.NET Core Module, see [Host on Windows with IIS](#).

For information on configuring the module, see the [ASP.NET Core Module configuration reference](#).

## Additional resources

- [Host on Windows with IIS](#)
- [ASP.NET Core Module configuration reference](#)
- [ASP.NET Core Module GitHub repository \(source code\)](#)

# HTTP.sys web server implementation in ASP.NET Core

6/21/2018 • 6 minutes to read • [Edit Online](#)

By [Tom Dykstra](#), [Chris Ross](#), and [Luke Latham](#)

## NOTE

This topic applies to ASP.NET Core 2.0 or later. In earlier versions of ASP.NET Core, HTTP.sys is named [WebListener](#).

HTTP.sys is a [web server for ASP.NET Core](#) that only runs on Windows. HTTP.sys is an alternative to [Kestrel](#) and offers some features that Kestrel doesn't provide.

## IMPORTANT

HTTP.sys is incompatible with the [ASP.NET Core Module](#) and can't be used with IIS or IIS Express.

HTTP.sys supports the following features:

- [Windows Authentication](#)
- Port sharing
- HTTPS with SNI
- HTTP/2 over TLS (Windows 10 or later)
- Direct file transmission
- Response caching
- WebSockets (Windows 8 or later)

Supported Windows versions:

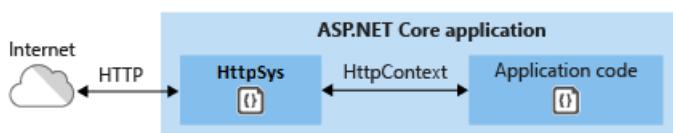
- Windows 7 or later
- Windows Server 2008 R2 or later

[View or download sample code \(how to download\)](#)

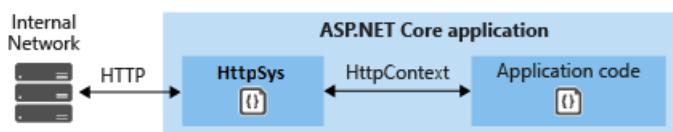
## When to use HTTP.sys

HTTP.sys is useful for deployments where:

- There's a need to expose the server directly to the Internet without using IIS.



- An internal deployment requires a feature not available in Kestrel, such as [Windows Authentication](#).



HTTP.sys is a mature technology that protects against many types of attacks and provides the robustness, security, and scalability of a full-featured web server. IIS itself runs as an HTTP listener on top of HTTP.sys.

## How to use HTTP.sys

### Configure the ASP.NET Core app to use HTTP.sys

1. A package reference in the project file isn't required when using the [Microsoft.AspNetCore.App metapackage \(nuget.org\)](#) (ASP.NET Core 2.1 or later). When not using the [Microsoft.AspNetCore.App](#) metapackage, add a package reference to [Microsoft.AspNetCore.Server.HttpSys](#).
2. Call the [UseHttpSys](#) extension method when building the web host, specifying any required [HTTP.sys options](#):

```
public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
    WebHost.CreateDefaultBuilder(args)
        .UseStartup<Startup]()
        .UseHttpSys(options =>
    {
        // The following options are set to default values.
        options.Authentication.Schemes = AuthenticationSchemes.None;
        options.Authentication.AllowAnonymous = true;
        options.MaxConnections = null;
        options.MaxRequestBodySize = 30000000;
        options.UrlPrefixes.Add("http://localhost:5000");
    });
}
```

Additional HTTP.sys configuration is handled through [registry settings](#).

### HTTP.sys options

PROPERTY	DESCRIPTION	DEFAULT
AllowSynchronousIO	Control whether synchronous input/output is allowed for the <a href="#">HttpContext.Request.Body</a> and <a href="#">HttpContext.Response.Body</a> .	true
Authentication.AllowAnonymous	Allow anonymous requests.	true
Authentication.Schemes	Specify the allowed authentication schemes. May be modified at any time prior to disposing the listener. Values are provided by the <a href="#">AuthenticationSchemes enum</a> : <a href="#">Basic</a> , <a href="#">Kerberos</a> , <a href="#">Negotiate</a> , <a href="#">None</a> , and <a href="#">NTLM</a> .	None
EnableResponseCaching	Attempt <a href="#">kernel-mode</a> caching for responses with eligible headers. The response may not include <a href="#">Set-Cookie</a> , <a href="#">Vary</a> , or <a href="#">Pragma</a> headers. It must include a <a href="#">Cache-Control</a> header that's <a href="#">public</a> and either a <a href="#">shared-max-age</a> or <a href="#">max-age</a> value, or an <a href="#">Expires</a> header.	true

PROPERTY	DESCRIPTION	DEFAULT
MaxAccepts	The maximum number of concurrent accepts.	5 × <a href="#">Environment.ProcessorCount</a>
MaxConnections	The maximum number of concurrent connections to accept. Use <code>-1</code> for infinite. Use <code>null</code> to use the registry's machine-wide setting.	<code>null</code> (unlimited)
MaxRequestBodySize	See the <a href="#">MaxRequestBodySize</a> section.	30000000 bytes (~28.6 MB)
RequestQueueLimit	The maximum number of requests that can be queued.	1000
ThrowWriteExceptions	Indicate if response body writes that fail due to client disconnects should throw exceptions or complete normally.	<code>false</code> (complete normally)
Timeouts	<p>Expose the HTTP.sys <a href="#">TimeoutManager</a> configuration, which may also be configured in the registry. Follow the API links to learn more about each setting, including default values:</p> <ul style="list-style-type: none"> <li>• <a href="#">Timeouts.DrainEntityBody</a> – Time allowed for the HTTP Server API to drain the entity body on a Keep-Alive connection.</li> <li>• <a href="#">Timeouts.EntityBody</a> – Time allowed for the request entity body to arrive.</li> <li>• <a href="#">Timeouts.HeaderWait</a> – Time allowed for the HTTP Server API to parse the request header.</li> <li>• <a href="#">Timeouts.IdleConnection</a> – Time allowed for an idle connection.</li> <li>• <a href="#">Timeouts.MinSendBytesPerSecond</a> – The minimum send rate for the response.</li> <li>• <a href="#">Timeouts.RequestQueue</a> – Time allowed for the request to remain in the request queue before the app picks it up.</li> </ul>	
UrlPrefixes	Specify the <a href="#">UrlPrefixCollection</a> to register with HTTP.sys. The most useful is <a href="#">UrlPrefixCollection.Add</a> , which is used to add a prefix to the collection. These may be modified at any time prior to disposing the listener.	

## MaxRequestBodySize

The maximum allowed size of any request body in bytes. When set to `null`, the maximum request body size is unlimited. This limit has no effect on upgraded connections, which are always unlimited.

The recommended method to override the limit in an ASP.NET Core MVC app for a single `IActionResult` is to use the [RequestSizeLimitAttribute](#) attribute on an action method:

```
[RequestSizeLimit(100000000)]
public IActionResult MyActionMethod()
```

An exception is thrown if the app attempts to configure the limit on a request after the app has started reading the request. An `IsReadOnly` property can be used to indicate if the `MaxRequestBodySize` property is in a read-only state, meaning it's too late to configure the limit.

If the app should override `MaxRequestBodySize` per-request, use the [IHttpMaxRequestBodySizeFeature](#):

```
public void Configure(IApplicationBuilder app, IHostingEnvironment env,
    ILogger<Startup> logger)
{
    app.Use(async (context, next) =>
    {
        context.Features.Get< IHttpMaxRequestBodySizeFeature >()
            .MaxRequestBodySize = 10 * 1024;

        var serverAddressesFeature = app.ServerFeatures.Get< IServerAddressesFeature >();
        var addresses = string.Join(", ", serverAddressesFeature?.Addresses);

        logger.LogInformation($"Addresses: {addresses}");

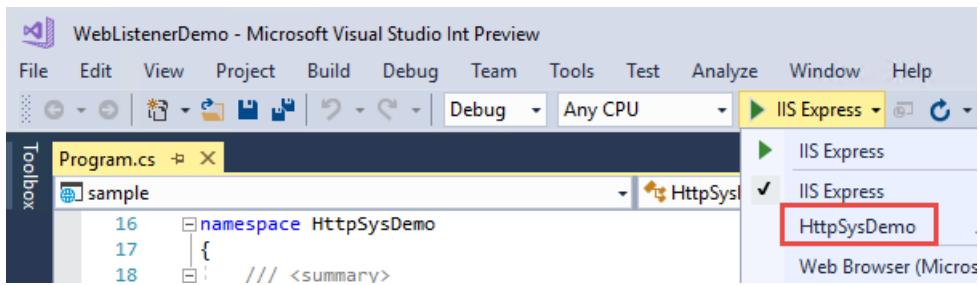
        await next.Invoke();
    });

    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
        app.UseDatabaseErrorPage();
    }
    else
    {
        app.UseExceptionHandler("/Error");
        app.UseHsts();
    }

    // Enable HTTPS Redirection Middleware when hosting the app securely.
    //app.UseHttpsRedirection();
    app.UseStaticFiles();
    app.UseCookiePolicy();
    app.UseMvc();
}
```

3. If using Visual Studio, make sure the app isn't configured to run IIS or IIS Express.

In Visual Studio, the default launch profile is for IIS Express. To run the project as a console app, manually change the selected profile, as shown in the following screen shot:



## Configure Windows Server

1. If the app is a [framework-dependent deployment](#), install .NET Core, .NET Framework, or both (if the app is a .NET Core app targeting the .NET Framework).
  - **.NET Core** – If the app requires .NET Core, obtain and run the .NET Core installer from [.NET All Downloads](#).
  - **.NET Framework** – If the app requires .NET Framework, see [.NET Framework: Installation guide](#) to find installation instructions. Install the required .NET Framework. The installer for the latest .NET Framework can be found at [.NET All Downloads](#).
2. Configure URLs and ports for the app.

By default, ASP.NET Core binds to `http://localhost:5000`. To configure URL prefixes and ports, options include using:

- `UseUrls`
- `urls` command-line argument
- `ASPNETCORE_URLS` environment variable
- [UrlPrefixes](#)

The following code example shows how to use [UrlPrefixes](#):

```
public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
    WebHost.CreateDefaultBuilder(args)
        .UseStartup<Startup>()
        .UseHttpSys(options =>
    {
        // The following options are set to default values.
        options.Authentication.Schemes = AuthenticationSchemes.None;
        options.Authentication.AllowAnonymous = true;
        options.MaxConnections = null;
        options.MaxRequestBodySize = 30000000;
        options.UrlPrefixes.Add("http://localhost:5000");
    });
}
```

An advantage of `UrlPrefixes` is that an error message is generated immediately for improperly formatted prefixes.

The settings in `UrlPrefixes` override `UseUrls` / `urls` / `ASPNETCORE_URLS` settings. Therefore, an advantage of `UseUrls`, `urls`, and the `ASPNETCORE_URLS` environment variable is that it's easier to switch between Kestrel and HTTP.sys. For more information on `UseUrls`, `urls`, and `ASPNETCORE_URLS`, see the [Host in ASP.NET Core](#) topic.

HTTP.sys uses the [HTTP Server API UrlPrefix string formats](#).

#### WARNING

Top-level wildcard bindings (`http://*:80/` and `http://+:80`) should **not** be used. Top-level wildcard bindings can open up your app to security vulnerabilities. This applies to both strong and weak wildcards. Use explicit host names rather than wildcards. Subdomain wildcard binding (for example, `*.mysub.com`) doesn't have this security risk if you control the entire parent domain (as opposed to `.com`, which is vulnerable). See [rfc7230 section-5.4](#) for more information.

### 3. Preregister URL prefixes to bind to HTTP.sys and set up X.509 certificates.

If URL prefixes aren't preregistered in Windows, run the app with administrator privileges. The only exception is when binding to localhost using HTTP (not HTTPS) with a port number greater than 1024. In that case, administrator privileges aren't required.

- a. The built-in tool for configuring HTTP.sys is `netsh.exe`. `netsh.exe` is used to reserve URL prefixes and assign X.509 certificates. The tool requires administrator privileges.

The following example shows the commands to reserve URL prefixes for ports 80 and 443:

```
netsh http add urlacl url=http://+:80/ user=Users  
netsh http add urlacl url=https://+:443/ user=Users
```

The following example shows how to assign an X.509 certificate:

```
netsh http add sslcert ipport=0.0.0.0:443 certhash=MyCertHash_Here appid="{00000000-0000-0000-  
0000-000000000000}"
```

Reference documentation for `netsh.exe`:

- [Netsh Commands for Hypertext Transfer Protocol \(HTTP\)](#)
- [UrlPrefix Strings](#)

- b. Create self-signed X.509 certificates, if required.

On Windows, self-signed certificates can be created using the [New-SelfSignedCertificate PowerShell cmdlet](#). For an unsupported example, see [UpdateIISExpressSSLForChrome.ps1](#).

On macOS, Linux, and Windows, certificates can be created using [OpenSSL](#).

### 4. Open firewall ports to allow traffic to reach HTTP.sys. Use `netsh.exe` or [PowerShell cmdlets](#).

## Proxy server and load balancer scenarios

For apps hosted by HTTP.sys that interact with requests from the Internet or a corporate network, additional configuration might be required when hosting behind proxy servers and load balancers. For more information, see [Configure ASP.NET Core to work with proxy servers and load balancers](#).

## Additional resources

- [HTTP Server API](#)
- [aspnet/HttpSysServer GitHub repository \(source code\)](#)
- [Host in ASP.NET Core](#)

# Globalization and localization in ASP.NET Core

7/3/2018 • 16 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [Damien Bowden](#), [Bart Calixto](#), [Nadeem Afana](#), and [Hisham Bin Ateya](#)

Creating a multilingual website with ASP.NET Core will allow your site to reach a wider audience. ASP.NET Core provides services and middleware for localizing into different languages and cultures.

Internationalization involves [Globalization](#) and [Localization](#). Globalization is the process of designing apps that support different cultures. Globalization adds support for input, display, and output of a defined set of language scripts that relate to specific geographic areas.

Localization is the process of adapting a globalized app, which you have already processed for localizability, to a particular culture/locale. For more information see **Globalization and localization terms** near the end of this document.

App localization involves the following:

1. Make the app's content localizable
2. Provide localized resources for the languages and cultures you support
3. Implement a strategy to select the language/culture for each request

## Make the app's content localizable

Introduced in ASP.NET Core, `IStringLocalizer` and `IStringLocalizer<T>` were architected to improve productivity when developing localized apps. `IStringLocalizer` uses the [ResourceManager](#) and [ResourceReader](#) to provide culture-specific resources at run time. The simple interface has an indexer and an `IEnumerable` for returning localized strings. `IStringLocalizer` doesn't require you to store the default language strings in a resource file. You can develop an app targeted for localization and not need to create resource files early in development. The code below shows how to wrap the string "About Title" for localization.

```
using Microsoft.AspNetCore.Mvc;
using Microsoft.Extensions.Localization;

namespace Localization.StarterWeb.Controllers
{
    [Route("api/[controller]")]
    public class AboutController : Controller
    {
        private readonly IStringLocalizer<AboutController> _localizer;

        public AboutController(IStringLocalizer<AboutController> localizer)
        {
            _localizer = localizer;
        }

        [HttpGet]
        public string Get()
        {
            return _localizer["About Title"];
        }
    }
}
```

In the code above, the `IStringLocalizer<T>` implementation comes from [Dependency Injection](#). If the localized value of "About Title" isn't found, then the indexer key is returned, that is, the string "About Title". You can leave the default language literal strings in the app and wrap them in the localizer, so that you can focus on developing the app. You develop your app with your default language and prepare it for the localization step without first creating a default resource file. Alternatively, you can use the traditional approach and provide a key to retrieve the default language string. For many developers the new workflow of not having a default language .resx file and simply wrapping the string literals can reduce the overhead of localizing an app. Other developers will prefer the traditional work flow as it can make it easier to work with longer string literals and make it easier to update localized strings.

Use the `IHtmlLocalizer<T>` implementation for resources that contain HTML. `IHtmlLocalizer` HTML encodes arguments that are formatted in the resource string, but doesn't HTML encode the resource string itself. In the sample highlighted below, only the value of `name` parameter is HTML encoded.

```
using System;
using Microsoft.AspNetCore.Http;
using Microsoft.AspNetCore.Localization;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.Localization;

namespace Localization.StarterWeb.Controllers
{
    public class BookController : Controller
    {
        private readonly IHtmlLocalizer<BookController> _localizer;

        public BookController(IHtmlLocalizer<BookController> localizer)
        {
            _localizer = localizer;
        }

        public IActionResult Hello(string name)
        {
            ViewData["Message"] = _localizer["<b>Hello</b><i> {0}</i>", name];

            return View();
        }
    }
}
```

**Note:** You generally want to only localize text and not HTML.

At the lowest level, you can get `IStringLocalizerFactory` out of [Dependency Injection](#):

```
{
    public class TestController : Controller
    {
        private readonly IStringLocalizer _localizer;
        private readonly IStringLocalizer _localizer2;

        public TestController(IStringLocalizerFactory factory)
        {
            var type = typeof(SharedResource);
            var assemblyName = new AssemblyName(type.GetTypeInfo().Assembly.FullName);
            _localizer = factory.Create(type);
            _localizer2 = factory.Create("SharedResource", assemblyName.Name);
        }

        public IActionResult About()
        {
            ViewData["Message"] = _localizer["Your application description page."]
                + " loc 2: " + _localizer2["Your application description page."];
        }
    }
}
```

The code above demonstrates each of the two factory create methods.

You can partition your localized strings by controller, area, or have just one container. In the sample app, a dummy class named `SharedResource` is used for shared resources.

```
// Dummy class to group shared resources

namespace Localization.StarterWeb
{
    public class SharedResource
    {
    }
}
```

Some developers use the `Startup` class to contain global or shared strings. In the sample below, the `InfoController` and the `SharedResource` localizers are used:

```
public class InfoController : Controller
{
    private readonly IStringLocalizer<InfoController> _localizer;
    private readonly IStringLocalizer<SharedResource> _sharedLocalizer;

    public InfoController(IStringLocalizer<InfoController> localizer,
                          IStringLocalizer<SharedResource> sharedLocalizer)
    {
        _localizer = localizer;
        _sharedLocalizer = sharedLocalizer;
    }

    public string TestLoc()
    {
        string msg = "Shared resx: " + _sharedLocalizer["Hello!"] +
                    " Info resx " + _localizer["Hello!"];
        return msg;
    }
}
```

## View localization

The `IViewLocalizer` service provides localized strings for a `view`. The `ViewLocalizer` class implements this interface and finds the resource location from the view file path. The following code shows how to use the default implementation of `IViewLocalizer`:

```
@using Microsoft.AspNetCore.Mvc.Localization

@inject IViewLocalizer Localizer

@{
    ViewData["Title"] = Localizer["About"];
}
<h2>@ViewData["Title"].</h2>
<h3>@ViewData["Message"]</h3>

<p>@Localizer["Use this area to provide additional information."]</p>
```

The default implementation of `IViewLocalizer` finds the resource file based on the view's file name. There's no option to use a global shared resource file. `ViewLocalizer` implements the localizer using `IHtmlLocalizer`, so Razor doesn't HTML encode the localized string. You can parameterize resource strings and `IViewLocalizer` will HTML encode the parameters, but not the resource string. Consider the following Razor markup:

```
@Localizer["<i>Hello</i> <b>{0}</b>", UserManager.GetUserName(User)]
```

A French resource file could contain the following:

KEY	VALUE
<i>Hello</i> <b>{0}</b>	<i>Bonjour</i> <b>{0}</b>

The rendered view would contain the HTML markup from the resource file.

**Note:** You generally want to only localize text and not HTML.

To use a shared resource file in a view, inject `IHtmlLocalizer<T>`:

```
@using Microsoft.AspNetCore.Mvc.Localization
@using Localization.StarterWeb.Services

@inject IViewLocalizer Localizer
@inject IHtmlLocalizer<SharedResource> SharedLocalizer

@{
    ViewData["Title"] = Localizer["About"];
}

<h2>@ViewData["Title"].</h2>

<h1>@SharedLocalizer["Hello!"]</h1>
```

## DataAnnotations localization

DataAnnotations error messages are localized with `IStringLocalizer<T>`. Using the option

`ResourcesPath = "Resources"`, the error messages in `RegisterViewModel` can be stored in either of the following paths:

- `Resources/ViewModels/Account/RegisterViewModel.fr.resx`
- `Resources/ViewModels/Account/RegisterViewModel.fr.resx`

```
public class RegisterViewModel
{
    [Required(ErrorMessage = "The Email field is required.")]
    [EmailAddress(ErrorMessage = "The Email field is not a valid email address.")]
    [Display(Name = "Email")]
    public string Email { get; set; }

    [Required(ErrorMessage = "The Password field is required.")]
    [StringLength(8, ErrorMessage = "The {0} must be at least {2} characters long.", MinimumLength = 6)]
    [DataType(DataType.Password)]
    [Display(Name = "Password")]
    public string Password { get; set; }

    [DataType(DataType.Password)]
    [Display(Name = "Confirm password")]
    [Compare("Password", ErrorMessage = "The password and confirmation password do not match.")]
    public string ConfirmPassword { get; set; }
}
```

In ASP.NET Core MVC 1.1.0 and higher, non-validation attributes are localized. ASP.NET Core MVC 1.0 does **not** look up localized strings for non-validation attributes.

## Using one resource string for multiple classes

The following code shows how to use one resource string for validation attributes with multiple classes:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc()
        .AddDataAnnotationsLocalization(options => {
            options.DataAnnotationLocalizerProvider = (type, factory) =>
                factory.Create(typeof(SharedResource));
        });
}
```

In the preceding code, `SharedResource` is the class corresponding to the resx where your validation messages are stored. With this approach, DataAnnotations will only use `sharedResource`, rather than the resource for each class.

## Provide localized resources for the languages and cultures you support

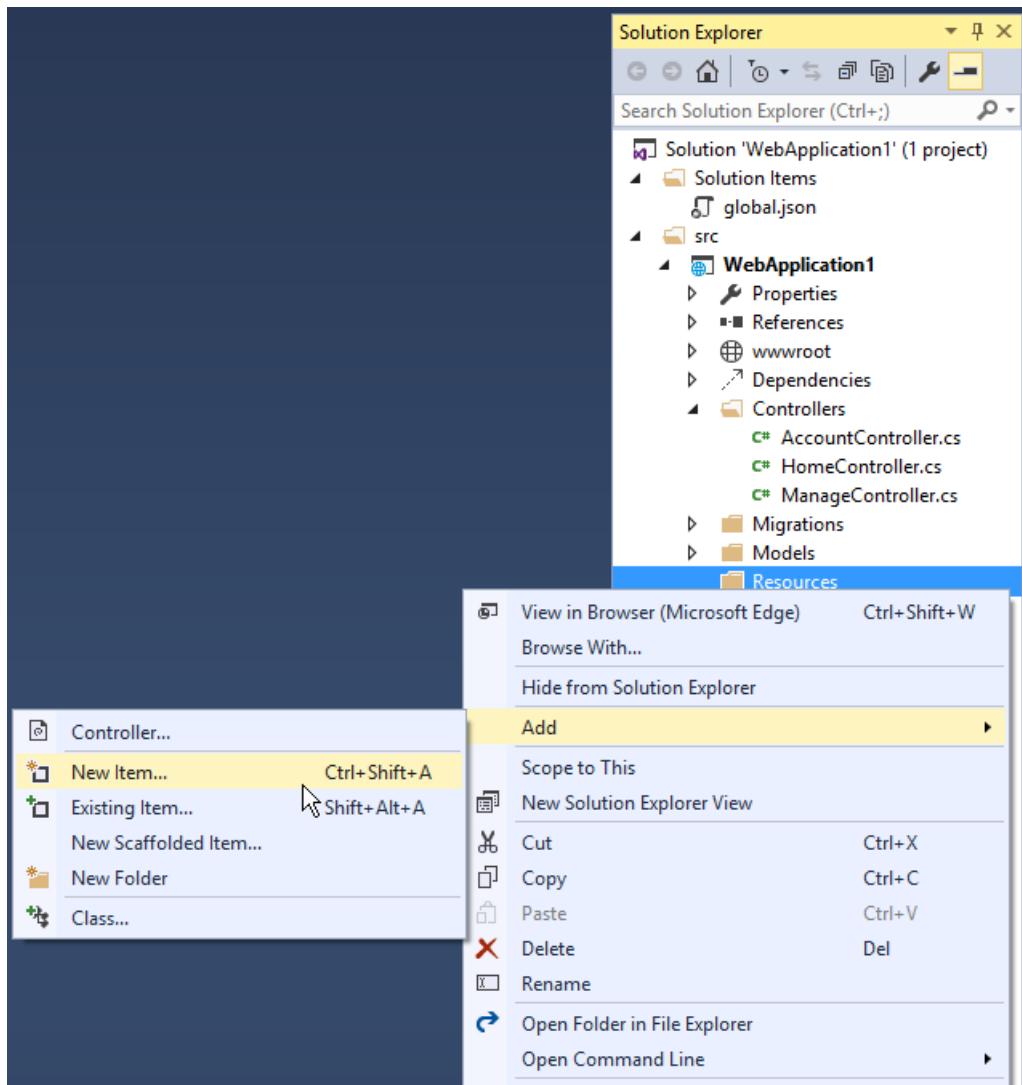
### SupportedCultures and SupportedUICultures

ASP.NET Core allows you to specify two culture values, `SupportedCultures` and `SupportedUICultures`. The `CultureInfo` object for `SupportedCultures` determines the results of culture-dependent functions, such as date, time, number, and currency formatting. `SupportedCultures` also determines the sorting order of text, casing conventions, and string comparisons. See [CultureInfo.CurrentCulture](#) for more info on how the server gets the Culture. The `SupportedUICultures` determines which translates strings (from .resx files) are looked up by the `ResourceManager`. The `ResourceManager` simply looks up culture-specific strings that's determined by `CurrentUICulture`. Every thread in .NET has `CurrentCulture` and `CurrentUICulture` objects. ASP.NET Core inspects these values when rendering culture-dependent functions. For example, if the current thread's culture is set to "en-US" (English, United States), `DateTime.Now.ToString("dddd, dd MMMM yyyy")` displays "Thursday, February 18, 2016", but if `CurrentCulture` is set to "es-ES" (Spanish, Spain) the output will be "jueves, 18 de febrero de 2016".

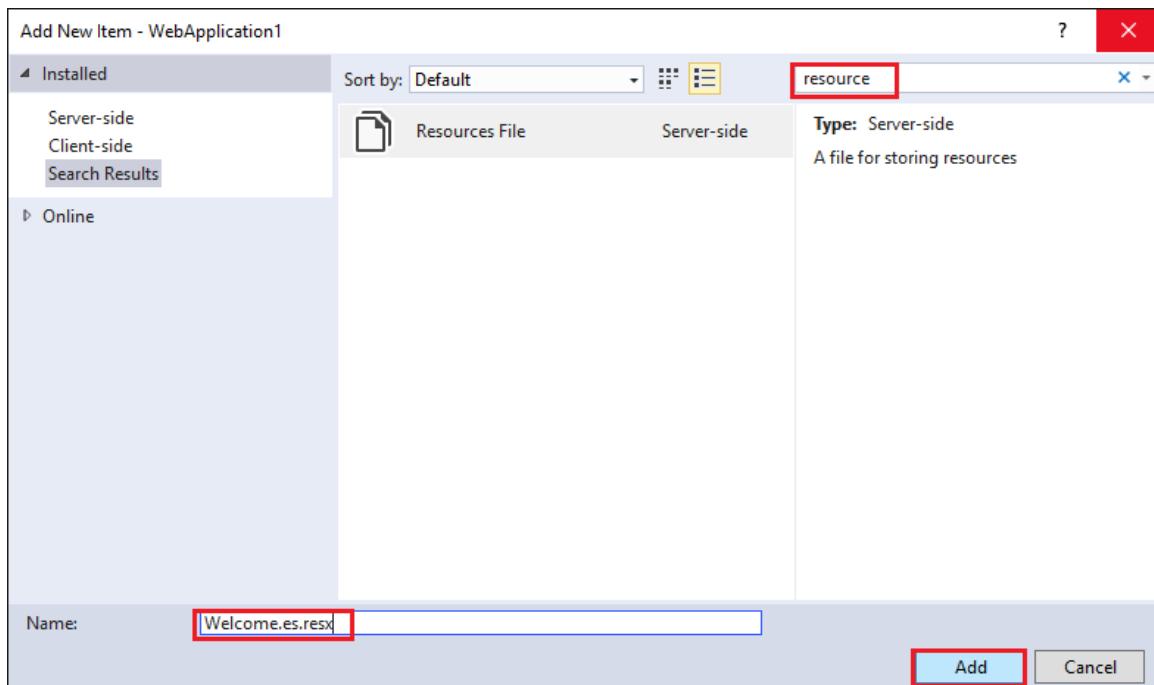
## Resource files

A resource file is a useful mechanism for separating localizable strings from code. Translated strings for the non-default language are isolated .resx resource files. For example, you might want to create Spanish resource file named *Welcome.es.resx* containing translated strings. "es" is the language code for Spanish. To create this resource file in Visual Studio:

1. In **Solution Explorer**, right click on the folder which will contain the resource file > **Add** > **New Item**.



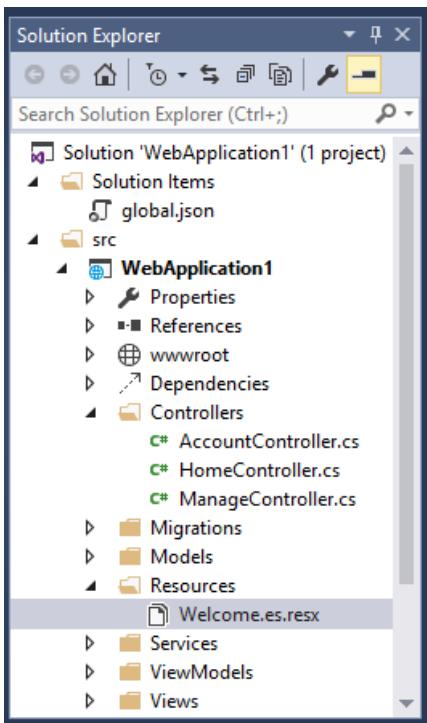
2. In the **Search installed templates** box, enter "resource" and name the file.



3. Enter the key value (native string) in the **Name** column and the translated string in the **Value** column.

	Name	Value	Comment
*	Hello	Hola	

Visual Studio shows the *Welcome.es.resx* file.



## Resource file naming

Resources are named for the full type name of their class minus the assembly name. For example, a French resource in a project whose main assembly is `LocalizationWebsite.Web.dll` for the class `LocalizationWebsite.Web.Startup` would be named `Startup.fr.resx`. A resource for the class `LocalizationWebsite.Web.Controllers.HomeController` would be named `Controllers.HomeControllerfr.resx`. If your targeted class's namespace isn't the same as the assembly name you will need the full type name. For example, in the sample project a resource for the type `ExtraNamespace.Tools` would be named `ExtraNamespace.Tools.fr.resx`.

In the sample project, the `ConfigureServices` method sets the `ResourcesPath` to "Resources", so the project relative path for the home controller's French resource file is `Resources/Controllers/HomeControllerfr.resx`. Alternatively, you can use folders to organize resource files. For the home controller, the path would be `Resources/Controllers/HomeControllerfr.resx`. If you don't use the `ResourcesPath` option, the `.resx` file would go in the project base directory. The resource file for `HomeController` would be named `Controllers.HomeControllerfr.resx`. The choice of using the dot or path naming convention depends on how you want to organize your resource files.

RESOURCE NAME	DOT OR PATH NAMING
Resources/Controllers.HomeController.fr.resx	Dot
Resources/Controllers/HomeController.fr.resx	Path

Resource files using `@inject IViewLocalizer` in Razor views follow a similar pattern. The resource file for a view can be named using either dot naming or path naming. Razor view resource files mimic the path of their associated view file. Assuming we set the `ResourcesPath` to "Resources", the French resource file associated with the `Views/Home/About.cshtml` view could be either of the following:

- Resources/Views/Home/About.fr.resx
- Resources/Views.Home.About.fr.resx

If you don't use the `ResourcesPath` option, the `.resx` file for a view would be located in the same folder as the view.

### RootNamespaceAttribute

The `RootNamespace` attribute provides the root namespace of an assembly when the root namespace of an assembly is different than the assembly name.

If the root namespace of an assembly is different than the assembly name:

- Localization does not work by default.
- Localization fails due to the way resources are searched for within the assembly. `RootNamespace` is a build-time value which is not available to the executing process.

If the `RootNamespace` is different from the `AssemblyName`, include the following in `AssemblyInfo.cs` (with parameter values replaced with the actual values):

```
using System.Reflection;
using Microsoft.Extensions.Localization;

[assembly: ResourceLocation("Resource Folder Name")]
[assembly: RootNamespace("App Root Namespace")]
```

The preceding code enables the successful resolution of resx files.

## Culture fallback behavior

When searching for a resource, localization engages in "culture fallback". Starting from the requested culture, if not found, it reverts to the parent culture of that culture. As an aside, the `CultureInfo.Parent` property represents the parent culture. This usually (but not always) means removing the national signifier from the ISO. For example, the dialect of Spanish spoken in Mexico is "es-MX". It has the parent "es"—Spanish non-specific to any country.

Imagine your site receives a request for a "Welcome" resource using culture "fr-CA". The localization system looks for the following resources, in order, and selects the first match:

- `Welcome.fr-CA.resx`
- `Welcome.fr.resx`
- `Welcome.resx` (if the `NeutralResourcesLanguage` is "fr-CA")

As an example, if you remove the ".fr" culture designator and you have the culture set to French, the default

resource file is read and strings are localized. The Resource manager designates a default or fallback resource for when nothing meets your requested culture. If you want to just return the key when missing a resource for the requested culture you must not have a default resource file.

### Generate resource files with Visual Studio

If you create a resource file in Visual Studio without a culture in the file name (for example, `Welcome.resx`), Visual Studio will create a C# class with a property for each string. That's usually not what you want with ASP.NET Core. You typically don't have a default `.resx` resource file (a `.resx` file without the culture name). We suggest you create the `.resx` file with a culture name (for example `Welcome.fr.resx`). When you create a `.resx` file with a culture name, Visual Studio won't generate the class file. We anticipate that many developers won't create a default language resource file.

### Add other cultures

Each language and culture combination (other than the default language) requires a unique resource file. You create resource files for different cultures and locales by creating new resource files in which the ISO language codes are part of the file name (for example, `en-us`, `fr-ca`, and `en-gb`). These ISO codes are placed between the file name and the `.resx` file extension, as in `Welcome.es-MX.resx` (Spanish/Mexico).

## Implement a strategy to select the language/culture for each request

### Configure localization

Localization is configured in the `ConfigureServices` method:

```
services.AddLocalization(options => options.ResourcesPath = "Resources");

services.AddMvc()
    .AddViewLocalization(LanguageViewLocationExpanderFormat.Suffix)
    .AddDataAnnotationsLocalization();
```

- `AddLocalization` Adds the localization services to the services container. The code above also sets the resources path to "Resources".
- `AddViewLocalization` Adds support for localized view files. In this sample view localization is based on the view file suffix. For example "fr" in the `Index.fr.cshtml` file.
- `AddDataAnnotationsLocalization` Adds support for localized `DataAnnotations` validation messages through `IStringLocalizer` abstractions.

### Localization middleware

The current culture on a request is set in the localization [Middleware](#). The localization middleware is enabled in the `Configure` method. The localization middleware must be configured before any middleware which might check the request culture (for example, `app.UseMvcWithDefaultRoute()` ).

```

var supportedCultures = new[]
{
    new CultureInfo(enUSCulture),
    new CultureInfo("en-AU"),
    new CultureInfo("en-GB"),
    new CultureInfo("en"),
    new CultureInfo("es-ES"),
    new CultureInfo("es-MX"),
    new CultureInfo("es"),
    new CultureInfo("fr-FR"),
    new CultureInfo("fr"),
};

app.UseRequestLocalization(new RequestLocalizationOptions
{
    DefaultRequestCulture = new RequestCulture(enUSCulture),
    // Formatting numbers, dates, etc.
    SupportedCultures = supportedCultures,
    // UI strings that we have localized.
    SupportedUITcultures = supportedCultures
});

app.UseStaticFiles();
// To configure external authentication,
// see: http://go.microsoft.com/fwlink/?LinkID=532715
app.UseAuthentication();
app.UseMvcWithDefaultRoute();

```

`UseRequestLocalization` initializes a `RequestLocalizationOptions` object. On every request the list of `RequestCultureProvider` in the `RequestLocalizationOptions` is enumerated and the first provider that can successfully determine the request culture is used. The default providers come from the `RequestLocalizationOptions` class:

1. `QueryStringRequestCultureProvider`
2. `CookieRequestCultureProvider`
3. `AcceptLanguageHeaderRequestCultureProvider`

The default list goes from most specific to least specific. Later in the article we'll see how you can change the order and even add a custom culture provider. If none of the providers can determine the request culture, the `DefaultRequestCulture` is used.

## QueryStringRequestCultureProvider

Some apps will use a query string to set the [culture and UI culture](#). For apps that use the cookie or Accept-Language header approach, adding a query string to the URL is useful for debugging and testing code. By default, the `queryStringRequestCultureProvider` is registered as the first localization provider in the `RequestCultureProvider` list. You pass the query string parameters `culture` and `ui-culture`. The following example sets the specific culture (language and region) to Spanish/Mexico:

```
http://localhost:5000/?culture=es-MX&ui-culture=es-MX
```

If you only pass in one of the two (`culture` or `ui-culture`), the query string provider will set both values using the one you passed in. For example, setting just the culture will set both the `Culture` and the `UICulture`:

```
http://localhost:5000/?culture=es-MX
```

## CookieRequestCultureProvider

Production apps will often provide a mechanism to set the culture with the ASP.NET Core culture cookie. Use the `MakeCookieValue` method to create a cookie.

The `CookieRequestCultureProvider` `DefaultCookieName` returns the default cookie name used to track the user's preferred culture information. The default cookie name is `.AspNetCore.Culture`.

The cookie format is `c=%LANGCODE%|uic=%LANGCODE%`, where `c` is `Culture` and `uic` is `UICulture`, for example:

```
c=en-UK|uic=en-US
```

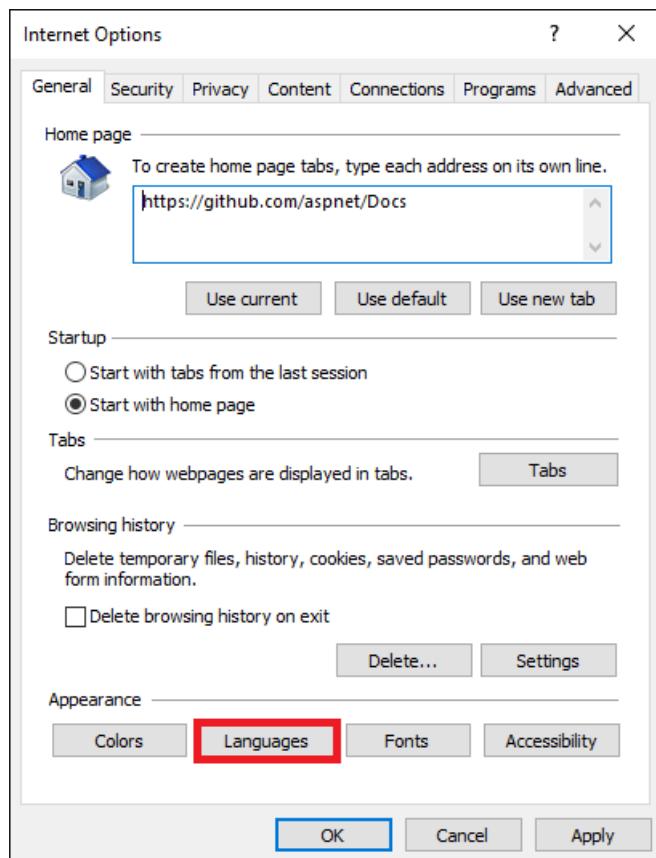
If you only specify one of culture info and UI culture, the specified culture will be used for both culture info and UI culture.

### The Accept-Language HTTP header

The [Accept-Language header](#) is settable in most browsers and was originally intended to specify the user's language. This setting indicates what the browser has been set to send or has inherited from the underlying operating system. The Accept-Language HTTP header from a browser request isn't an infallible way to detect the user's preferred language (see [Setting language preferences in a browser](#)). A production app should include a way for a user to customize their choice of culture.

### Set the Accept-Language HTTP header in IE

1. From the gear icon, tap **Internet Options**.
2. Tap **Languages**.



3. Tap **Set Language Preferences**.
4. Tap **Add a language**.
5. Add the language.
6. Tap the language, then tap **Move Up**.

### Use a custom provider

Suppose you want to let your customers store their language and culture in your databases. You could write a provider to look up these values for the user. The following code shows how to add a custom provider:

```

private const string enUSCulture = "en-US";

services.Configure<RequestLocalizationOptions>(options =>
{
    var supportedCultures = new[]
    {
        new CultureInfo(enUSCulture),
        new CultureInfo("fr")
    };

    options.DefaultRequestCulture = new RequestCulture(culture: enUSCulture, uiCulture: enUSCulture);
    options.SupportedCultures = supportedCultures;
    options.SupportedUICultures = supportedCultures;

    options.RequestCultureProviders.Insert(0, new CustomRequestCultureProvider(async context =>
    {
        // My custom request culture logic
        return new ProviderCultureResult("en");
    }));
});

```

Use `RequestLocalizationOptions` to add or remove localization providers.

## Set the culture programmatically

This sample **Localization.StarterWeb** project on [GitHub](#) contains UI to set the `Culture`. The `Views/Shared/_SelectLanguagePartial.cshtml` file allows you to select the culture from the list of supported cultures:

```

@using Microsoft.AspNetCore.Builder
@using Microsoft.AspNetCore.Http.Features
@using Microsoft.AspNetCore.Localization
@using Microsoft.AspNetCore.Mvc.Localization
@using Microsoft.Extensions.Options

@inject IViewLocalizer Localizer
@inject IOptions<RequestLocalizationOptions> LocOptions

 @{
    var requestCulture = Context.Features.Get<IRRequestCultureFeature>();
    var cultureItems = LocOptions.Value.SupportedUICultures
        .Select(c => new SelectListItem { Value = c.Name, Text = c.DisplayName })
        .ToList();
    var returnUrl = string.IsNullOrEmpty(Context.Request.Path) ? "~/" : $"~{Context.Request.Path.Value}";
}

<div title="@Localizer["Request culture provider:"] @requestCulture?.Provider?.GetType().Name">
    <form id="selectLanguage" asp-controller="Home"
        asp-action="SetLanguage" asp-route-returnUrl="@returnUrl"
        method="post" class="form-horizontal" role="form">
        <label asp-for="@requestCulture.RequestCulture.UICulture.Name">@Localizer["Language:"]</label>
        <select name="culture"
            onchange="this.form.submit();"
            asp-for="@requestCulture.RequestCulture.UICulture.Name" asp-items="cultureItems">
        </select>
    </form>
</div>

```

The `Views/Shared/_SelectLanguagePartial.cshtml` file is added to the `footer` section of the layout file so it will be available to all views:

```

<div class="container body-content" style="margin-top:60px">
    @RenderBody()
    <hr>
    <footer>
        <div class="row">
            <div class="col-md-6">
                <p>&copy; @System.DateTime.Now.Year - Localization.StarterWeb</p>
            </div>
            <div class="col-md-6 text-right">
                @await Html.PartialAsync("_SelectLanguagePartial")
            </div>
        </div>
    </footer>
</div>

```

The `SetLanguage` method sets the culture cookie.

```

[HttpPost]
public IActionResult SetLanguage(string culture, string returnUrl)
{
    Response.Cookies.Append(
        CookieRequestCultureProvider.DefaultCookieName,
        CookieRequestCultureProvider.MakeCookieValue(new RequestCulture(culture)),
        new CookieOptions { Expires = DateTimeOffset.UtcNow.AddYears(1) }
    );

    return LocalRedirect(returnUrl);
}

```

You can't plug in the `_SelectLanguagePartial.cshtml` to sample code for this project. The **Localization.StarterWeb** project on [GitHub](#) has code to flow the `RequestLocalizationOptions` to a Razor partial through the [Dependency Injection](#) container.

## Globalization and localization terms

The process of localizing your app also requires a basic understanding of relevant character sets commonly used in modern software development and an understanding of the issues associated with them. Although all computers store text as numbers (codes), different systems store the same text using different numbers. The localization process refers to translating the app user interface (UI) for a specific culture/locale.

[Localizability](#) is an intermediate process for verifying that a globalized app is ready for localization.

The [RFC 4646](#) format for the culture name is `<languagecode2>-<country/regioncode2>`, where `<languagecode2>` is the language code and `<country/regioncode2>` is the subculture code. For example, `es-CL` for Spanish (Chile), `en-US` for English (United States), and `en-AU` for English (Australia). [RFC 4646](#) is a combination of an ISO 639 two-letter lowercase culture code associated with a language and an ISO 3166 two-letter uppercase subculture code associated with a country or region. See [Language Culture Name](#).

Internationalization is often abbreviated to "I18N". The abbreviation takes the first and last letters and the number of letters between them, so 18 stands for the number of letters between the first "I" and the last "N". The same applies to Globalization (G11N), and Localization (L10N).

Terms:

- Globalization (G11N): The process of making an app support different languages and regions.
- Localization (L10N): The process of customizing an app for a given language and region.
- Internationalization (I18N): Describes both globalization and localization.
- Culture: It's a language and, optionally, a region.

- Neutral culture: A culture that has a specified language, but not a region. (for example "en", "es")
- Specific culture: A culture that has a specified language and region. (for example "en-US", "en-GB", "es-CL")
- Parent culture: The neutral culture that contains a specific culture. (for example, "en" is the parent culture of "en-US" and "en-GB")
- Locale: A locale is the same as a culture.

## Additional resources

- [Localization Starter Web project](#) used in the article.
- [Resource Files in Visual Studio](#)
- [Resources in .resx Files](#)
- [Microsoft Multilingual App Toolkit](#)

# Configure portable object localization in ASP.NET Core

6/21/2018 • 6 minutes to read • [Edit Online](#)

By Sébastien Ros and Scott Addie

This article walks through the steps for using Portable Object (PO) files in an ASP.NET Core application with the [Orchard Core](#) framework.

**Note:** Orchard Core isn't a Microsoft product. Consequently, Microsoft provides no support for this feature.

[View or download sample code \(how to download\)](#)

## What is a PO file?

PO files are distributed as text files containing the translated strings for a given language. Some advantages of using PO files instead .resx files include:

- PO files support pluralization; .resx files don't support pluralization.
- PO files aren't compiled like .resx files. As such, specialized tooling and build steps aren't required.
- PO files work well with collaborative online editing tools.

### Example

Here is a sample PO file containing the translation for two strings in French, including one with its plural form:

*fr.po*

```
#: Services/EmailService.cs:29
msgid "Enter a comma separated list of email addresses."
msgstr "Entrez une liste d'emails séparés par une virgule.

#: Views/Email.cshtml:112
msgid "The email address is \"{0}\"."
msgid_plural "The email addresses are \"{0}\"."
msgstr[0] "L'adresse email est \"{0}\"."
msgstr[1] "Les adresses email sont \"{0}\\""
```

This example uses the following syntax:

- `#:` : A comment indicating the context of the string to be translated. The same string might be translated differently depending on where it's being used.
- `msgid` : The untranslated string.
- `msgstr` : The translated string.

In the case of pluralization support, more entries can be defined.

- `msgid_plural` : The untranslated plural string.
- `msgstr[0]` : The translated string for the case 0.
- `msgstr[N]` : The translated string for the case N.

The PO file specification can be found [here](#).

# Configuring PO file support in ASP.NET Core

This example is based on an ASP.NET Core MVC application generated from a Visual Studio 2017 project template.

## Referencing the package

Add a reference to the `OrchardCore.Localization.Core` NuGet package. It's available on [MyGet](#) at the following package source: <https://www.myget.org/F/orchardcore-preview/api/v3/index.json>

The `.csproj` file now contains a line similar to the following (version number may vary):

```
<PackageReference Include="OrchardCore.Localization.Core" Version="1.0.0-beta1-3187" />
```

## Registering the service

Add the required services to the `ConfigureServices` method of `Startup.cs`:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc()
        .AddViewLocalization(LanguageViewLocationExpanderFormat.Suffix);

    services.AddPortableObjectLocalization();

    services.Configure<RequestLocalizationOptions>(options =>
    {
        var supportedCultures = new List<CultureInfo>
        {
            new CultureInfo("en-US"),
            new CultureInfo("en"),
            new CultureInfo("fr-FR"),
            new CultureInfo("fr")
        };

        options.DefaultRequestCulture = new RequestCulture("en-US");
        options.SupportedCultures = supportedCultures;
        options.SupportedUICultures = supportedCultures;
    });
}
```

Add the required middleware to the `Configure` method of `Startup.cs`:

```
public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
        app.UseBrowserLink();
    }
    else
    {
        app.UseExceptionHandler("/Home/Error");
    }

    app.UseStaticFiles();

    app.UseRequestLocalization();

    app.UseMvcWithDefaultRoute();
}
```

Add the following code to your Razor view of choice. `About.cshtml` is used in this example.

```
@using Microsoft.AspNetCore.Mvc.Localization  
@inject IViewLocalizer Localizer  
  
<p>@Localizer["Hello world!"]</p>
```

An `IViewLocalizer` instance is injected and used to translate the text "Hello world!".

## Creating a PO file

Create a file named `.po` in your application root folder. In this example, the file name is `fr.po` because the French language is used:

```
msgid "Hello world!"  
msgstr "Bonjour le monde!"
```

This file stores both the string to translate and the French-translated string. Translations revert to their parent culture, if necessary. In this example, the `fr.po` file is used if the requested culture is `fr-FR` or `fr-CA`.

## Testing the application

Run your application, and navigate to the URL `/Home/About`. The text **Hello world!** is displayed.

Navigate to the URL `/Home/About?culture=fr-FR`. The text **Bonjour le monde!** is displayed.

## Pluralization

PO files support pluralization forms, which is useful when the same string needs to be translated differently based on a cardinality. This task is made complicated by the fact that each language defines custom rules to select which string to use based on the cardinality.

The Orchard Localization package provides an API to invoke these different plural forms automatically.

### Creating pluralization PO files

Add the following content to the previously mentioned `fr.po` file:

```
msgid "There is one item."  
msgid_plural "There are {0} items."  
msgstr[0] "Il y a un élément."  
msgstr[1] "Il y a {0} éléments."
```

See [What is a PO file?](#) for an explanation of what each entry in this example represents.

### Adding a language using different pluralization forms

English and French strings were used in the previous example. English and French have only two pluralization forms and share the same form rules, which is that a cardinality of one is mapped to the first plural form. Any other cardinality is mapped to the second plural form.

Not all languages share the same rules. This is illustrated with the Czech language, which has three plural forms.

Create the `cs.po` file as follows, and note how the pluralization needs three different translations:

```
msgid "Hello world!"  
msgstr "Ahoj světe!!"  
  
msgid "There is one item."  
msgid_plural "There are {0} items."  
msgstr[0] "Existuje jedna položka."  
msgstr[1] "Existují {0} položky."  
msgstr[2] "Existuje {0} položek."
```

To accept Czech localizations, add `"cs"` to the list of supported cultures in the `ConfigureServices` method:

```
var supportedCultures = new List<CultureInfo>  
{  
    new CultureInfo("en-US"),  
    new CultureInfo("en"),  
    new CultureInfo("fr-FR"),  
    new CultureInfo("fr"),  
    new CultureInfo("cs")  
};
```

Edit the `Views/Home/About.cshtml` file to render localized, plural strings for several cardinalities:

```
<p>@Localizer.Plural(1, "There is one item.", "There are {0} items.")</p>  
<p>@Localizer.Plural(2, "There is one item.", "There are {0} items.")</p>  
<p>@Localizer.Plural(5, "There is one item.", "There are {0} items.")</p>
```

**Note:** In a real world scenario, a variable would be used to represent the count. Here, we repeat the same code with three different values to expose a very specific case.

Upon switching cultures, you see the following:

For `/Home/About` :

```
There is one item.  
There are 2 items.  
There are 5 items.
```

For `/Home/About?culture=fr` :

```
Il y a un élément.  
Il y a 2 éléments.  
Il y a 5 éléments.
```

For `/Home/About?culture=cs` :

```
Existuje jedna položka.  
Existují 2 položky.  
Existuje 5 položek.
```

Note that for the Czech culture, the three translations are different. The French and English cultures share the same construction for the two last translated strings.

## Advanced tasks

### Contextualizing strings

Applications often contain the strings to be translated in several places. The same string may have a different translation in certain locations within an app (Razor views or class files). A PO file supports the notion of a file context, which can be used to categorize the string being represented. Using a file context, a string can be translated differently, depending on the file context (or lack of a file context).

The PO localization services use the name of the full class or the view that's used when translating a string. This is accomplished by setting the value on the `msgctxt` entry.

Consider a minor addition to the previous `fr.po` example. A Razor view located at `Views/Home/About.cshtml` can be defined as the file context by setting the reserved `msgctxt` entry's value:

```
msgctxt "Views.Home.About"
msgid "Hello world!"
msgstr "Bonjour le monde!"
```

With the `msgctxt` set as such, text translation occurs when navigating to `/Home/About?culture=fr-FR`. The translation won't occur when navigating to `/Home/Contact?culture=fr-FR`.

When no specific entry is matched with a given file context, Orchard Core's fallback mechanism looks for an appropriate PO file without a context. Assuming there's no specific file context defined for `Views/Home/Contact.cshtml`, navigating to `/Home/Contact?culture=fr-FR` loads a PO file such as:

```
msgid "Hello world!"
msgstr "Bonjour le monde!"
```

## Changing the location of PO files

The default location of PO files can be changed in `ConfigureServices`:

```
services.AddPortableObjectLocalization(options => options.ResourcesPath = "Localization");
```

In this example, the PO files are loaded from the `Localization` folder.

## Implementing a custom logic for finding localization files

When more complex logic is needed to locate PO files, the

`OrchardCore.Localization.PortableObject.ILocalizationFileLocationProvider` interface can be implemented and registered as a service. This is useful when PO files can be stored in varying locations or when the files have to be found within a hierarchy of folders.

## Using a different default pluralized language

The package includes a `Plural` extension method that's specific to two plural forms. For languages requiring more plural forms, create an extension method. With an extension method, you won't need to provide any localization file for the default language — the original strings are already available directly in the code.

You can use the more generic `Plural(int count, string[] pluralForms, params object[] arguments)` overload which accepts a string array of translations.

# Initiate HTTP requests

6/22/2018 • 12 minutes to read • [Edit Online](#)

By [Glenn Condon](#), [Ryan Nowak](#), and [Steve Gordon](#)

An `IHttpClientFactory` can be registered and used to configure and create `HttpClient` instances in an app. It offers the following benefits:

- Provides a central location for naming and configuring logical `HttpClient` instances. For example, a "github" client can be registered and configured to access GitHub. A default client can be registered for other purposes.
- Codifies the concept of outgoing middleware via delegating handlers in `HttpClient` and provides extensions for Polly-based middleware to take advantage of that.
- Manages the pooling and lifetime of underlying `HttpClientMessageHandler` instances to avoid common DNS problems that occur when manually managing `HttpClient` lifetimes.
- Adds a configurable logging experience (via `ILogger`) for all requests sent through clients created by the factory.

## Consumption patterns

There are several ways `IHttpClientFactory` can be used in an app:

- [Basic usage](#)
- [Named clients](#)
- [Typed clients](#)
- [Generated clients](#)

None of them are strictly superior to another. The best approach depends upon the app's constraints.

### Basic usage

The `IHttpClientFactory` can be registered by calling the `AddHttpClient` extension method on the `IServiceCollection`, inside the `Startup.ConfigureServices` method.

```
services.AddHttpClient();
```

Once registered, code can accept an `IHttpClientFactory` anywhere services can be injected with [dependency injection](#) (DI). The `IHttpClientFactory` can be used to create a `HttpClient` instance:

```

public class BasicUsageModel : PageModel
{
    private readonly IHttpClientFactory _clientFactory;

    public IEnumerable<GitHubBranch> Branches { get; private set; }

    public bool GetBranchesError { get; private set; }

    public BasicUsageModel(IHttpClientFactory clientFactory)
    {
        _clientFactory = clientFactory;
    }

    public async Task OnGet()
    {
        var request = new HttpRequestMessage(HttpMethod.Get,
"https://api.github.com/repos/aspnet/docs/branches");
        request.Headers.Add("Accept", "application/vnd.github.v3+json");
        request.Headers.Add("User-Agent", "HttpClientFactory-Sample");

        var client = _clientFactory.CreateClient();

        var response = await client.SendAsync(request);

        if (response.IsSuccessStatusCode)
        {
            Branches = await response.Content.ReadAsAsync<IEnumerable<GitHubBranch>>();
        }
        else
        {
            GetBranchesError = true;
            Branches = Array.Empty<GitHubBranch>();
        }
    }
}

```

Using `IHttpClientFactory` in this fashion is a great way to refactor an existing app. It has no impact on the way `HttpClient` is used. In places where `HttpClient` instances are currently created, replace those occurrences with a call to `CreateClient`.

## Named clients

If an app requires multiple distinct uses of `HttpClient`, each with a different configuration, an option is to use **named clients**. Configuration for a named `HttpClient` can be specified during registration in `Startup.ConfigureServices`.

```

services.AddHttpClient("github", c =>
{
    c.BaseAddress = new Uri("https://api.github.com/");
    c.DefaultRequestHeaders.Add("Accept", "application/vnd.github.v3+json"); // Github API versioning
    c.DefaultRequestHeaders.Add("User-Agent", "HttpClientFactory-Sample"); // Github requires a user-agent
});

```

In the preceding code, `AddHttpClient` is called, providing the name "github". This client has some default configuration applied—namely the base address and two headers required to work with the GitHub API.

Each time `CreateClient` is called, a new instance of `HttpClient` is created and the configuration action is called.

To consume a named client, a string parameter can be passed to `CreateClient`. Specify the name of the client to be created:

```

public class NamedClientModel : PageModel
{
    private readonly IHttpClientFactory _clientFactory;

    public IEnumerable<GitHubPullRequest> PullRequests { get; private set; }

    public bool GetPullRequestsError { get; private set; }

    public bool HasPullRequests => PullRequests.Any();

    public NamedClientModel(IHttpClientFactory clientFactory)
    {
        _clientFactory = clientFactory;
    }

    public async Task OnGet()
    {
        var request = new HttpRequestMessage(HttpMethod.Get, "repos/aspnet/docs/pulls");

        var client = _clientFactory.CreateClient("github");

        var response = await client.SendAsync(request);

        if (response.IsSuccessStatusCode)
        {
            PullRequests = await response.Content.ReadAsAsync<IEnumerable<GitHubPullRequest>>();
        }
        else
        {
            GetPullRequestsError = true;
            PullRequests = Array.Empty<GitHubPullRequest>();
        }
    }
}

```

In the preceding code, the request doesn't need to specify a hostname. It can pass just the path, since the base address configured for the client is used.

## Typed clients

Typed clients provide the same capabilities as named clients without the need to use strings as keys. The typed client approach provides IntelliSense and compiler help when consuming clients. They provide a single location to configure and interact with a particular `HttpClient`. For example, a single typed client might be used for a single backend endpoint and encapsulate all logic dealing with that endpoint. Another advantage is that they work with DI and can be injected where required in your app.

A typed client accepts a `HttpClient` parameter in its constructor:

```

public class GitHubService
{
    public HttpClient Client { get; }

    public GitHubService(HttpClient client)
    {
        client.BaseAddress = new Uri("https://api.github.com/");
        client.DefaultRequestHeaders.Add("Accept", "application/vnd.github.v3+json"); // GitHub API versioning
        client.DefaultRequestHeaders.Add("User-Agent", "HttpClientFactory-Sample"); // GitHub requires a user-agent

        Client = client;
    }

    public async Task<IEnumerable<GitHubIssue>> GetAspNetDocsIssues()
    {
        var response = await Client.GetAsync("/repos/aspnet/docs/issues?state=open&sort=created&direction=desc");

        response.EnsureSuccessStatusCode();

        var result = await response.Content.ReadAsAsync<IEnumerable<GitHubIssue>>();

        return result;
    }
}

```

In the preceding code, the configuration is moved into the typed client. The `HttpClient` object is exposed as a public property. It's possible to define API-specific methods that expose `HttpClient` functionality. The `GetAspNetDocsIssues` method encapsulates the code needed to query for and parse out the latest open issues from a GitHub repository.

To register a typed client, the generic `AddHttpClient` extension method can be used within `Startup.ConfigureServices`, specifying the typed client class:

```
services.AddHttpClient<GitHubService>();
```

The typed client is registered as transient with DI. The typed client can be injected and consumed directly:

```

public class TypedClientModel : PageModel
{
    private readonly GitHubService _gitHubService;

    public IEnumerable<GitHubIssue> LatestIssues { get; private set; }

    public bool HasIssue => LatestIssues.Any();

    public bool GetIssuesError { get; private set; }

    public TypedClientModel(GitHubService gitHubService)
    {
        _gitHubService = gitHubService;
    }

    public async Task OnGet()
    {
        try
        {
            LatestIssues = await _gitHubService.GetAspNetDocsIssues();
        }
        catch(HttpRequestException)
        {
            GetIssuesError = true;
            LatestIssues = Array.Empty<GitHubIssue>();
        }
    }
}

```

If preferred, the configuration for a typed client can be specified during registration in `Startup.ConfigureServices`, rather than in the typed client's constructor:

```

services.AddHttpClient<RepoService>(c =>
{
    c.BaseAddress = new Uri("https://api.github.com/");
    c.DefaultRequestHeaders.Add("Accept", "application/vnd.github.v3+json");
    c.DefaultRequestHeaders.Add("User-Agent", "HttpClientFactory-Sample");
});

```

It's possible to entirely encapsulate the `HttpClient` within a typed client. Rather than exposing it as a property, public methods can be provided which call the `HttpClient` instance internally.

```

public class RepoService
{
    private readonly HttpClient _httpClient; // not exposed publicly

    public RepoService(HttpClient client)
    {
        _httpClient = client;
    }

    public async Task<IEnumerable<string>> GetRepos()
    {
        var response = await _httpClient.GetAsync("aspnet/repos");

        response.EnsureSuccessStatusCode();

        var result = await response.Content.ReadAsAsync<IEnumerable<string>>();

        return result;
    }
}

```

In the preceding code, the `HttpClient` is stored as a private field. All access to make external calls goes through the `GetRepos` method.

## Generated clients

`IHttpClientFactory` can be used in combination with other third-party libraries such as [Refit](#). Refit is a REST library for .NET. It converts REST APIs into live interfaces. An implementation of the interface is generated dynamically by the `RestService`, using `HttpClient` to make the external HTTP calls.

An interface and a reply are defined to represent the external API and its response:

```
public interface IHelloClient
{
    [Get("/helloworld")]
    Task<Reply> GetMessageAsync();
}

public class Reply
{
    public string Message { get; set; }
}
```

A typed client can be added, using Refit to generate the implementation:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddHttpClient("hello", c =>
    {
        c.BaseAddress = new Uri("http://localhost:5000");
    })
    .AddTypedClient(c => Refit.RestService.For<IHelloClient>(c));

    services.AddMvc();
}
```

The defined interface can be consumed where necessary, with the implementation provided by DI and Refit:

```
[ApiController]
public class ValuesController : ControllerBase
{
    private readonly IHelloClient _client;

    public ValuesController(IHelloClient client)
    {
        _client = client;
    }

    [HttpGet("/")]
    public async Task<ActionResult<Reply>> Index()
    {
        return await _client.GetMessageAsync();
    }
}
```

## Outgoing request middleware

`HttpClient` already has the concept of delegating handlers that can be linked together for outgoing HTTP requests. The `IHttpClientFactory` makes it easy to define the handlers to apply for each named client. It supports registration and chaining of multiple handlers to build an outgoing request middleware pipeline. Each of these handlers is able to perform work before and after the outgoing request. This pattern is similar to the inbound

middleware pipeline in ASP.NET Core. The pattern provides a mechanism to manage cross-cutting concerns around HTTP requests, including caching, error handling, serialization, and logging.

To create a handler, define a class deriving from `DelegatingHandler`. Override the `SendAsync` method to execute code before passing the request to the next handler in the pipeline:

```
public class ValidateHeaderHandler : DelegatingHandler
{
    protected override async Task<HttpResponseMessage> SendAsync(HttpRequestMessage request,
        CancellationToken cancellationToken)
    {
        if (!request.Headers.Contains("X-API-KEY"))
        {
            return new HttpResponseMessage(HttpStatusCode.BadRequest);
        }
        Content = new StringContent("You must supply an API key header called X-API-KEY");
    }

    return await base.SendAsync(request, cancellationToken);
}
```

The preceding code defines a basic handler. It checks to see if an X-API-KEY header has been included on the request. If the header is missing, it can avoid the HTTP call and return a suitable response.

During registration, one or more handlers can be added to the configuration for a `HttpClient`. This task is accomplished via extension methods on the `IHttpClientBuilder`.

```
services.AddTransient<ValidateHeaderHandler>();

services.AddHttpClient("externalservice", c =>
{
    c.BaseAddress = new Uri("https://localhost:5000/"); // assume this is an "external" service which requires
    an API KEY
})
.AddHttpMessageHandler<ValidateHeaderHandler>();
```

In the preceding code, the `ValidateHeaderHandler` is registered with DI. The handler **must** be registered in DI as transient. Once registered, `AddHttpMessageHandler` can be called, passing in the type for the handler.

Multiple handlers can be registered in the order that they should execute. Each handler wraps the next handler until the final `HttpClientHandler` executes the request:

```
services.AddTransient<SecureRequestHandler>();
services.AddTransient<requestDataHandler>();

services.AddHttpClient("clientwithhandlers")
    // This handler is on the outside and called first during the request, last during the response.
    .AddHttpMessageHandler<SecureRequestHandler>()
    // This handler is on the inside, closest to the request being sent.
    .AddHttpMessageHandler<requestDataHandler>();
```

## Use Polly-based handlers

`IHttpClientFactory` integrates with a popular third-party library called [Polly](#). Polly is a comprehensive resilience and transient fault-handling library for .NET. It allows developers to express policies such as Retry, Circuit Breaker, Timeout, Bulkhead Isolation, and Fallback in a fluent and thread-safe manner.

Extension methods are provided to enable the use of Polly policies with configured `HttpClient` instances. The Polly extensions are available in the [Microsoft.Extensions.Http.Polly](#) NuGet package. This package isn't included in the [Microsoft.AspNetCore.App metapackage](#). To use the extensions, an explicit `<PackageReference />` should be included in the project.

```
<Project Sdk="Microsoft.NET.Sdk.Web">

<PropertyGroup>
  <TargetFramework>netcoreapp2.1</TargetFramework>
</PropertyGroup>

<ItemGroup>
  <PackageReference Include="Microsoft.AspNetCore.App" Version="2.1.1" />
  <PackageReference Include="Microsoft.Extensions.Http.Polly" Version="2.1.1" />
</ItemGroup>

</Project>
```

After restoring this package, extension methods are available to support adding Polly-based handlers to clients.

### Handle transient faults

The most common faults you may expect to occur when making external HTTP calls will be transient. A convenient extension method called `AddTransientHttpErrorPolicy` is included which allows a policy to be defined to handle transient errors. Policies configured with this extension method handle `HttpRequestException`, HTTP 5xx responses, and HTTP 408 responses.

The `AddTransientHttpErrorPolicy` extension can be used within `Startup.ConfigureServices`. The extension provides access to a `PolicyBuilder` object configured to handle errors representing a possible transient fault:

```
services.AddHttpClient<UnreliableEndpointCallerService>()
    .AddTransientHttpErrorPolicy(p => p.WaitAndRetryAsync(3, _ => TimeSpan.FromMilliseconds(600)));
```

In the preceding code, a `WaitAndRetryAsync` policy is defined. Failed requests are retried up to three times with a delay of 600 ms between attempts.

### Dynamically select policies

Additional extension methods exist which can be used to add Polly-based handlers. One such extension is `AddPolicyHandler`, which has multiple overloads. One overload allows the request to be inspected when defining which policy to apply:

```
var timeout = Policy.TimeoutAsync<HttpResponseMessage>(TimeSpan.FromSeconds(10));
var longTimeout = Policy.TimeoutAsync<HttpResponseMessage>(TimeSpan.FromSeconds(30));

services.AddHttpClient("conditionalpolicy")
// Run some code to select a policy based on the request
    .AddPolicyHandler(request => request.Method == HttpMethod.Get ? timeout : longTimeout);
```

In the preceding code, if the outgoing request is a GET, a 10-second timeout is applied. For any other HTTP method, a 30-second timeout is used.

### Add multiple Polly handlers

It is common to nest Polly policies to provide enhanced functionality:

```
services.AddHttpClient("multiplepolicies")
    .AddTransientHttpErrorPolicy(p => p.RetryAsync(3))
    .AddTransientHttpErrorPolicy(p => p.CircuitBreakerAsync(5, TimeSpan.FromSeconds(30)));
```

In the preceding example, two handlers are added. The first uses the `AddTransientHttpErrorPolicy` extension to add a retry policy. Failed requests are retried up to three times. The second call to `AddTransientHttpErrorPolicy` adds a circuit breaker policy. Further external requests are blocked for 30 seconds if five failed attempts occur sequentially. Circuit breaker policies are stateful. All calls through this client share the same circuit state.

### Add policies from the Polly registry

An approach to managing regularly used policies is to define them once and register them with a `PolicyRegistry`. An extension method is provided which allows a handler to be added using a policy from the registry:

```
var registry = services.AddPolicyRegistry();

registry.Add("regular", timeout);
registry.Add("long", longTimeout);

services.AddHttpClient("regulartimeouthandler")
    .AddPolicyHandlerFromRegistry("regular");
```

In the preceding code, a `PolicyRegistry` is added to the `ServiceCollection` and two policies are registered with it. In order to use a policy from the registry, the `AddPolicyHandlerFromRegistry` method is used, passing the name of the policy to apply.

Further information about `IHttpClientFactory` and Polly integrations can be found on the [Polly wiki](#).

## HttpClient and lifetime management

Each time `CreateClient` is called on the `IHttpClientFactory`, a new instance of a `HttpClient` is returned. There will be a `HttpMessageHandler` per named client. `IHttpClientFactory` will pool the `HttpMessageHandler` instances created by the factory to reduce resource consumption. A `HttpMessageHandler` instance may be reused from the pool when creating a new `HttpClient` instance if its lifetime hasn't expired.

Pooling of handlers is desirable as each handler typically manages its own underlying HTTP connections; creating more handlers than necessary can result in connection delays. Some handlers also keep connections open indefinitely, which can prevent the handler from reacting to DNS changes.

The default handler lifetime is two minutes. The default value can be overridden on a per named client basis. To override it, call `SetHandlerLifetime` on the `IHttpClientBuilder` that is returned when creating the client:

```
services.AddHttpClient("extendedhandlerlifetime")
    .SetHandlerLifetime(TimeSpan.FromMinutes(5));
```

## Logging

Clients created via `IHttpClientFactory` record log messages for all requests. You'll need to enable the appropriate information level in your logging configuration to see the default log messages. Additional logging, such as the logging of request headers, is only included at trace level.

The log category used for each client includes the name of the client. A client named "MyNamedClient", for example, logs messages with a category of `System.Net.Http.HttpClient.MyNamedClient.LogicalHandler`. Messages with the suffix of "LogicalHandler" occur on the outside of request handler pipeline. On the request, messages are logged before any other handlers in the pipeline have processed it. On the response, messages are logged after

any other pipeline handlers have received the response.

Logging also occurs on the inside of the request handler pipeline. In the case of the "MyNamedClient" example, those messages are logged against the log category `System.Net.Http.HttpClient.MyNamedClient.ClientHandler`. For the request, this occurs after all other handlers have run and immediately before the request is sent out on the network. On the response, this logging includes the state of the response before it passes back through the handler pipeline.

Enabling logging on the outside and inside of the pipeline enables inspection of the changes made by the other pipeline handlers. This may include changes to request headers, for example, or to the response status code.

Including the name of the client in the log category enables log filtering for specific named clients where necessary.

## Configure the `HttpMessageHandler`

It may be necessary to control the configuration of the inner `HttpMessageHandler` used by a client.

An `IHttpClientBuilder` is returned when adding named or typed clients. The `ConfigurePrimaryHttpMessageHandler` extension method can be used to define a delegate. The delegate is used to create and configure the primary `HttpMessageHandler` used by that client:

```
services.AddHttpClient("configured-inner-handler")
    .ConfigurePrimaryHttpMessageHandler(() =>
{
    return new HttpClientHandler()
    {
        AllowAutoRedirect = false,
        UseDefaultCredentials = true
    };
});
```

# Request Features in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Steve Smith](#)

Web server implementation details related to HTTP requests and responses are defined in interfaces. These interfaces are used by server implementations and middleware to create and modify the application's hosting pipeline.

## Feature interfaces

ASP.NET Core defines a number of HTTP feature interfaces in `Microsoft.AspNetCore.Http.Features` which are used by servers to identify the features they support. The following feature interfaces handle requests and return responses:

`IHttpRequestFeature` Defines the structure of an HTTP request, including the protocol, path, query string, headers, and body.

`IHttpResponseFeature` Defines the structure of an HTTP response, including the status code, headers, and body of the response.

`IHttpAuthenticationFeature` Defines support for identifying users based on a `ClaimsPrincipal` and specifying an authentication handler.

`IHttpUpgradeFeature` Defines support for [HTTP Upgrades](#), which allow the client to specify which additional protocols it would like to use if the server wishes to switch protocols.

`IHttpBufferingFeature` Defines methods for disabling buffering of requests and/or responses.

`IHttpConnectionFeature` Defines properties for local and remote addresses and ports.

`IHttpRequestLifetimeFeature` Defines support for aborting connections, or detecting if a request has been terminated prematurely, such as by a client disconnect.

`IHttpSendFileFeature` Defines a method for sending files asynchronously.

`IHttpWebSocketFeature` Defines an API for supporting web sockets.

`IHttpRequestIdentifierFeature` Adds a property that can be implemented to uniquely identify requests.

`ISessionFeature` Defines `ISessionFactory` and `ISession` abstractions for supporting user sessions.

`ITlsConnectionFeature` Defines an API for retrieving client certificates.

`ITlsTokenBindingFeature` Defines methods for working with TLS token binding parameters.

### NOTE

`ISessionFeature` isn't a server feature, but is implemented by the `SessionMiddleware` (see [Managing Application State](#)).

## Feature collections

The `Features` property of `HttpContext` provides an interface for getting and setting the available HTTP features for the current request. Since the feature collection is mutable even within the context of a request, middleware

can be used to modify the collection and add support for additional features.

## Middleware and request features

While servers are responsible for creating the feature collection, middleware can both add to this collection and consume features from the collection. For example, the `StaticFileMiddleware` accesses the `IHttpSendFileFeature` feature. If the feature exists, it's used to send the requested static file from its physical path. Otherwise, a slower alternative method is used to send the file. When available, the `IHttpSendFileFeature` allows the operating system to open the file and perform a direct kernel mode copy to the network card.

Additionally, middleware can add to the feature collection established by the server. Existing features can even be replaced by middleware, allowing the middleware to augment the functionality of the server. Features added to the collection are available immediately to other middleware or the underlying application itself later in the request pipeline.

By combining custom server implementations and specific middleware enhancements, the precise set of features an application requires can be constructed. This allows missing features to be added without requiring a change in server, and ensures only the minimal amount of features are exposed, thus limiting attack surface area and improving performance.

## Summary

Feature interfaces define specific HTTP features that a given request may support. Servers define collections of features, and the initial set of features supported by that server, but middleware can be used to enhance these features.

## Additional resources

- [Servers](#)
- [Middleware](#)
- [Open Web Interface for .NET \(OWIN\)](#)

# Primitives in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

ASP.NET Core primitives are low-level building blocks shared by framework extensions. You can use these building blocks in your own code.

[Detect changes with Change Tokens](#)

# Detect changes with change tokens in ASP.NET Core

6/21/2018 • 8 minutes to read • [Edit Online](#)

By [Luke Latham](#)

A *change token* is a general-purpose, low-level building block used to track changes.

[View or download sample code \(how to download\)](#)

## IChangeToken interface

`IChangeToken` propagates notifications that a change has occurred. `IChangeToken` resides in the `Microsoft.Extensions.Primitives` namespace. For apps that don't use the `Microsoft.AspNetCore.App` metapackage (ASP.NET Core 2.1 or later), reference the `Microsoft.Extensions.Primitives` NuGet package in the project file.

`IChangeToken` has two properties:

- `ActiveChangedCallbacks` indicate if the token proactively raises callbacks. If `ActiveChangedCallbacks` is set to `false`, a callback is never called, and the app must poll `HasChanged` for changes. It's also possible for a token to never be cancelled if no changes occur or the underlying change listener is disposed or disabled.
- `HasChanged` gets a value that indicates if a change has occurred.

The interface has one method, `RegisterChangeCallback(Action<Object>, Object)`, which registers a callback that's invoked when the token has changed. `HasChanged` must be set before the callback is invoked.

## ChangeToken class

`ChangeToken` is a static class used to propagate notifications that a change has occurred. `ChangeToken` resides in the `Microsoft.Extensions.Primitives` namespace. For apps that don't use the `Microsoft.AspNetCore.App` metapackage, reference the `Microsoft.Extensions.Primitives` NuGet package in the project file.

The `ChangeToken` `OnChange(Func<IChangeToken>, Action)` method registers an `Action` to call whenever the token changes:

- `Func<IChangeToken>` produces the token.
- `Action` is called when the token changes.

`ChangeToken` has an `OnChange<TState>(Func<IChangeToken>, Action<TState>, TState)` overload that takes an additional `TState` parameter that's passed into the token consumer `Action`.

`OnChange` returns an `IDisposable`. Calling `Dispose` stops the token from listening for further changes and releases the token's resources.

## Example uses of change tokens in ASP.NET Core

Change tokens are used in prominent areas of ASP.NET Core monitoring changes to objects:

- For monitoring changes to files, `IFileProvider`'s `Watch` method creates an `IChangeToken` for the specified files or folder to watch.
- `IChangeToken` tokens can be added to cache entries to trigger cache evictions on change.
- For `TOptions` changes, the default `OptionsMonitor` implementation of `IOptionsMonitor` has an overload that accepts one or more `IOptionsChangeSource` instances. Each instance returns an `IChangeToken` to register

a change notification callback for tracking options changes.

## Monitoring for configuration changes

By default, ASP.NET Core templates use [JSON configuration files](#) (`appsettings.json`, `appsettings.Development.json`, and `appsettings.Production.json`) to load app configuration settings.

These files are configured using the `AddJsonFile(IConfigurationBuilder, String, Boolean, Boolean)` extension method on [ConfigurationBuilder](#) that accepts a `reloadOnChange` parameter (ASP.NET Core 1.1 and later).

`reloadOnChange` indicates if configuration should be reloaded on file changes. See this setting in the [WebHost](#) convenience method `CreateDefaultBuilder`:

```
config.AddJsonFile("appsettings.json", optional: true, reloadOnChange: true)
    .AddJsonFile($"appsettings.{env.EnvironmentName}.json", optional: true, reloadOnChange: true);
```

File-based configuration is represented by [FileConfigurationSource](#). `FileConfigurationSource` uses [IFileProvider](#) to monitor files.

By default, the `IFileMonitor` is provided by a [PhysicalFileProvider](#), which uses [FileSystemWatcher](#) to monitor for configuration file changes.

The sample app demonstrates two implementations for monitoring configuration changes. If either the `appsettings.json` file changes or the Environment version of the file changes, each implementation executes custom code. The sample app writes a message to the console.

A configuration file's `FileSystemWatcher` can trigger multiple token callbacks for a single configuration file change. The sample's implementation guards against this problem by checking file hashes on the configuration files. Checking file hashes ensures that at least one of the configuration files has changed before running the custom code. The sample uses SHA1 file hashing (`Utilities/Utilities.cs`):

```

public static byte[] ComputeHash(string filePath)
{
    var runCount = 1;

    while(runCount < 4)
    {
        try
        {
            if (File.Exists(filePath))
            {
                using (var fs = File.OpenRead(filePath))
                {
                    return System.Security.Cryptography.SHA1.Create().ComputeHash(fs);
                }
            }
            else
            {
                throw new FileNotFoundException();
            }
        }
        catch (IOException ex)
        {
            if (runCount == 3 || ex.HResult != -2147024864)
            {
                throw;
            }
            else
            {
                Thread.Sleep(TimeSpan.FromSeconds(Math.Pow(2, runCount)));
                runCount++;
            }
        }
    }

    return new byte[20];
}

```

A retry is implemented with an exponential back-off. The re-try is present because file locking may occur that temporarily prevents computing a new hash on one of the files.

### Simple startup change token

Register a token consumer `Action` callback for change notifications to the configuration reload token (*Startup.cs*):

```

ChangeToken.OnChange(
    () => config.GetReloadToken(),
    (state) => InvokeChanged(state),
    env);

```

`config.GetReloadToken()` provides the token. The callback is the `InvokeChanged` method:

```

private void InvokeChanged(IHostingEnvironment env)
{
    byte[] appsettingsHash = ComputeHash("appSettings.json");
    byte[] appsettingsEnvHash =
        ComputeHash($"appSettings.{env.EnvironmentName}.json");

    if (!appsettingsHash.SequenceEqual(appsettingsHash) ||
        !_appsettingsEnvHash.SequenceEqual(appsettingsEnvHash))
    {
        _appsettingsHash = appsettingsHash;
        _appsettingsEnvHash = appsettingsEnvHash;

        WriteConsole("Configuration changed (Simple Startup Change Token)");
    }
}

```

The `state` of the callback is used to pass in the `IHostingEnvironment`. This is useful to determine the correct `appsettings` configuration JSON file to monitor, `appsettings.<Environment>.json`. File hashes are used to prevent the `WriteConsole` statement from running multiple times due to multiple token callbacks when the configuration file has only changed once.

This system runs as long as the app is running and can't be disabled by the user.

## Monitoring configuration changes as a service

The sample implements:

- Basic startup token monitoring.
- Monitoring as a service.
- A mechanism to enable and disable monitoring.

The sample establishes an `IConfigurationMonitor` interface (*Extensions/ConfigurationMonitor.cs*):

```

public interface IConfigurationMonitor
{
    bool MonitoringEnabled { get; set; }
    string CurrentState { get; set; }
}

```

The constructor of the implemented class, `ConfigurationMonitor`, registers a callback for change notifications:

```

public ConfigurationMonitor(IConfiguration config, IHostingEnvironment env)
{
    _env = env;

    ChangeToken.OnChange< IConfigurationMonitor>(
        () => config.GetReloadToken(),
        InvokeChanged,
        this);
}

public bool MonitoringEnabled { get; set; } = false;
public string CurrentState { get; set; } = "Not monitoring";

```

`config.GetReloadToken()` supplies the token. `InvokeChanged` is the callback method. The `state` in this instance is a reference to the `IConfigurationMonitor` instance that is used to access the monitoring state. Two properties are used:

- `MonitoringEnabled` indicates if the callback should run its custom code.

- `CurrentState` describes the current monitoring state for use in the UI.

The `InvokeChanged` method is similar to the earlier approach, except that it:

- Doesn't run its code unless `MonitoringEnabled` is `true`.
- Notes the current `state` in its `WriteConsole` output.

```
private void InvokeChanged(IConfigurationMonitor state)
{
    if (MonitoringEnabled)
    {
        byte[] appsettingsHash = ComputeHash("appSettings.json");
        byte[] appsettingsEnvHash =
            ComputeHash($"appSettings.{_env.EnvironmentName}.json");

        if (!_appsettingsHash.SequenceEqual(appsettingsHash) ||
            !_appsettingsEnvHash.SequenceEqual(appsettingsEnvHash))
        {
            string message = $"State updated at {DateTime.Now}";

            _appsettingsHash = appsettingsHash;
            _appsettingsEnvHash = appsettingsEnvHash;

            WriteConsole($"Configuration changed (ConfigurationMonitor Class) {message}, state:
{state.CurrentState}");
        }
    }
}
```

An instance `ConfigurationMonitor` is registered as a service in `ConfigureServices` of `Startup.cs`:

```
services.AddSingleton<IConfigurationMonitor, ConfigurationMonitor>();
```

The Index page offers the user control over configuration monitoring. The instance of `IConfigurationMonitor` is injected into the `IndexModel`:

```
public IndexModel(
    IConfiguration config,
    IConfigurationMonitor monitor,
    FileService fileService)
{
    _config = config;
    _monitor = monitor;
    _fileService = fileService;
}
```

A button enables and disables monitoring:

```
<button class="btn btn-danger" asp-page-handler="StopMonitoring">Stop Monitoring</button>
```

```

public IActionResult OnPostStartMonitoring()
{
    _monitor.MonitoringEnabled = true;
    _monitor.CurrentState = "Monitoring!";

    return RedirectToPage();
}

public IActionResult OnPostStopMonitoring()
{
    _monitor.MonitoringEnabled = false;
    _monitor.CurrentState = "Not monitoring";

    return RedirectToPage();
}

```

When `OnPostStartMonitoring` is triggered, monitoring is enabled, and the current state is cleared. When `OnPostStopMonitoring` is triggered, monitoring is disabled, and the state is set to reflect that monitoring isn't occurring.

## Monitoring cached file changes

File content can be cached in-memory using [IMemoryCache](#). In-memory caching is described in the [Cache in-memory](#) topic. Without taking additional steps, such as the implementation described below, *stale* (outdated) data is returned from a cache if the source data changes.

Not taking into account the status of a cached source file when renewing a [sliding expiration](#) period leads to stale cache data. Each request for the data renews the sliding expiration period, but the file is never reloaded into the cache. Any app features that use the file's cached content are subject to possibly receiving stale content.

Using change tokens in a file caching scenario prevents stale file content in the cache. The sample app demonstrates an implementation of the approach.

The sample uses `GetFileContent` to:

- Return file content.
- Implement a retry algorithm with exponential back-off to cover cases where a file lock is temporarily preventing a file from being read.

*Utilities/Utilities.cs*:

```

public async static Task<string> GetFileContent(string filePath)
{
    var runCount = 1;

    while(runCount < 4)
    {
        try
        {
            if (File.Exists(filePath))
            {
                using (var fileStreamReader = File.OpenText(filePath))
                {
                    return await fileStreamReader.ReadToEndAsync();
                }
            }
            else
            {
                throw new FileNotFoundException();
            }
        }
        catch (IOException ex)
        {
            if (runCount == 3 || ex.HResult != -2147024864)
            {
                throw;
            }
            else
            {
                await Task.Delay(TimeSpan.FromSeconds(Math.Pow(2, runCount)));
                runCount++;
            }
        }
    }

    return null;
}

```

A `FileService` is created to handle cached file lookups. The `GetFileContent` method call of the service attempts to obtain file content from the in-memory cache and return it to the caller (*Services/FileService.cs*).

If cached content isn't found using the cache key, the following actions are taken:

1. The file content is obtained using `GetFileContent`.
2. A change token is obtained from the file provider with `IFileProviders.Watch`. The token's callback is triggered when the file is modified.
3. The file content is cached with a `sliding expiration` period. The change token is attached with `MemoryCacheEntryExtensions.AddExpirationToken` to evict the cache entry if the file changes while it's cached.

```

public class FileService
{
    private readonly IMemoryCache _cache;
    private readonly IFileProvider _fileProvider;
    private List<string> _tokens = new List<string>();

    public FileService(IMemoryCache cache, IHostingEnvironment env)
    {
        _cache = cache;
        _fileProvider = env.ContentRootFileProvider;
    }

    public async Task<string> GetFileContents(string fileName)
    {
        // For the purposes of this example, files are stored
        // in the content root of the app. To obtain the physical
        // path to a file at the content root, use the
        // ContentRootFileProvider on IHostingEnvironment.
        var filePath = _fileProvider.GetFileInfo(fileName).PhysicalPath;
        string fileContent;

        // Try to obtain the file contents from the cache.
        if (_cache.TryGetValue(filePath, out fileContent))
        {
            return fileContent;
        }

        // The cache doesn't have the entry, so obtain the file
        // contents from the file itself.
        fileContent = await GetFileContent(filePath);

        if (fileContent != null)
        {
            // Obtain a change token from the file provider whose
            // callback is triggered when the file is modified.
            var changeToken = _fileProvider.Watch(fileName);

            // Configure the cache entry options for a five minute
            // sliding expiration and use the change token to
            // expire the file in the cache if the file is
            // modified.
            var cacheEntryOptions = new MemoryCacheEntryOptions()
                .SetSlidingExpiration(TimeSpan.FromMinutes(5))
                .AddExpirationToken(changeToken);

            // Put the file contents into the cache.
            _cache.Set(filePath, fileContent, cacheEntryOptions);
        }
    }

    return string.Empty;
}
}

```

The `FileService` is registered in the service container along with the memory caching service (*Startup.cs*):

```

services.AddMemoryCache();
services.AddSingleton<FileService>();

```

The page model loads the file's content using the service (*Pages/Index.cshtml.cs*):

```

var fileContent = await _fileService.GetFileContents("poem.txt");

```

## CompositeChangeToken class

For representing one or more `IChangeToken` instances in a single object, use the [CompositeChangeToken](#) class.

```
var firstCancellationTokenSource = new CancellationTokenSource();
var secondCancellationTokenSource = new CancellationTokenSource();

var firstCancellationToken = firstCancellationTokenSource.Token;
var secondCancellationToken = secondCancellationTokenSource.Token;

var firstCancellationChangeToken = new CancellationChangeToken(firstCancellationToken);
var secondCancellationChangeToken = new CancellationChangeToken(secondCancellationToken);

var compositeChangeToken =
    new CompositeChangeToken(
        new List<IChangeToken>
    {
        firstCancellationChangeToken,
        secondCancellationChangeToken
    });
}
```

`HasChanged` on the composite token reports `true` if any represented token `HasChanged` is `true`.

`ActiveChangeCallbacks` on the composite token reports `true` if any represented token `ActiveChangeCallbacks` is `true`. If multiple concurrent change events occur, the composite change callback is invoked exactly one time.

## Additional resources

- [Cache in-memory](#)
- [Work with a distributed cache](#)
- [Response caching](#)
- [Response Caching Middleware](#)
- [Cache Tag Helper](#)
- [Distributed Cache Tag Helper](#)

# Open Web Interface for .NET (OWIN) with ASP.NET Core

7/2/2018 • 5 minutes to read • [Edit Online](#)

By [Steve Smith](#) and [Rick Anderson](#)

ASP.NET Core supports the Open Web Interface for .NET (OWIN). OWIN allows web apps to be decoupled from web servers. It defines a standard way for middleware to be used in a pipeline to handle requests and associated responses. ASP.NET Core applications and middleware can interoperate with OWIN-based applications, servers, and middleware.

OWIN provides a decoupling layer that allows two frameworks with disparate object models to be used together. The `Microsoft.AspNetCore.Owin` package provides two adapter implementations:

- ASP.NET Core to OWIN
- OWIN to ASP.NET Core

This allows ASP.NET Core to be hosted on top of an OWIN compatible server/host or for other OWIN compatible components to be run on top of ASP.NET Core.

## NOTE

Using these adapters comes with a performance cost. Apps using only ASP.NET Core components shouldn't use the `Microsoft.AspNetCore.Owin` package or adapters.

[View or download sample code](#) ([how to download](#))

## Running OWIN middleware in the ASP.NET pipeline

ASP.NET Core's OWIN support is deployed as part of the `Microsoft.AspNetCore.Owin` package. You can import OWIN support into your project by installing this package.

OWIN middleware conforms to the [OWIN specification](#), which requires a

`Func<IDictionary<string, object>, Task>` interface, and specific keys be set (such as `owin.ResponseBody`). The following simple OWIN middleware displays "Hello World":

```
public Task OwinHello(IDictionary<string, object> environment)
{
    string responseText = "Hello World via OWIN";
    byte[] responseBytes = Encoding.UTF8.GetBytes(responseText);

    // OWIN Environment Keys: http://owin.org/spec/spec/owin-1.0.0.html
    var responseStream = (Stream)environment["owin.ResponseBody"];
    var responseHeaders = (IDictionary<string, string[]>)environment["owin.ResponseHeaders"];

    responseHeaders["Content-Length"] = new string[] {
        responseBytes.Length.ToString(CultureInfo.InvariantCulture) };
    responseHeaders["Content-Type"] = new string[] { "text/plain" };

    return responseStream.WriteAsync(responseBytes, 0, responseBytes.Length);
}
```

The sample signature returns a `Task` and accepts an `IDictionary<string, object>` as required by OWIN.

The following code shows how to add the `OwinHello` middleware (shown above) to the ASP.NET pipeline with the `UseOwin` extension method.

```
public void Configure(IApplicationBuilder app)
{
    app.UseOwin(pipeline =>
    {
        pipeline(next => OwinHello);
    });
}
```

You can configure other actions to take place within the OWIN pipeline.

#### NOTE

Response headers should only be modified prior to the first write to the response stream.

#### NOTE

Multiple calls to `UseOwin` is discouraged for performance reasons. OWIN components will operate best if grouped together.

```
app.UseOwin(pipeline =>
{
    pipeline(async (next) =>
    {
        // do something before
        await OwinHello(new OwinEnvironment(HttpContext));
        // do something after
    });
});
```

## Using ASP.NET Hosting on an OWIN-based server

OWIN-based servers can host ASP.NET applications. One such server is [Nowin](#), a .NET OWIN web server. In the sample for this article, I've included a project that references Nowin and uses it to create an `IServer` capable of self-hosting ASP.NET Core.

```

using System;
using System.Collections.Generic;
using System.IO;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Hosting;

namespace NowinSample
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = new WebHostBuilder()
                .UseNowin()
                .UseContentRoot(Directory.GetCurrentDirectory())
                .UseIISIntegration()
                .UseStartup<Startup>()
                .Build();

            host.Run();
        }
    }
}

```

`IIServer` is an interface that requires a `Features` property and a `start` method.

`Start` is responsible for configuring and starting the server, which in this case is done through a series of fluent API calls that set addresses parsed from the `IIServerAddressesFeature`. Note that the fluent configuration of the `_builder` variable specifies that requests will be handled by the `appFunc` defined earlier in the method. This `Func` is called on each request to process incoming requests.

We'll also add an `IWebHostBuilder` extension to make it easy to add and configure the Nowin server.

```

using System;
using Microsoft.AspNetCore.Hosting.Server;
using Microsoft.Extensions.DependencyInjection;
using Nowin;
using NowinSample;

namespace Microsoft.AspNetCore.Hosting
{
    public static class NowinWebHostBuilderExtensions
    {
        public static IWebHostBuilder UseNowin(this IWebHostBuilder builder)
        {
            return builder.ConfigureServices(services =>
            {
                services.AddSingleton<IServer, NowinServer>();
            });
        }

        public static IWebHostBuilder UseNowin(this IWebHostBuilder builder, Action<ServerBuilder> configure)
        {
            builder.ConfigureServices(services =>
            {
                services.Configure(configure);
            });
            return builder.UseNowin();
        }
    }
}

```

With this in place, invoke the extension in *Program.cs* to run an ASP.NET Core app using this custom server:

```
using System;
using System.Collections.Generic;
using System.IO;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Hosting;

namespace NowinSample
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = new WebHostBuilder()
                .UseNowin()
                .UseContentRoot(Directory.GetCurrentDirectory())
                .UseIISIntegration()
                .UseStartup<Startup>()
                .Build();

            host.Run();
        }
    }
}
```

Learn more about [ASP.NET Servers](#).

## Run ASP.NET Core on an OWIN-based server and use its WebSockets support

Another example of how OWIN-based servers' features can be leveraged by ASP.NET Core is access to features like WebSockets. The .NET OWIN web server used in the previous example has support for Web Sockets built in, which can be leveraged by an ASP.NET Core application. The example below shows a simple web app that supports Web Sockets and echoes back everything sent to the server through WebSockets.

```

public class Startup
{
    public void Configure(IApplicationBuilder app)
    {
        app.Use(async (context, next) =>
        {
            if (context.WebSockets.IsWebSocketRequest)
            {
                WebSocket webSocket = await context.WebSockets.AcceptWebSocketAsync();
                await EchoWebSocket(webSocket);
            }
            else
            {
                await next();
            }
        });
    }

    app.Run(context =>
    {
        return context.Response.WriteAsync("Hello World");
    });
}

private async Task EchoWebSocket(WebSocket webSocket)
{
    byte[] buffer = new byte[1024];
    WebSocketReceiveResult received = await webSocket.ReceiveAsync(
        new ArraySegment<byte>(buffer), CancellationToken.None);

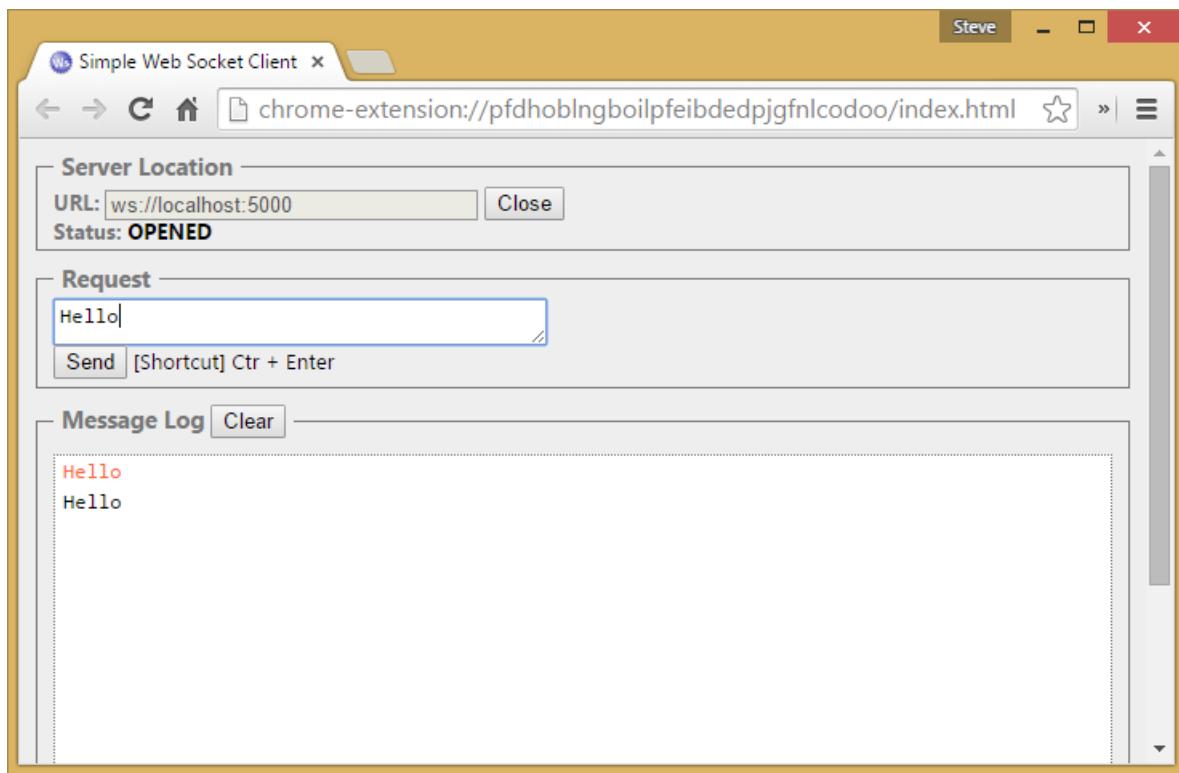
    while (!webSocket.CloseStatus.HasValue)
    {
        // Echo anything we receive
        await webSocket.SendAsync(new ArraySegment<byte>(buffer, 0, received.Count),
            received.MessageType, received.EndOfMessage, CancellationToken.None);

        received = await webSocket.ReceiveAsync(new ArraySegment<byte>(buffer),
            CancellationToken.None);
    }

    await webSocket.CloseAsync(webSocket.CloseStatus.Value,
        webSocket.CloseStatusDescription, CancellationToken.None);
}
}

```

This [sample](#) is configured using the same `NowInServer` as the previous one - the only difference is in how the application is configured in its `Configure` method. A test using [a simple websocket client](#) demonstrates the application:



## OWIN environment

You can construct an OWIN environment using the `HttpContext`.

```
var environment = new OwinEnvironment(HttpContext);
var features = new OwinFeatureCollection(environment);
```

## OWIN keys

OWIN depends on an `IDictionary<string,object>` object to communicate information throughout an HTTP Request/Response exchange. ASP.NET Core implements the keys listed below. See the [primary specification](#), [extensions](#), and [OWIN Key Guidelines and Common Keys](#).

### Request data (OWIN v1.0.0)

KEY	VALUE (TYPE)	DESCRIPTION
owin.RequestScheme	String	
owin.RequestMethod	String	
owin.RequestPathBase	String	
owin.RequestPath	String	
owin.RequestQueryString	String	
owin.RequestProtocol	String	
owin.RequestHeaders	<code>IDictionary&lt;string,string[]&gt;</code>	

KEY	VALUE (TYPE)	DESCRIPTION
owin.RequestBody	Stream	

### Request data (OWIN v1.1.0)

KEY	VALUE (TYPE)	DESCRIPTION
owin.RequestId	String	Optional

### Response data (OWIN v1.0.0)

KEY	VALUE (TYPE)	DESCRIPTION
owin.ResponseStatusCode	int	Optional
owin.ResponseReasonPhrase	String	Optional
owin.ResponseHeaders	IDictionary<string, string[]>	
owin.ResponseBody	Stream	

### Other data (OWIN v1.0.0)

KEY	VALUE (TYPE)	DESCRIPTION
owin.CallCancelled	CancellationToken	
owin.Version	String	

### Common keys

KEY	VALUE (TYPE)	DESCRIPTION
ssl.ClientCertificate	X509Certificate	
ssl.LoadClientCertAsync	Func<Task>	
server.RemoteIpAddress	String	
server.RemotePort	String	
server.LocalIpAddress	String	
server.LocalPort	String	
server.IsLocal	bool	
server.OnSendingHeaders	Action<Action<object>, object>	

### SendFiles v0.3.0

KEY	VALUE (TYPE)	DESCRIPTION
sendfile.SendAsync	See <a href="#">delegate signature</a>	Per Request

## Opaque v0.3.0

KEY	VALUE (TYPE)	DESCRIPTION
opaque.Version	String	
opaque.Upgrade	OpaqueUpgrade	See <a href="#">delegate signature</a>
opaque.Stream	Stream	
opaque.CallCancelled	CancellationToken	

## WebSocket v0.3.0

KEY	VALUE (TYPE)	DESCRIPTION
websocket.Version	String	
websocket.Accept	WebSocketAccept	See <a href="#">delegate signature</a>
websocket.AcceptAlt		Non-spec
websocket.SubProtocol	String	See <a href="#">RFC6455 Section 4.2.2 Step 5.5</a>
websocket.SendAsync	WebSocketSendAsync	See <a href="#">delegate signature</a>
websocket.ReceiveAsync	WebSocketReceiveAsync	See <a href="#">delegate signature</a>
websocket.CloseAsync	WebSocketCloseAsync	See <a href="#">delegate signature</a>
websocket.CallCancelled	CancellationToken	
websocket.ClientCloseStatus	int	Optional
websocket.ClientCloseDescription	String	Optional

## Additional resources

- [Middleware](#)
- [Servers](#)

# WebSockets support in ASP.NET Core

7/3/2018 • 4 minutes to read • [Edit Online](#)

By [Tom Dykstra](#) and [Andrew Stanton-Nurse](#)

This article explains how to get started with WebSockets in ASP.NET Core. [WebSocket \(RFC 6455\)](#) is a protocol that enables two-way persistent communication channels over TCP connections. It's used in apps that benefit from fast, real-time communication, such as chat, dashboard, and game apps.

[View or download sample code \(how to download\)](#). See the [Next steps](#) section for more information.

## Prerequisites

- ASP.NET Core 1.1 or later
- Any OS that supports ASP.NET Core:
  - Windows 7 / Windows Server 2008 or later
  - Linux
  - macOS
- If the app runs on Windows with IIS:
  - Windows 8 / Windows Server 2012 or later
  - IIS 8 / IIS 8 Express
  - WebSockets must be enabled in IIS (See the [IIS/IIS Express support](#) section.)
- If the app runs on [HTTP.sys](#):
  - Windows 8 / Windows Server 2012 or later
- For supported browsers, see <https://caniuse.com/#feat=websockets>.

## When to use WebSockets

Use WebSockets to work directly with a socket connection. For example, use WebSockets for the best possible performance with a real-time game.

[ASP.NET Core SignalR](#) is a library that simplifies adding real-time web functionality to apps. It uses WebSockets whenever possible.

## How to use WebSockets

- Install the [Microsoft.AspNetCore.WebSockets](#) package.
- Configure the middleware.
- Accept WebSocket requests.
- Send and receive messages.

### Configure the middleware

Add the WebSockets middleware in the `Configure` method of the `Startup` class:

```
app.UseWebSockets();
```

The following settings can be configured:

- `KeepAliveInterval` - How frequently to send "ping" frames to the client to ensure proxies keep the connection open.
- `ReceiveBufferSize` - The size of the buffer used to receive data. Advanced users may need to change this for performance tuning based on the size of the data.

```
var webSocketOptions = new WebSocketOptions()
{
    KeepAliveInterval = TimeSpan.FromSeconds(120),
    ReceiveBufferSize = 4 * 1024
};
app.UseWebSockets(webSocketOptions);
```

## Accept WebSocket requests

Somewhere later in the request life cycle (later in the `Configure` method or in an MVC action, for example) check if it's a WebSocket request and accept the WebSocket request.

The following example is from later in the `Configure` method:

```
app.Use(async (context, next) =>
{
    if (context.Request.Path == "/ws")
    {
        if (context.WebSockets.IsWebSocketRequest)
        {
            WebSocket webSocket = await context.WebSockets.AcceptWebSocketAsync();
            await Echo(context, webSocket);
        }
        else
        {
            context.Response.StatusCode = 400;
        }
    }
    else
    {
        await next();
    }
});
```

A WebSocket request could come in on any URL, but this sample code only accepts requests for `/ws`.

## Send and receive messages

The `AcceptWebSocketAsync` method upgrades the TCP connection to a WebSocket connection and provides a `WebSocket` object. Use the `WebSocket` object to send and receive messages.

The code shown earlier that accepts the WebSocket request passes the `WebSocket` object to an `Echo` method. The code receives a message and immediately sends back the same message. Messages are sent and received in a loop until the client closes the connection:

```

private async Task Echo(HttpContext context, WebSocket webSocket)
{
    var buffer = new byte[1024 * 4];
    WebSocketReceiveResult result = await webSocket.ReceiveAsync(new ArraySegment<byte>(buffer),
CancellationToken.None);
    while (!result.CloseStatus.HasValue)
    {
        await webSocket.SendAsync(new ArraySegment<byte>(buffer, 0, result.Count), result.MessageType,
result.EndOfMessage, CancellationToken.None);

        result = await webSocket.ReceiveAsync(new ArraySegment<byte>(buffer), CancellationToken.None);
    }
    await webSocket.CloseAsync(result.CloseStatus.Value, result.CloseStatusDescription,
CancellationToken.None);
}

```

When accepting the WebSocket connection before beginning the loop, the middleware pipeline ends. Upon closing the socket, the pipeline unwinds. That is, the request stops moving forward in the pipeline when the WebSocket is accepted. When the loop is finished and the socket is closed, the request proceeds back up the pipeline.

## IIS/IIS Express support

Windows Server 2012 or later and Windows 8 or later with IIS/IIS Express 8 or later has support for the WebSocket protocol.

To enable support for the WebSocket protocol on Windows Server 2012 or later:

1. Use the **Add Roles and Features** wizard from the **Manage** menu or the link in **Server Manager**.
2. Select **Role-based or Feature-based Installation**. Select **Next**.
3. Select the appropriate server (the local server is selected by default). Select **Next**.
4. Expand **Web Server (IIS)** in the **Roles** tree, expand **Web Server**, and then expand **Application Development**.
5. Select **WebSocket Protocol**. Select **Next**.
6. If additional features aren't needed, select **Next**.
7. Select **Install**.
8. When the installation completes, select **Close** to exit the wizard.

To enable support for the WebSocket protocol on Windows 8 or later:

1. Navigate to **Control Panel > Programs > Programs and Features > Turn Windows features on or off** (left side of the screen).
2. Open the following nodes: **Internet Information Services > World Wide Web Services > Application Development Features**.
3. Select the **WebSocket Protocol** feature. Select **OK**.

### Disable WebSocket when using socket.io on node.js

If using the WebSocket support in [socket.io](#) on [Node.js](#), disable the default IIS WebSocket module using the `WebSocket` element in `web.config` or `applicationHost.config`. If this step isn't performed, the IIS WebSocket module attempts to handle the WebSocket communication rather than Node.js and the app.

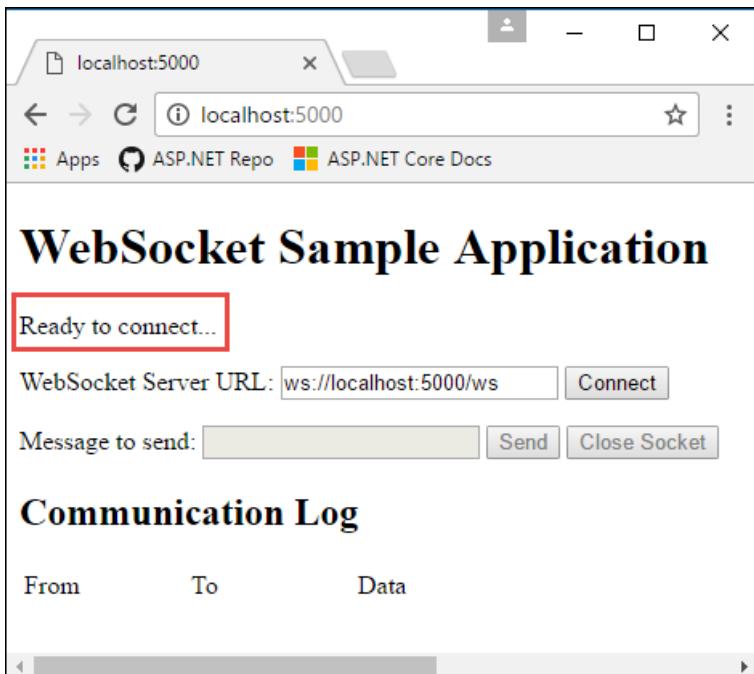
```

<system.webServer>
    <WebSocket enabled="false" />
</system.webServer>

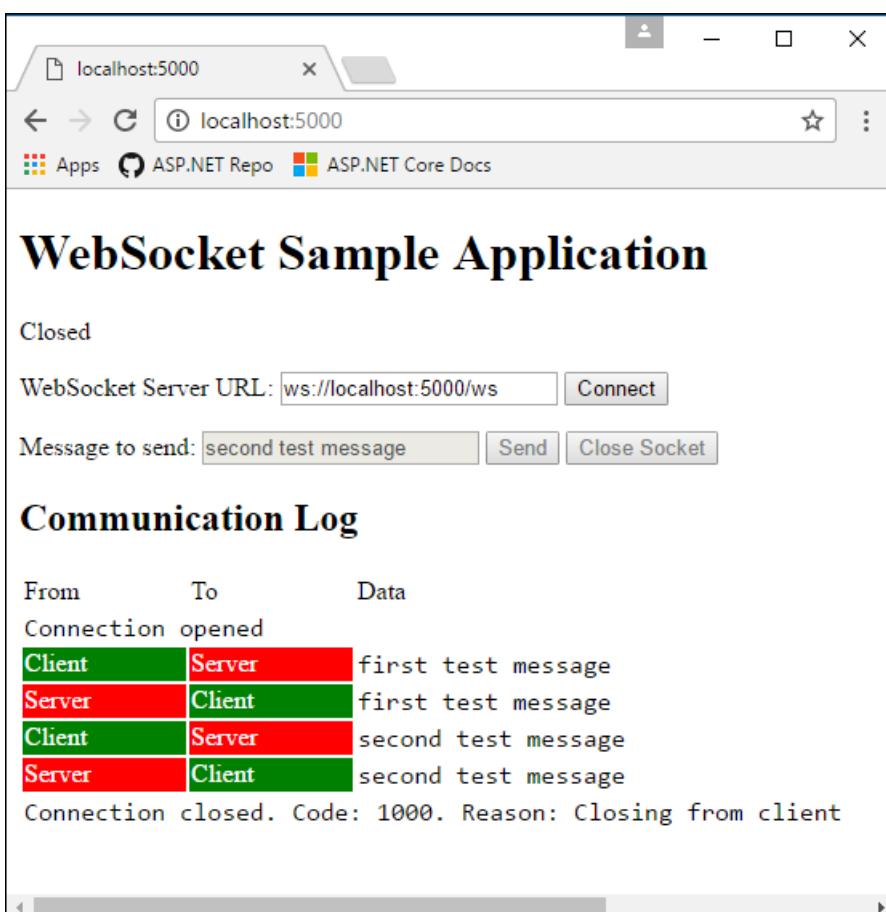
```

## Next steps

The [sample app](#) that accompanies this article is an echo app. It has a web page that makes WebSocket connections, and the server resends any messages it receives back to the client. Run the app from a command prompt (it's not set up to run from Visual Studio with IIS Express) and navigate to <http://localhost:5000>. The web page shows the connection status in the upper left:



Select **Connect** to send a WebSocket request to the URL shown. Enter a test message and select **Send**. When done, select **Close Socket**. The **Communication Log** section reports each open, send, and close action as it happens.



# Microsoft.AspNetCore.App metapackage for ASP.NET Core 2.1

7/10/2018 • 2 minutes to read • [Edit Online](#)

This feature requires ASP.NET Core 2.1 and later targeting .NET Core 2.1 and later.

The [Microsoft.AspNetCore.App metapackage](#) for ASP.NET Core:

- Does not include third-party dependencies except for [Json.NET](#), [Remotion.Linq](#), and [IX-Async](#). These 3rd-party dependencies are deemed necessary to ensure the major frameworks features function.
- Includes all supported packages by the ASP.NET Core team except those that contain third-party dependencies (other than those previously mentioned).
- Includes all supported packages by the Entity Framework Core team except those that contain third-party dependencies (other than those previously mentioned).

All the features of ASP.NET Core 2.1 and later and Entity Framework Core 2.1 and later are included in the `Microsoft.AspNetCore.App` package. The default project templates targeting ASP.NET Core 2.1 and later use this package. We recommend applications targeting ASP.NET Core 2.1 and later and Entity Framework Core 2.1 and later use the `Microsoft.AspNetCore.App` package.

The version number of the `Microsoft.AspNetCore.App` metapackage represents the ASP.NET Core version and Entity Framework Core version.

Using the `Microsoft.AspNetCore.App` metapackage provides version restrictions that protect your app:

- If a package is included that has a transitive (not direct) dependency on a package in `Microsoft.AspNetCore.App`, and those version numbers differ, NuGet will generate an error.
- Other packages added to your app cannot change the version of packages included in `Microsoft.AspNetCore.App`.
- Version consistency ensures a reliable experience. `Microsoft.AspNetCore.App` was designed to prevent untested version combinations of related bits being used together in the same app.

Applications that use the `Microsoft.AspNetCore.App` metapackage automatically take advantage of the ASP.NET Core shared framework. When you use the `Microsoft.AspNetCore.App` metapackage, **no** assets from the referenced ASP.NET Core NuGet packages are deployed with the application—the ASP.NET Core shared framework contains these assets. The assets in the shared framework are precompiled to improve application startup time. For more information, see "shared framework" in [.NET Core distribution packaging](#).

The following project file references the `Microsoft.AspNetCore.App` metapackage for ASP.NET Core and represents a typical ASP.NET Core 2.1 template:

```
<Project Sdk="Microsoft.NET.Sdk.Web">

<PropertyGroup>
  <TargetFramework>netcoreapp2.1</TargetFramework>
</PropertyGroup>

<ItemGroup>
  <PackageReference Include="Microsoft.AspNetCore.App" Version="2.1.1" />
</ItemGroup>

</Project>
```

The version number on the `Microsoft.AspNetCore.App` reference does **not** guarantee that version of the shared framework will be used. For example, suppose version `2.1.1` is specified, but `2.1.3` is installed. In that case, the app uses `2.1.3`. Although not recommended, you can disable roll-forward behavior (patch and/or minor). For more information on package version roll-forward behavior, see [dotnet host roll forward](#).

The `Microsoft.AspNetCore.App` [metapackage](#) isn't a traditional package that's updated from NuGet. Similar to `Microsoft.NETCore.App`, `Microsoft.AspNetCore.App` represents a shared runtime, which has special versioning semantics handled outside of NuGet. For more information, see [Packages, metapackages and frameworks](#).

If your application previously used `Microsoft.AspNetCore.All`, see [Migrating from Microsoft.AspNetCore.All to Microsoft.AspNetCore.App](#).

# Microsoft.AspNetCore.All metapackage for ASP.NET Core 2.0

6/21/2018 • 2 minutes to read • [Edit Online](#)

## NOTE

We recommend applications targeting ASP.NET Core 2.1 and later use the [Microsoft.AspNetCore.App](#) rather than this package. See [Migrating from Microsoft.AspNetCore.All to Microsoft.AspNetCore.App](#) in this article.

This feature requires ASP.NET Core 2.x targeting .NET Core 2.x.

The [Microsoft.AspNetCore.All](#) metapackage for ASP.NET Core includes:

- All supported packages by the ASP.NET Core team.
- All supported packages by the Entity Framework Core.
- Internal and 3rd-party dependencies used by ASP.NET Core and Entity Framework Core.

All the features of ASP.NET Core 2.x and Entity Framework Core 2.x are included in the [Microsoft.AspNetCore.All](#) package. The default project templates targeting ASP.NET Core 2.0 use this package.

The version number of the [Microsoft.AspNetCore.All](#) metapackage represents the ASP.NET Core version and Entity Framework Core version.

Applications that use the [Microsoft.AspNetCore.All](#) metapackage automatically take advantage of the [.NET Core Runtime Store](#). The Runtime Store contains all the runtime assets needed to run ASP.NET Core 2.x applications. When you use the [Microsoft.AspNetCore.All](#) metapackage, **no** assets from the referenced ASP.NET Core NuGet packages are deployed with the application — the .NET Core Runtime Store contains these assets. The assets in the Runtime Store are precompiled to improve application startup time.

You can use the package trimming process to remove packages that you don't use. Trimmed packages are excluded in published application output.

The following `.csproj` file references the [Microsoft.AspNetCore.All](#) metapackage for ASP.NET Core:

```
<Project Sdk="Microsoft.NET.Sdk.Web">
  <PropertyGroup>
    <TargetFramework>netcoreapp2.0</TargetFramework>
  </PropertyGroup>
  <ItemGroup>
    <PackageReference Include="Microsoft.AspNetCore.All" Version="2.0.0" />
  </ItemGroup>
</Project>
```

## Migrating from Microsoft.AspNetCore.All to Microsoft.AspNetCore.App

The following packages are included in [Microsoft.AspNetCore.All](#) but not the [Microsoft.AspNetCore.App](#) package.

- [Microsoft.AspNetCore.ApplicationInsights.HostingStartup](#)

- `Microsoft.AspNetCore.AzureAppServices.HostingStartup`
- `Microsoft.AspNetCore.AzureAppServicesIntegration`
- `Microsoft.AspNetCore.DataProtection.AzureKeyVault`
- `Microsoft.AspNetCore.DataProtection.AzureStorage`
- `Microsoft.AspNetCore.Server.Kestrel.Transport.Libuv`
- `Microsoft.AspNetCore.SignalR.Redis`
- `Microsoft.Data.Sqlite`
- `Microsoft.Data.Sqlite.Core`
- `Microsoft.EntityFrameworkCore.Sqlite`
- `Microsoft.EntityFrameworkCore.Sqlite.Core`
- `Microsoft.Extensions.Caching.Redis`
- `Microsoft.Extensions.Configuration.AzureKeyVault`
- `Microsoft.Extensions.Logging.AzureAppServices`
- `Microsoft.VisualStudio.Web.BrowserLink`

To move from `Microsoft.AspNetCore.All` to `Microsoft.AspNetCore.App`, if your app uses any APIs from the above packages, or packages brought in by those packages, add references to those packages in your project.

Any dependencies of the preceding packages that otherwise aren't dependencies of `Microsoft.AspNetCore.App` are not included implicitly. For example:

- `StackExchange.Redis` as a dependency of `Microsoft.Extensions.Caching.Redis`
- `Microsoft.ApplicationInsights` as a dependency of `Microsoft.AspNetCore.ApplicationInsights.HostingStartup`

# Choose between ASP.NET and ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

No matter the web app you're creating, ASP.NET has a solution for you: from enterprise web apps targeting Windows Server, to small microservices targeting Linux containers, and everything in between.

## ASP.NET Core

ASP.NET Core is an open-source, cross-platform framework for building modern, cloud-based web apps on Windows, macOS, or Linux.

## ASP.NET

ASP.NET is a mature framework that provides all the services needed to build enterprise-grade, server-based web apps on Windows.

## Framework selection

Review the table below to determine which framework is most appropriate for your needs.

ASP.NET CORE	ASP.NET
Build for Windows, macOS, or Linux	Build for Windows
<a href="#">Razor Pages</a> is the recommended approach to create a Web UI as of ASP.NET Core 2.x. See also <a href="#">MVC</a> , <a href="#">Web API</a> , and <a href="#">SignalR</a> .	Use <a href="#">Web Forms</a> , <a href="#">SignalR</a> , <a href="#">MVC</a> , <a href="#">Web API</a> , <a href="#">WebHooks</a> , or <a href="#">Web Pages</a>
Multiple versions per machine	One version per machine
Develop with Visual Studio, <a href="#">Visual Studio for Mac</a> , or <a href="#">Visual Studio Code</a> using C# or F#	Develop with Visual Studio using C#, VB, or F#
Higher performance than ASP.NET	Good performance
<a href="#">Choose .NET Framework or .NET Core runtime</a>	Use .NET Framework runtime

## ASP.NET Core scenarios

- [Razor Pages](#) is the recommended approach to create a Web UI as of ASP.NET Core 2.x.
- [Websites](#)
- [APIs](#)
- [Real-time](#)

## ASP.NET scenarios

- [Websites](#)
- [APIs](#)
- [Real-time](#)

## Resources

- [Introduction to ASP.NET](#)
- [Introduction to ASP.NET Core](#)

# Introduction to Razor Pages in ASP.NET Core

7/6/2018 • 20 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Ryan Nowak](#)

Razor Pages is a new aspect of ASP.NET Core MVC that makes coding page-focused scenarios easier and more productive.

If you're looking for a tutorial that uses the Model-View-Controller approach, see [Get started with ASP.NET Core MVC](#).

This document provides an introduction to Razor Pages. It's not a step by step tutorial. If you find some of the sections too advanced, see [Get started with Razor Pages](#). For an overview of ASP.NET Core, see the [Introduction to ASP.NET Core](#).

## Prerequisites

Install **one** of the following:

- CLI tooling: Windows, Linux, or macOS: [.NET Core SDK 2.0 or later](#)
- IDE/editor tooling
  - Windows: [Visual Studio for Windows](#)
    - **ASP.NET and web development** workload
    - **.NET Core cross-platform development** workload
  - Linux: [Visual Studio Code](#)
  - macOS: [Visual Studio for Mac](#)

## Creating a Razor Pages project

- [Visual Studio](#)
- [Visual Studio for Mac](#)
- [Visual Studio Code](#)
- [.NET Core CLI](#)

See [Get started with Razor Pages](#) for detailed instructions on how to create a Razor Pages project using Visual Studio.

## Razor Pages

Razor Pages is enabled in *Startup.cs*:

```

public class Startup
{
    public void ConfigureServices(IServiceCollection services)
    {
        // Includes support for Razor Pages and controllers.
        services.AddMvc();
    }

    public void Configure(IApplicationBuilder app)
    {
        app.UseMvc();
    }
}

```

Consider a basic page:

```

@page

<h1>Hello, world!</h1>
<h2>The time on the server is @DateTime.Now</h2>

```

The preceding code looks a lot like a Razor view file. What makes it different is the `@page` directive. `@page` makes the file into an MVC action - which means that it handles requests directly, without going through a controller. `@page` must be the first Razor directive on a page. `@page` affects the behavior of other Razor constructs.

A similar page, using a `PageModel` class, is shown in the following two files. The *Pages/Index2.cshtml* file:

```

@page
@using RazorPagesIntro.Pages
@model IndexModel2

<h2>Separate page model</h2>
<p>
    @Model.Message
</p>

```

The *Pages/Index2.cshtml.cs* page model:

```

using Microsoft.AspNetCore.Mvc.RazorPages;
using System;

namespace RazorPagesIntro.Pages
{
    public class IndexModel2 : PageModel
    {
        public string Message { get; private set; } = "PageModel in C#";

        public void OnGet()
        {
            Message += $" Server time is { DateTime.Now }";
        }
    }
}

```

By convention, the `PageModel` class file has the same name as the Razor Page file with `.cs` appended. For example, the previous Razor Page is *Pages/Index2.cshtml*. The file containing the `PageModel` class is named *Pages/Index2.cshtml.cs*.

The associations of URL paths to pages are determined by the page's location in the file system. The following table shows a Razor Page path and the matching URL:

FILE NAME AND PATH	MATCHING URL
/Pages/Index.cshtml	/ or /Index
/Pages/Contact.cshtml	/Contact
/Pages/Store/Contact.cshtml	/Store/Contact
/Pages/Store/Index.cshtml	/Store or /Store/Index

Notes:

- The runtime looks for Razor Pages files in the *Pages* folder by default.
- `Index` is the default page when a URL doesn't include a page.

## Writing a basic form

Razor Pages is designed to make common patterns used with web browsers easy to implement when building an app. [Model binding](#), [Tag Helpers](#), and HTML helpers all *just work* with the properties defined in a Razor Page class. Consider a page that implements a basic "contact us" form for the `Contact` model:

For the samples in this document, the `DbContext` is initialized in the [Startup.cs](#) file.

```
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using RazorPagesContacts.Data;

namespace RazorPagesContacts
{
    public class Startup
    {
        public IHostingEnvironment HostingEnvironment { get; }

        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<AppDbContext>(options =>
                options.UseInMemoryDatabase("name"));
            services.AddMvc();
        }

        public void Configure(IApplicationBuilder app)
        {
            app.UseMvc();
        }
    }
}
```

The data model:

```

using System.ComponentModel.DataAnnotations;

namespace RazorPagesContacts.Data
{
    public class Customer
    {
        public int Id { get; set; }

        [Required, StringLength(100)]
        public string Name { get; set; }
    }
}

```

The db context:

```

using Microsoft.EntityFrameworkCore;

namespace RazorPagesContacts.Data
{
    public class AppDbContext : DbContext
    {
        public AppDbContext(DbContextOptions options)
            : base(options)
        {
        }

        public DbSet<Customer> Customers { get; set; }
    }
}

```

The *Pages/Create.cshtml* view file:

```

@page
@model RazorPagesContacts.Pages.CreateModel
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers

<html>
<body>
    <p>
        Enter your name.
    </p>
    <div asp-validation-summary="All"></div>
    <form method="POST">
        <div>Name: <input asp-for="Customer.Name" /></div>
        <input type="submit" />
    </form>
</body>
</html>

```

The *Pages/Create.cshtml.cs* page model:

```

using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using RazorPagesContacts.Data;

namespace RazorPagesContacts.Pages
{
    public class CreateModel : PageModel
    {
        private readonly ApplicationDbContext _db;

        public CreateModel(ApplicationDbContext db)
        {
            _db = db;
        }

        [BindProperty]
        public Customer Customer { get; set; }

        public async Task<IActionResult> OnPostAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            _db.Customers.Add(Customer);
            await _db.SaveChangesAsync();
            return RedirectToPage("/Index");
        }
    }
}

```

By convention, the `PageModel` class is called `<PageName>Model` and is in the same namespace as the page.

The `PageModel` class allows separation of the logic of a page from its presentation. It defines page handlers for requests sent to the page and the data used to render the page. This separation allows you to manage page dependencies through [dependency injection](#) and to [unit test](#) the pages.

The page has an `OnPostAsync` *handler method*, which runs on `POST` requests (when a user posts the form). You can add handler methods for any HTTP verb. The most common handlers are:

- `OnGet` to initialize state needed for the page. [OnGet](#) sample.
- `OnPost` to handle form submissions.

The `Async` naming suffix is optional but is often used by convention for asynchronous functions. The `OnPostAsync` code in the preceding example looks similar to what you would normally write in a controller. The preceding code is typical for Razor Pages. Most of the MVC primitives like [model binding](#), [validation](#), and action results are shared.

The previous `OnPostAsync` method:

```

public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    _db.Customers.Add(Customer);
    await _db.SaveChangesAsync();
    return RedirectToPage("/Index");
}

```

The basic flow of `OnPostAsync`:

Check for validation errors.

- If there are no errors, save the data and redirect.
- If there are errors, show the page again with validation messages. Client-side validation is identical to traditional ASP.NET Core MVC applications. In many cases, validation errors would be detected on the client, and never submitted to the server.

When the data is entered successfully, the `OnPostAsync` handler method calls the `RedirectToPage` helper method to return an instance of `RedirectToPageResult`. `RedirectToPage` is a new action result, similar to `RedirectToAction` or `RedirectToRoute`, but customized for pages. In the preceding sample, it redirects to the root Index page (`/Index`). `RedirectToPage` is detailed in the [URL generation for Pages](#) section.

When the submitted form has validation errors (that are passed to the server), the `OnPostAsync` handler method calls the `Page` helper method. `Page` returns an instance of `PageResult`. Returning `Page` is similar to how actions in controllers return `View`. `PageResult` is the default return type for a handler method. A handler method that returns `void` renders the page.

The `Customer` property uses `[BindProperty]` attribute to opt in to model binding.

```

public class CreateModel : PageModel
{
    private readonly AppDbContext _db;

    public CreateModel(AppDbContext db)
    {
        _db = db;
    }

    [BindProperty]
    public Customer Customer { get; set; }

    public async Task<IActionResult> OnPostAsync()
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        _db.Customers.Add(Customer);
        await _db.SaveChangesAsync();
        return RedirectToPage("/Index");
    }
}

```

Razor Pages, by default, bind properties only with non-GET verbs. Binding to properties can reduce the amount of code you have to write. Binding reduces code by using the same property to render form fields (

```
<input asp-for="Customer.Name" />) and accept the input.
```

#### NOTE

For security reasons, you must opt in to binding GET request data to page model properties. Verify user input before mapping it to properties. Opting in to this behavior is useful when addressing scenarios which rely on query string or route values.

To bind a property on GET requests, set the `[BindProperty]` attribute's `SupportsGet` property to `true`:

```
[BindProperty(SupportsGet = true)]
```

The home page (*Index.cshtml*):

```
@page
@model RazorPagesContacts.Pages.IndexModel
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers

<h1>Contacts</h1>
<form method="post">
    <table class="table">
        <thead>
            <tr>
                <th>ID</th>
                <th>Name</th>
            </tr>
        </thead>
        <tbody>
            @foreach (var contact in Model.Customers)
            {
                <tr>
                    <td>@contact.Id</td>
                    <td>@contact.Name</td>
                    <td>
                        <a asp-page=".Edit" asp-route-id="@contact.Id">edit</a>
                        <button type="submit" asp-page-handler="delete"
                                asp-route-id="@contact.Id">delete</button>
                    </td>
                </tr>
            }
        </tbody>
    </table>

    <a asp-page=".Create">Create</a>
</form>
```

The associated `PageModel` class (*Index.cshtml.cs*):

```

using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using RazorPagesContacts.Data;
using System.Collections.Generic;
using Microsoft.EntityFrameworkCore;

namespace RazorPagesContacts.Pages
{
    public class IndexModel : PageModel
    {
        private readonly AppDbContext _db;

        public IndexModel(AppDbContext db)
        {
            _db = db;
        }

        public IList<Customer> Customers { get; private set; }

        public async Task OnGetAsync()
        {
            Customers = await _db.Customers.AsNoTracking().ToListAsync();
        }

        public async Task<IActionResult> OnPostDeleteAsync(int id)
        {
            var contact = await _db.Customers.FindAsync(id);

            if (contact != null)
            {
                _db.Customers.Remove(contact);
                await _db.SaveChangesAsync();
            }

            return RedirectToPage();
        }
    }
}

```

The *Index.cshtml* file contains the following markup to create an edit link for each contact:

```
<a asp-page="./Edit" asp-route-id="@contact.Id">edit</a>
```

The [Anchor Tag Helper](#) used the `asp-route-{value}` attribute to generate a link to the Edit page. The link contains route data with the contact ID. For example, `http://localhost:5000/Edit/1`.

The *Pages/Edit.cshtml* file:

```

@page "{id:int}"
@model RazorPagesContacts.Pages.EditModel
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers

 @{
     ViewData["Title"] = "Edit Customer";
 }

<h1>Edit Customer - @Model.Customer.Id</h1>
<form method="post">
    <div asp-validation-summary="All"></div>
    <input asp-for="Customer.Id" type="hidden" />
    <div>
        <label asp-for="Customer.Name"></label>
        <div>
            <input asp-for="Customer.Name" />
            <span asp-validation-for="Customer.Name" ></span>
        </div>
    </div>

    <div>
        <button type="submit">Save</button>
    </div>
</form>

```

The first line contains the `@page "{id:int}"` directive. The routing constraint `{id:int}` tells the page to accept requests to the page that contain `int` route data. If a request to the page doesn't contain route data that can be converted to an `int`, the runtime returns an HTTP 404 (not found) error. To make the ID optional, append `?` to the route constraint:

```

@page "{id:int?}"

```

The *Pages/Edit.cshtml.cs* file:

```

using System;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using RazorPagesContacts.Data;

namespace RazorPagesContacts.Pages
{
    public class EditModel : PageModel
    {
        private readonly ApplicationDbContext _db;

        public EditModel(ApplicationDbContext db)
        {
            _db = db;
        }

        [BindProperty]
        public Customer Customer { get; set; }

        public async Task<IActionResult> OnGetAsync(int id)
        {
            Customer = await _db.Customers.FindAsync(id);

            if (Customer == null)
            {
                return RedirectToPage("/Index");
            }

            return Page();
        }

        public async Task<IActionResult> OnPostAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            _db.Attach(Customer).State = EntityState.Modified;

            try
            {
                await _db.SaveChangesAsync();
            }
            catch (DbUpdateConcurrencyException)
            {
                throw new Exception($"Customer {Customer.Id} not found!");
            }

            return RedirectToPage("/Index");
        }
    }
}

```

The *Index.cshtml* file also contains markup to create a delete button for each customer contact:

```

<button type="submit" asp-page-handler="delete"
        asp-route-id="@contact.Id">Delete</button>

```

When the delete button is rendered in HTML, its `formaction` includes parameters for:

- The customer contact ID specified by the `asp-route-id` attribute.

- The `handler` specified by the `asp-page-handler` attribute.

Here is an example of a rendered delete button with a customer contact ID of `1`:

```
<button type="submit" formaction="/?id=1&handler=delete">delete</button>
```

When the button is selected, a form `POST` request is sent to the server. By convention, the name of the handler method is selected based the value of the `handler` parameter according to the scheme `OnPost[handler]Async`.

Because the `handler` is `delete` in this example, the `OnPostDeleteAsync` handler method is used to process the `POST` request. If the `asp-page-handler` is set to a different value, such as `remove`, a page handler method with the name `OnPostRemoveAsync` is selected.

```
public async Task<IActionResult> OnPostDeleteAsync(int id)
{
    var contact = await _db.Customers.FindAsync(id);

    if (contact != null)
    {
        _db.Customers.Remove(contact);
        await _db.SaveChangesAsync();
    }

    return RedirectToPage();
}
```

The `OnPostDeleteAsync` method:

- Accepts the `id` from the query string.
- Queries the database for the customer contact with `FindAsync`.
- If the customer contact is found, they're removed from the list of customer contacts. The database is updated.
- Calls `RedirectToPage` to redirect to the root Index page (`/Index`).

## Mark page properties required

Properties on a `PageModel` can be decorated with the `Required` attribute:

```

using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using System.ComponentModel.DataAnnotations;

namespace RazorPagesMovie.Pages.Movies
{
    public class CreateModel : PageModel
    {
        public IActionResult OnGet()
        {
            return Page();
        }

        [BindProperty]
        [Required(ErrorMessage = "Color is required")]
        public string Color { get; set; }

        public IActionResult OnPostAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            // Process color.

            return RedirectToPage("./Index");
        }
    }
}

```

See [Model validation](#) for more information.

## Manage HEAD requests with the OnGet handler

Ordinarily, a HEAD handler is created and called for HEAD requests:

```

public void OnHead()
{
    HttpContext.Response.Headers.Add("HandledBy", "Handled by OnHead!");
}

```

If no HEAD handler (`OnHead`) is defined, Razor Pages falls back to calling the GET page handler (`OnGet`) in ASP.NET Core 2.1 or later. Opt in to this behavior with the [SetCompatibilityVersion method](#) in `Startup.Configure` for ASP.NET Core 2.1 to 2.x:

```

services.AddMvc()
    .SetCompatibilityVersion(Microsoft.AspNetCore.Mvc.CompatibilityVersion.Version_2_1);

```

`SetCompatibilityVersion` effectively sets the Razor Pages option `AllowMappingHeadRequestsToGetHandler` to `true`.

Rather than opting into all 2.1 behaviors with `SetCompatibilityVersion`, you can explicitly opt-in to specific behaviors. The following code opts into the mapping HEAD requests to the GET handler.

```
services.AddMvc()
    .AddRazorPagesOptions(options =>
{
    options.AllowMappingHeadRequestsToGetHandler = true;
});
```

## XSRF/CSRF and Razor Pages

You don't have to write any code for [antiforgery validation](#). Antiforgery token generation and validation are automatically included in Razor Pages.

## Using Layouts, partials, templates, and Tag Helpers with Razor Pages

Pages work with all the capabilities of the Razor view engine. Layouts, partials, templates, Tag Helpers, `_ViewStart.cshtml`, `_ViewImports.cshtml` work in the same way they do for conventional Razor views.

Let's declutter this page by taking advantage of some of those capabilities.

Add a [layout page](#) to `Pages/Shared/_Layout.cshtml`:

Add a [layout page](#) to `Pages/_Layout.cshtml`:

```
<!DOCTYPE html>
<html>
<head>
    <title>Razor Pages Sample</title>
</head>
<body>
    <a asp-page="/Index">Home</a>
    @RenderBody()
    <a asp-page="/Customers/Create">Create</a> <br />
</body>
</html>
```

The [Layout](#):

- Controls the layout of each page (unless the page opts out of layout).
- Imports HTML structures such as JavaScript and stylesheets.

See [layout page](#) for more information.

The [Layout](#) property is set in `Pages/_ViewStart.cshtml`:

```
@{
    Layout = "_Layout";
}
```

The layout is in the `Pages/Shared` folder. Pages look for other views (layouts, templates, partials) hierarchically, starting in the same folder as the current page. A layout in the `Pages/Shared` folder can be used from any Razor page under the `Pages` folder.

The layout file should go in the `Pages/Shared` folder.

The layout is in the `Pages` folder. Pages look for other views (layouts, templates, partials) hierarchically, starting in the same folder as the current page. A layout in the `Pages` folder can be used from any Razor page under the `Pages` folder.

We recommend you **not** put the layout file in the *Views/Shared* folder. *Views/Shared* is an MVC views pattern. Razor Pages are meant to rely on folder hierarchy, not path conventions.

View search from a Razor Page includes the *Pages* folder. The layouts, templates, and partials you're using with MVC controllers and conventional Razor views *just work*.

Add a *Pages/\_ViewImports.cshtml* file:

```
@namespace RazorPagesContacts.Pages  
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers
```

`@namespace` is explained later in the tutorial. The `@addTagHelper` directive brings in the [built-in Tag Helpers](#) to all the pages in the *Pages* folder.

When the `@namespace` directive is used explicitly on a page:

```
@page  
@namespace RazorPagesIntro.Pages.Customers  
  
@model NameSpaceModel  
  
<h2>Name space</h2>  
<p>  
    @Model.Message  
</p>
```

The directive sets the namespace for the page. The `@model` directive doesn't need to include the namespace.

When the `@namespace` directive is contained in *\_ViewImports.cshtml*, the specified namespace supplies the prefix for the generated namespace in the Page that imports the `@namespace` directive. The rest of the generated namespace (the suffix portion) is the dot-separated relative path between the folder containing *\_ViewImports.cshtml* and the folder containing the page.

For example, the `PageModel` class *Pages/Customers/Edit.cshtml.cs* explicitly sets the namespace:

```
namespace RazorPagesContacts.Pages  
{  
    public class EditModel : PageModel  
    {  
        private readonly AppDbContext _db;  
  
        public EditModel(AppDbContext db)  
        {  
            _db = db;  
        }  
  
        // Code removed for brevity.
```

The *Pages/\_ViewImports.cshtml* file sets the following namespace:

```
@namespace RazorPagesContacts.Pages  
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers
```

The generated namespace for the *Pages/Customers/Edit.cshtml* Razor Page is the same as the `PageModel` class.

`@namespace` also works with conventional Razor views.

The original *Pages/Create.cshtml* view file:

```
@page
@model RazorPagesContacts.Pages.CreateModel
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers

<html>
<body>
    <p>
        Enter your name.
    </p>
    <div asp-validation-summary="All"></div>
    <form method="POST">
        <div>Name: <input asp-for="Customer.Name" /></div>
        <input type="submit" />
    </form>
</body>
</html>
```

The updated *Pages/Create.cshtml* view file:

```
@page
@model CreateModel

<html>
<body>
    <p>
        Enter your name.
    </p>
    <div asp-validation-summary="All"></div>
    <form method="POST">
        <div>Name: <input asp-for="Customer.Name" /></div>
        <input type="submit" />
    </form>
</body>
</html>
```

The [Razor Pages starter project](#) contains the *Pages/\_ValidationScriptsPartial.cshtml*, which hooks up client-side validation.

## URL generation for Pages

The `Create` page, shown previously, uses `RedirectToPage`:

```
public async Task<IActionResult> OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    _db.Customers.Add(Customer);
    await _db.SaveChangesAsync();
    return RedirectToPage("/Index");
}
```

The app has the following file/folder structure:

- `/Pages`
  - `Index.cshtml`

- `/Customers`
  - `Create.cshtml`
  - `Edit.cshtml`
  - `Index.cshtml`

The `Pages/Customers/Create.cshtml` and `Pages/Customers/Edit.cshtml` pages redirect to `Pages/Index.cshtml` after success. The string `/Index` is part of the URI to access the preceding page. The string `/Index` can be used to generate URLs to the `Pages/Index.cshtml` page. For example:

- `Url.Page("/Index", ...)`
- `<a asp-page="/Index">My Index Page</a>`
- `RedirectToPage("/Index")`

The page name is the path to the page from the root `Pages` folder including a leading `/` (for example, `/Index`). The preceding URL generation samples offer enhanced options and functional capabilities over hardcoding a URL. URL generation uses [routing](#) and can generate and encode parameters according to how the route is defined in the destination path.

URL generation for pages supports relative names. The following table shows which Index page is selected with different `RedirectToPage` parameters from `Pages/Customers/Create.cshtml`:

REDIRECTTOPAGE(X)	PAGE
<code>RedirectToPage("/Index")</code>	<code>Pages/Index</code>
<code>RedirectToPage("./Index");</code>	<code>Pages/Customers/Index</code>
<code>RedirectToPage("../Index")</code>	<code>Pages/Index</code>
<code>RedirectToPage("Index")</code>	<code>Pages/Customers/Index</code>

`RedirectToPage("Index")`, `RedirectToPage("./Index")`, and `RedirectToPage("../Index")` are *relative names*. The `RedirectToPage` parameter is *combined* with the path of the current page to compute the name of the destination page.

Relative name linking is useful when building sites with a complex structure. If you use relative names to link between pages in a folder, you can rename that folder. All the links still work (because they didn't include the folder name).

## ViewData attribute

Data can be passed to a page with [ViewDataAttribute](#). Properties on controllers or Razor Page models decorated with `[ViewData]` have their values stored and loaded from the [ViewDataDictionary](#).

In the following example, the `AboutModel` contains a `Title` property decorated with `[ViewData]`. The `Title` property is set to the title of the About page:

```
public class AboutModel : PageModel
{
    [ViewData]
    public string Title { get; } = "About";

    public void OnGet()
    {
    }
}
```

In the About page, access the `Title` property as a model property:

```
<h1>@Model.Title</h1>
```

In the layout, the title is read from the ViewData dictionary:

```
<!DOCTYPE html>
<html lang="en">
<head>
<title>@ViewData["Title"] - WebApplication</title>
...
```

## TempData

ASP.NET Core exposes the `TempData` property on a `controller`. This property stores data until it's read. The `Keep` and `Peek` methods can be used to examine the data without deletion. `TempData` is useful for redirection, when data is needed for more than a single request.

The `[TempData]` attribute is new in ASP.NET Core 2.0 and is supported on controllers and pages.

The following code sets the value of `Message` using `TempData`:

```
public class CreateDotModel : PageModel
{
    private readonly AppDbContext _db;

    public CreateDotModel(AppDbContext db)
    {
        _db = db;
    }

    [TempData]
    public string Message { get; set; }

    [BindProperty]
    public Customer Customer { get; set; }

    public async Task<IActionResult> OnPostAsync()
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        _db.Customers.Add(Customer);
        await _db.SaveChangesAsync();
        Message = $"Customer {Customer.Name} added";
        return RedirectToPage("./Index");
    }
}
```

The following markup in the `Pages/Customers/Index.cshtml` file displays the value of `Message` using `TempData`.

```
<h3>Msg: @Model.Message</h3>
```

The `Pages/Customers/Index.cshtml.cs` page model applies the `[TempData]` attribute to the `Message` property.

```
[TempData]
public string Message { get; set; }
```

See [TempData](#) for more information.

## Multiple handlers per page

The following page generates markup for two page handlers using the `asp-page-handler` Tag Helper:

```
@page
@model CreateFATHModel

<html>
<body>
    <p>
        Enter your name.
    </p>
    <div asp-validation-summary="All"></div>
    <form method="POST">
        <div>Name: <input asp-for="Customer.Name" /></div>
        <input type="submit" asp-page-handler="JoinList" value="Join" />
        <input type="submit" asp-page-handler="JoinListUC" value="JOIN UC" />
    </form>
</body>
</html>
```

The form in the preceding example has two submit buttons, each using the `FormActionTagHelper` to submit to a different URL. The `asp-page-handler` attribute is a companion to `asp-page`. `asp-page-handler` generates URLs that submit to each of the handler methods defined by a page. `asp-page` isn't specified because the sample is linking to the current page.

The page model:

```

using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using RazorPagesContacts.Data;

namespace RazorPagesContacts.Pages.Customers
{
    public class CreateFATHModel : PageModel
    {
        private readonly ApplicationDbContext _db;

        public CreateFATHModel(ApplicationDbContext db)
        {
            _db = db;
        }

        [BindProperty]
        public Customer Customer { get; set; }

        public async Task<IActionResult> OnPostJoinListAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }

            _db.Customers.Add(Customer);
            await _db.SaveChangesAsync();
            return RedirectToPage("/Index");
        }

        public async Task<IActionResult> OnPostJoinListUCAsync()
        {
            if (!ModelState.IsValid)
            {
                return Page();
            }
            Customer.Name = Customer.Name?.ToUpper();
            return await OnPostJoinListAsync();
        }
    }
}

```

The preceding code uses *named handler methods*. Named handler methods are created by taking the text in the name after `On<HTTP Verb>` and before `Async` (if present). In the preceding example, the page methods are `OnPostJoinListAsync` and `OnPostJoinListUCAsync`. With `OnPost` and `Async` removed, the handler names are `JoinList` and `JoinListUC`.

```

<input type="submit" asp-page-handler="JoinList" value="Join" />
<input type="submit" asp-page-handler="JoinListUC" value="JOIN UC" />

```

Using the preceding code, the URL path that submits to `OnPostJoinListAsync` is `http://localhost:5000/Customers/CreateFATH?handler=JoinList`. The URL path that submits to `OnPostJoinListUCAsync` is `http://localhost:5000/Customers/CreateFATH?handler=JoinListUC`.

## Custom routes

Use the `@page` directive to:

- Specify a custom route to a page. For example, the route to the About page can be set to `/Some/Other/Path` with `@page "/Some/Other/Path"`.

- Append segments to a page's default route. For example, an "item" segment can be added to a page's default route with `@page "item"`.
- Append parameters to a page's default route. For example, an ID parameter, `id`, can be required for a page with `@page "{id}"`.

A root-relative path designated by a tilde (`~`) at the beginning of the path is supported. For example, `@page "~/Some/Other/Path"` is the same as `@page "/Some/Other/Path"`.

You can change the query string `?handler=JoinList` in the URL to a route segment `/JoinList` by specifying the route template `@page "{handler?}"`.

If you don't like the query string `?handler=JoinList` in the URL, you can change the route to put the handler name in the path portion of the URL. You can customize the route by adding a route template enclosed in double quotes after the `@page` directive.

```
@page "{handler?}"
@model CreateRouteModel

<html>
<body>
    <p>
        Enter your name.
    </p>
    <div asp-validation-summary="All"></div>
    <form method="POST">
        <div>Name: <input asp-for="Customer.Name" /></div>
        <input type="submit" asp-page-handler="JoinList" value="Join" />
        <input type="submit" asp-page-handler="JoinListUC" value="JOIN UC" />
    </form>
</body>
</html>
```

Using the preceding code, the URL path that submits to `OnPostJoinListAsync` is `http://localhost:5000/Customers/CreateFATH/JoinList`. The URL path that submits to `OnPostJoinListUCAsync` is `http://localhost:5000/Customers/CreateFATH/JoinListUC`.

The `?` following `handler` means the route parameter is optional.

## Configuration and settings

To configure advanced options, use the extension method `AddRazorPagesOptions` on the MVC builder:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc()
        .AddRazorPagesOptions(options =>
    {
        options.RootDirectory = "/MyPages";
        options.Conventions.AuthorizeFolder("/MyPages/Admin");
    });
}
```

Currently you can use the `RazorPagesOptions` to set the root directory for pages, or add application model conventions for pages. We'll enable more extensibility this way in the future.

To precompile views, see [Razor view compilation](#).

[Download or view sample code](#).

See [Get started with Razor Pages](#), which builds on this introduction.

## Specify that Razor Pages are at the content root

By default, Razor Pages are rooted in the `/Pages` directory. Add [WithRazorPagesAtContentRoot](#) to [AddMvc](#) to specify that your Razor Pages are at the content root ([ContentRootPath](#)) of the app:

```
services.AddMvc()
    .AddRazorPagesOptions(options =>
{
    ...
})
    .WithRazorPagesAtContentRoot();
```

## Specify that Razor Pages are at a custom root directory

Add [WithRazorPagesRoot](#) to [AddMvc](#) to specify that your Razor Pages are at a custom root directory in the app (provide a relative path):

```
services.AddMvc()
    .AddRazorPagesOptions(options =>
{
    ...
})
    .WithRazorPagesRoot("/path/to/razor/pages");
```

## See also

- [Introduction to ASP.NET Core](#)
- [Razor syntax](#)
- [Get started with Razor Pages](#)
- [Razor Pages authorization conventions](#)
- [Razor Pages custom route and page model providers](#)
- [Razor Pages unit tests](#)

# Filter methods for Razor Pages in ASP.NET Core

6/28/2018 • 4 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

Razor Page filters [IPageFilter](#) and [IAsyncPageFilter](#) allow Razor Pages to run code before and after a Razor Page handler is run. Razor Page filters are similar to [ASP.NET Core MVC action filters](#), except they can't be applied to individual page handler methods.

Razor Page filters:

- Run code after a handler method has been selected, but before model binding occurs.
- Run code before the handler method executes, after model binding is complete.
- Run code after the handler method executes.
- Can be implemented on a page or globally.
- Cannot be applied to specific page handler methods.

Code can be run before a handler method executes using the page constructor or middleware, but only Razor Page filters have access to [HttpContext](#). Filters have a [FilterContext](#) derived parameter, which provides access to [HttpContext](#). For example, the [Implement a filter attribute](#) sample adds a header to the response, something that can't be done with constructors or middleware.

[View or download sample code \(how to download\)](#)

Razor Page filters provide the following methods, which can be applied globally or at the page level:

- Synchronous methods:
  - [OnPageHandlerSelected](#) : Called after a handler method has been selected, but before model binding occurs.
  - [OnPageHandlerExecuting](#) : Called before the handler method executes, after model binding is complete.
  - [OnPageHandlerExecuted](#) : Called after the handler method executes, before the action result.
- Asynchronous methods:
  - [OnPageHandlerSelectionAsync](#) : Called asynchronously after the handler method has been selected, but before model binding occurs.
  - [OnPageHandlerExecutionAsync](#) : Called asynchronously before the handler method is invoked, after model binding is complete.

## NOTE

Implement **either** the synchronous or the async version of a filter interface, not both. The framework checks first to see if the filter implements the async interface, and if so, it calls that. If not, it calls the synchronous interface's method(s). If both interfaces are implemented, only the async methods are be called. The same rule applies to overrides in pages, implement the synchronous or the async version of the override, not both.

## Implement Razor Page filters globally

The following code implements [IAsyncPageFilter](#):

```

using Microsoft.AspNetCore.Mvc.Filters;
using Microsoft.Extensions.Logging;
using System.Threading.Tasks;

namespace PageFilter.Filters
{
    public class SampleAsyncPageFilter : IAsyncPageFilter
    {
        private readonly ILogger _logger;

        public SampleAsyncPageFilter(ILogger logger)
        {
            _logger = logger;
        }

        public async Task OnPageHandlerSelectionAsync(
            PageHandlerSelectedContext context)
        {
            _logger.LogDebug("Global OnPageHandlerSelectionAsync called.");
            await Task.CompletedTask;
        }

        public async Task OnPageHandlerExecutionAsync(
            PageHandlerExecutingContext context,
            PageHandlerExecutionDelegate next)
        {
            _logger.LogDebug("Global OnPageHandlerExecutionAsync called.");
            await next.Invoke();
        }
    }
}

```

In the preceding code, `ILogger` is not required. It's used in the sample to provide trace information for the application.

The following code enables the `SampleAsyncPageFilter` in the `Startup` class:

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc(options =>
    {
        options.Filters.Add(new SampleAsyncPageFilter(_logger));
    });
}

```

The following code shows the complete `Startup` class:

```

using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.Configuration;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;
using PageFilter.Filters;

namespace PageFilter
{
    public class Startup
    {
        ILogger _logger;
        public Startup	ILoggerFactory loggerFactory, IConfiguration configuration)
        {
            _logger = loggerFactory.CreateLogger<GlobalFiltersLogger>();
            Configuration = configuration;
        }

        public IConfiguration Configuration { get; }

        public void ConfigureServices(IServiceCollection services)
        {
            services.AddMvc(options =>
            {
                options.Filters.Add(new SampleAsyncPageFilter(_logger));
            });
        }

        public void Configure(IApplicationBuilder app, IHostingEnvironment env)
        {
            if (env.IsDevelopment())
            {
                app.UseDeveloperExceptionPage();
            }
            else
            {
                app.UseExceptionHandler("/Error");
                app.UseHsts();
            }

            app.UseHttpsRedirection();
            app.UseStaticFiles();
            app.UseCookiePolicy();

            app.UseMvc();
        }
    }
}

```

The following code calls `AddFolderApplicationModelConvention` to apply the `SampleAsyncPageFilter` to only pages in `/subFolder`:

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc()
        .AddRazorPagesOptions(options =>
    {
        options.Conventions.AddFolderApplicationModelConvention(
            "/subFolder",
            model => model.Filters.Add(new SampleAsyncPageFilter(_logger)));
    });
}

```

The following code implements the synchronous `IPageFilter`:

```

using Microsoft.AspNetCore.Mvc.Filters;
using Microsoft.Extensions.Logging;

namespace PageFilter.Filters
{
    public class SamplePageFilter : IPageFilter
    {
        private readonly ILogger _logger;

        public SamplePageFilter(ILogger logger)
        {
            _logger = logger;
        }

        public void OnPageHandlerSelected(PageHandlerSelectedContext context)
        {
            _logger.LogDebug("Global sync OnPageHandlerSelected called.");
        }

        public void OnPageHandlerExecuting(PageHandlerExecutingContext context)
        {
            _logger.LogDebug("Global sync PageHandlerExecutingContext called.");
        }

        public void OnPageHandlerExecuted(PageHandlerExecutedContext context)
        {
            _logger.LogDebug("Global sync OnPageHandlerExecuted called.");
        }
    }
}

```

The following code enables the `SamplePageFilter`:

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc(options =>
    {
        options.Filters.Add(new SamplePageFilter(_logger));
    });
}

```

## Implement Razor Page filters by overriding filter methods

The following code overrides the synchronous Razor Page filters:

```

using Microsoft.AspNetCore.Mvc.Filters;
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.Extensions.Logging;

namespace PageFilter.Pages
{
    public class IndexModel : PageModel
    {
        private readonly ILogger _logger;

        public IndexModel(ILogger<IndexModel> logger)
        {
            _logger = logger;
        }
        public string Message { get; set; }

        public void OnGet()
        {
            _logger.LogDebug("IndexModel/OnGet");
        }

        public override void OnPageHandlerSelected(
            PageHandlerSelectedContext context)
        {
            _logger.LogDebug("IndexModel/OnPageHandlerSelected");
        }

        public override void OnPageHandlerExecuting(
            PageHandlerExecutingContext context)
        {
            Message = "Message set in handler executing";
            _logger.LogDebug("IndexModel/OnPageHandlerExecuting");
        }

        public override void OnPageHandlerExecuted(
            PageHandlerExecutedContext context)
        {
            _logger.LogDebug("IndexModel/OnPageHandlerExecuted");
        }
    }
}

```

## Implement a filter attribute

The built-in attribute-based filter [OnResultExecutionAsync](#) filter can be subclassed. The following filter adds a header to the response:

```

using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc.Filters;

namespace PageFilter.Filters
{
    public class AddHeaderAttribute : ResultFilterAttribute
    {
        private readonly string _name;
        private readonly string _value;

        public AddHeaderAttribute (string name, string value)
        {
            _name = name;
            _value = value;
        }

        public override void OnResultExecuting(ResultExecutingContext context)
        {
            context.HttpContext.Response.Headers.Add(_name, new string[] { _value });
        }
    }
}

```

The following code applies the `AddHeader` attribute:

```

[AddHeader("Author", "Rick")]
public class ContactModel : PageModel
{
    private readonly ILogger _logger;

    public ContactModel(ILogger<ContactModel> logger)
    {
        _logger = logger;
    }
    public string Message { get; set; }

    public async Task OnGetAsync()
    {
        Message = "Your contact page.";
        _logger.LogDebug("Contact/OnGet");
        await Task.CompletedTask;
    }
}

```

See [Overriding the default order](#) for instructions on overriding the order.

See [Cancellation and short circuiting](#) for instructions to short-circuit the filter pipeline from a filter.

## Authorize filter attribute

The `Authorize` attribute can be applied to a `PageModel`:

```
using Microsoft.AspNetCore.Authorization;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;

namespace PageFilter.Pages
{
    [Authorize]
    public class ModelWithAuthFilterModel : PageModel
    {
        public IActionResult OnGet() => Page();
    }
}
```

# Create reusable UI using the Razor Class Library project in ASP.NET Core.

7/11/2018 • 4 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

Razor views, pages, controllers, page models, [View components](#), and data models can be built into a Razor Class Library (RCL). The RCL can be packaged and reused. Applications can include the RCL and override the views and pages it contains. When a view, partial view, or Razor Page is found in both the web app and the RCL, the Razor markup (.cshtml file) in the web app takes precedence.

This feature requires [.NET Core 2.1 SDK or later](#)

[View or download sample code](#) ([how to download](#))

## Create a class library containing Razor UI

- [Visual Studio](#)
- [.NET Core CLI](#)
- From the Visual Studio **File** menu, select **New > Project**.
- Select **ASP.NET Core Web Application**.
- Name the library (for example, "RazorClassLib") > **OK**. To avoid a file name collision with the generated view library, ensure the library name doesn't end in `.Views`.
- Verify **ASP.NET Core 2.1** or later is selected.
- Select **Razor Class Library** > **OK**.

Add Razor files to the RCL.

We recommend RCL content go in the *Areas* folder.

## Referencing Razor Class Library content

The RCL can be referenced by:

- NuGet package. See [Creating NuGet packages](#) and [dotnet add package](#) and [Create and publish a NuGet package](#).
- `{ProjectName}.csproj`. See [dotnet-add reference](#).

## Walkthrough: Create a Razor Class Library project and use from a Razor Pages project

You can download the [complete project](#) and test it rather than creating it. The sample download contains additional code and links that make the project easy to test. You can leave feedback in [this GitHub issue](#) with your comments on download samples versus step-by-step instructions.

### Test the download app

If you haven't downloaded the completed app and would rather create the walkthrough project, skip to the [next section](#).

- [Visual Studio](#)

- [.NET Core CLI](#)

Open the *.sln* file in Visual Studio. Run the app.

Follow the instructions in [Test WebApp1](#)

## Create a Razor Class Library

In this section, a Razor Class Library (RCL) is created. Razor files are added to the RCL.

- [Visual Studio](#)
- [.NET Core CLI](#)

Create the RCL project:

- From the Visual Studio **File** menu, select **New > Project**.
- Select **ASP.NET Core Web Application**.
- Name the app **RazorUIClassLib** > **OK**.
- Verify **ASP.NET Core 2.1** or later is selected.
- Select **Razor Class Library** > **OK**.
- Add a Razor partial view file named *RazorUIClassLib/Areas/MyFeature/Pages/Shared/\_Message.cshtml*.

### Add Razor files and folders to the project.

- Replace the markup in *RazorUIClassLib/Areas/MyFeature/Pages/Shared/\_Message.cshtml* with the following code:

```
<h3> _Message.cshtml partial view.</h3>

<p>RazorUIClassLib\Areas\MyFeature\Pages\Shared\_Message.cshtml</p>
```

- Replace the markup in *RazorUIClassLib/Areas/MyFeature/Pages/Page1.cshtml* with the following code:

```
@page
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers

<h2>Hello from a Razor UI class library!</h2>
<p> From RazorUIClassLib\Areas\MyFeature\Pages\Page1.cshtml</p>

<partial name="_Message" />
```

`@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers` is required to use the partial view (`<partial name="_Message" />`). Rather than including the `@addTagHelper` directive, you can add a `_ViewImports.cshtml` file. For example:

```
dotnet new viewimports -o RazorUIClassLib/Areas/MyFeature/Pages
```

For more information on `viewimports`, see [Importing Shared Directives](#)

- Build the class library to verify there are no compiler errors:

```
dotnet build RazorUIClassLib
```

The build output contains *RazorUIClassLib.dll* and *RazorUIClassLib.Views.dll*. *RazorUIClassLib.Views.dll* contains the compiled Razor content.

## Use the Razor UI library from a Razor Pages project

- [Visual Studio](#)
- [.NET Core CLI](#)

Create the Razor Pages web app:

- From **Solution Explorer**, right-click the solution > **Add > New Project**.
- Select **ASP.NET Core Web Application**.
- Name the app **WebApp1**.
- Verify **ASP.NET Core 2.1** or later is selected.
- Select **Web Application > OK**.
- From **Solution Explorer**, right-click on **WebApp1** and select **Set as StartUp Project**.
- From **Solution Explorer**, right-click on **WebApp1** and select **Build Dependencies > Project Dependencies**.
- Check **RazorUIClassLib** as a dependency of **WebApp1**.
- From **Solution Explorer**, right-click on **WebApp1** and select **Add > Reference**.
- In the **Reference Manager** dialog, check **RazorUIClassLib > OK**.

Run the app.

### Test WebApp1

Verify the Razor UI class library is being used.

- Browse to `/MyFeature/Page1`.

## Override views, partial views, and pages

When a view, partial view, or Razor Page is found in both the web app and the Razor Class Library, the Razor markup (*.cshtml* file) in the web app takes precedence. For example, add `WebApp1/Areas/MyFeature/Pages/Page1.cshtml` to WebApp1, and Page1 in the WebApp1 will take precedence over Page1 in the Razor Class Library.

In the sample download, rename `WebApp1/Areas/MyFeature2` to `WebApp1/Areas/MyFeature` to test precedence.

Copy the `RazorUIClassLib/Areas/MyFeature/Pages/Shared/_Message.cshtml` partial view to `WebApp1/Areas/MyFeature/Pages/Shared/_Message.cshtml`. Update the markup to indicate the new location. Build and run the app to verify the app's version of the partial is being used.

# Razor Pages route and app conventions in ASP.NET Core

6/21/2018 • 15 minutes to read • [Edit Online](#)

By [Luke Latham](#)

Learn how to use page [route and app model provider conventions](#) to control page routing, discovery, and processing in Razor Pages apps.

When you need to configure custom page routes for individual pages, configure routing to pages with the [AddPageRoute convention](#) described later in this topic.

To specify a page route, add route segments, or add parameters to a route, use the page's `@page` directive. For more information, see [Custom routes](#).

There are reserved words that can't be used as route segments or parameter names. For more information, see [Routing: Reserved routing names](#).

[View or download sample code \(how to download\)](#)

SCENARIO	THE SAMPLE DEMONSTRATES ...
<a href="#">Model conventions</a>  Conventions.Add <ul style="list-style-type: none"><li>• <a href="#">IPageRouteModelConvention</a></li><li>• <a href="#">IPageApplicationModelConvention</a></li></ul>	Add a route template and header to an app's pages.
<a href="#">Page route action conventions</a> <ul style="list-style-type: none"><li>• <a href="#">AddFolderRouteModelConvention</a></li><li>• <a href="#">AddPageRouteModelConvention</a></li><li>• <a href="#">AddPageRoute</a></li></ul>	Add a route template to pages in a folder and to a single page.
<a href="#">Page model action conventions</a> <ul style="list-style-type: none"><li>• <a href="#">AddFolderApplicationModelConvention</a></li><li>• <a href="#">AddPageApplicationModelConvention</a></li><li>• <a href="#">ConfigureFilter</a> (filter class, lambda expression, or filter factory)</li></ul>	Add a header to pages in a folder, add a header to a single page, and configure a <a href="#">filter factory</a> to add a header to an app's pages.
<a href="#">Default page app model provider</a>	Replace the default page model provider to change the conventions for handler names.
SCENARIO	THE SAMPLE DEMONSTRATES ...
<a href="#">Model conventions</a>  Conventions.Add <ul style="list-style-type: none"><li>• <a href="#">IPageRouteModelConvention</a></li><li>• <a href="#">IPageApplicationModelConvention</a></li><li>• <a href="#">IPageHandlerModelConvention</a></li></ul>	Add a route template and header to an app's pages.

SCENARIO	THE SAMPLE DEMONSTRATES ...
<p><a href="#">Page route action conventions</a></p> <ul style="list-style-type: none"> <li>• <code>AddFolderRouteModelConvention</code></li> <li>• <code>AddPageRouteModelConvention</code></li> <li>• <code>AddPageRoute</code></li> </ul>	Add a route template to pages in a folder and to a single page.
<p><a href="#">Page model action conventions</a></p> <ul style="list-style-type: none"> <li>• <code>AddFolderApplicationModelConvention</code></li> <li>• <code>AddPageApplicationModelConvention</code></li> <li>• <code>ConfigureFilter</code> (filter class, lambda expression, or filter factory)</li> </ul>	Add a header to pages in a folder, add a header to a single page, and configure a <a href="#">filter factory</a> to add a header to an app's pages.
<p><a href="#">Default page app model provider</a></p>	Replace the default page model provider to change the conventions for handler names.

Razor Pages conventions are added and configured using the [AddRazorPagesOptions](#) extension method to [AddMvc](#) on the service collection in the `Startup` class. The following convention examples are explained later in this topic:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc()
        .AddRazorPagesOptions(options =>
    {
        options.Conventions.Add( ... );
        options.Conventions.AddFolderRouteModelConvention("/OtherPages", model => { ... });
        options.Conventions.AddPageRouteModelConvention("/About", model => { ... });
        options.Conventions.AddPageRoute("/Contact", "TheContactPage/{text?}");
        options.Conventions.AddFolderApplicationModelConvention("/OtherPages", model => { ... });
        options.Conventions.AddPageApplicationModelConvention("/About", model => { ... });
        options.Conventions.ConfigureFilter(model => { ... });
        options.Conventions.ConfigureFilter( ... );
    });
}
```

## Model conventions

Add a delegate for [IPageConvention](#) to add [model conventions](#) that apply to Razor Pages.

### Add a route model convention to all pages

Use [Conventions](#) to create and add an [IPageRouteModelConvention](#) to the collection of [IPageConvention](#) instances that are applied during page route model construction.

The sample app adds a `{globalTemplate?}` route template to all of the pages in the app:

```

public class GlobalTemplatePageRouteModelConvention
    : IPageRouteModelConvention
{
    public void Apply(PageRouteModel model)
    {
        var selectorCount = model.Selectors.Count;
        for (var i = 0; i < selectorCount; i++)
        {
            var selector = model.Selectors[i];
            model.Selectors.Add(new SelectorModel
            {
                AttributeRouteModel = new AttributeRouteModel
                {
                    Order = -1,
                    Template = AttributeRouteModel.CombineTemplates(
                        selector.AttributeRouteModel.Template,
                        "{globalTemplate?}"),
                }
            });
        }
    }
}

```

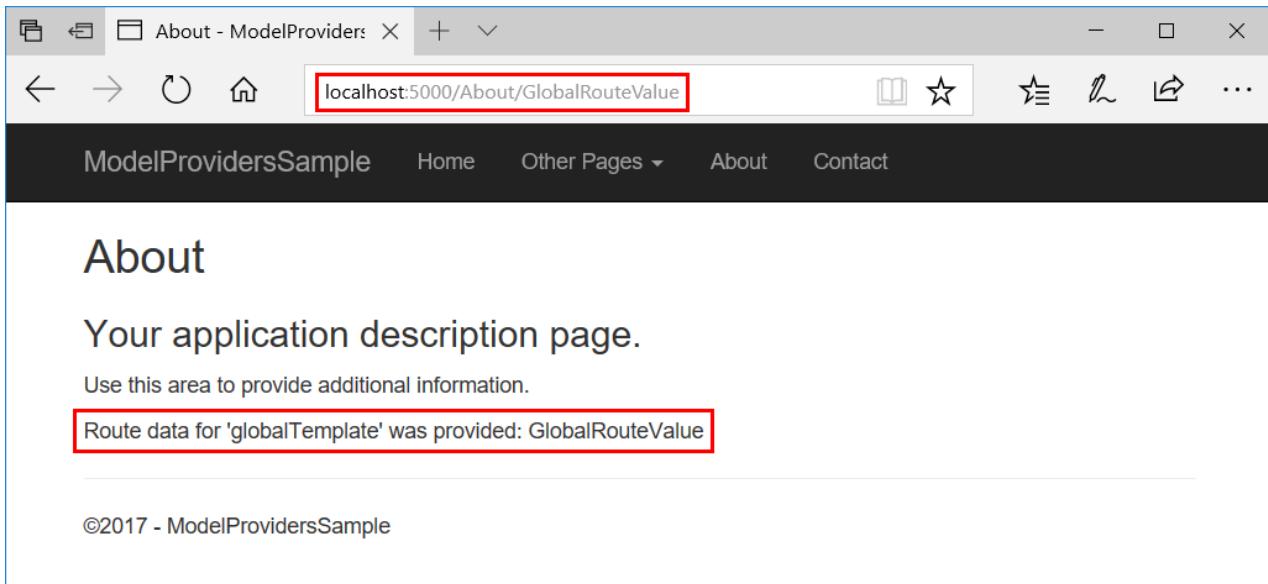
#### NOTE

The `Order` property for the `AttributeRouteModel` is set to `-1`. This ensures that this template is given priority for the first route data value position when a single route value is provided and also that it would have priority over automatically generated Razor Pages routes. For example, the sample adds an `{aboutTemplate?}` route template later in the topic. The `{aboutTemplate?}` template is given an `Order` of `1`. When the About page is requested at `/About/RouteDataValue`, "RouteDataValue" is loaded into `RouteData.Values["globalTemplate"]` (`Order = -1`) and not `RouteData.Values["aboutTemplate"]` (`Order = 1`) due to setting the `Order` property.

Razor Pages options, such as adding [Conventions](#), are added when MVC is added to the service collection in `Startup.ConfigureServices`. For an example, see the [sample app](#).

```
options.Conventions.Add(new GlobalTemplatePageRouteModelConvention());
```

Request the sample's About page at `localhost:5000/About/GlobalRouteValue` and inspect the result:



[Add an app model convention to all pages](#)

Use [Conventions](#) to create and add an [IPageApplicationModelConvention](#) to the collection of [IPageConvention](#) instances that are applied during page app model construction.

To demonstrate this and other conventions later in the topic, the sample app includes an [AddHeaderAttribute](#) class. The class constructor accepts a `name` string and a `values` string array. These values are used in its `OnResultExecuting` method to set a response header. The full class is shown in the [Page model action conventions](#) section later in the topic.

The sample app uses the [AddHeaderAttribute](#) class to add a header, `GlobalHeader`, to all of the pages in the app:

```
public class GlobalHeaderPageApplicationModelConvention
    : IPageApplicationModelConvention
{
    public void Apply(PageApplicationModel model)
    {
        model.Filters.Add(new AddHeaderAttribute(
            "GlobalHeader", new string[] { "Global Header Value" }));
    }
}
```

*Startup.cs:*

```
options.Conventions.Add(new GlobalHeaderPageApplicationModelConvention());
```

Request the sample's About page at `localhost:5000/About` and inspect the headers to view the result:

▼ **Response Headers** [view source](#)

**AboutHeader:** About Header Value  
**Content-Type:** text/html; charset=utf-8  
**Date:** Thu, 19 Oct 2017 21:09:07 GMT  
**FilterFactoryHeader:** Filter Factory Header Value 1  
**FilterFactoryHeader:** Filter Factory Header Value 2  
**GlobalHeader:** Global Header Value    
**Server:** Kestrel  
**Transfer-Encoding:** chunked

## Add a handler model convention to all pages

Use [Conventions](#) to create and add an [IPageHandlerModelConvention](#) to the collection of [IPageConvention](#) instances that are applied during page handler model construction.

```
public class GlobalPageHandlerModelConvention
    : IPageHandlerModelConvention
{
    public void Apply(PageHandlerModel model)
    {
        ...
    }
}
```

`Startup.ConfigureServices` :

```
services.AddMvc()
    .AddRazorPagesOptions(options =>
{
    options.Conventions.Add(new GlobalPageHandlerModelConvention());
});
```

# Page route action conventions

The default route model provider that derives from [IPageRouteModelProvider](#) invokes conventions which are designed to provide extensibility points for configuring page routes.

## Folder route model convention

Use [AddFolderRouteModelConvention](#) to create and add an [IPageRouteModelConvention](#) that invokes an action on the [PageRouteModel](#) for all of the pages under the specified folder.

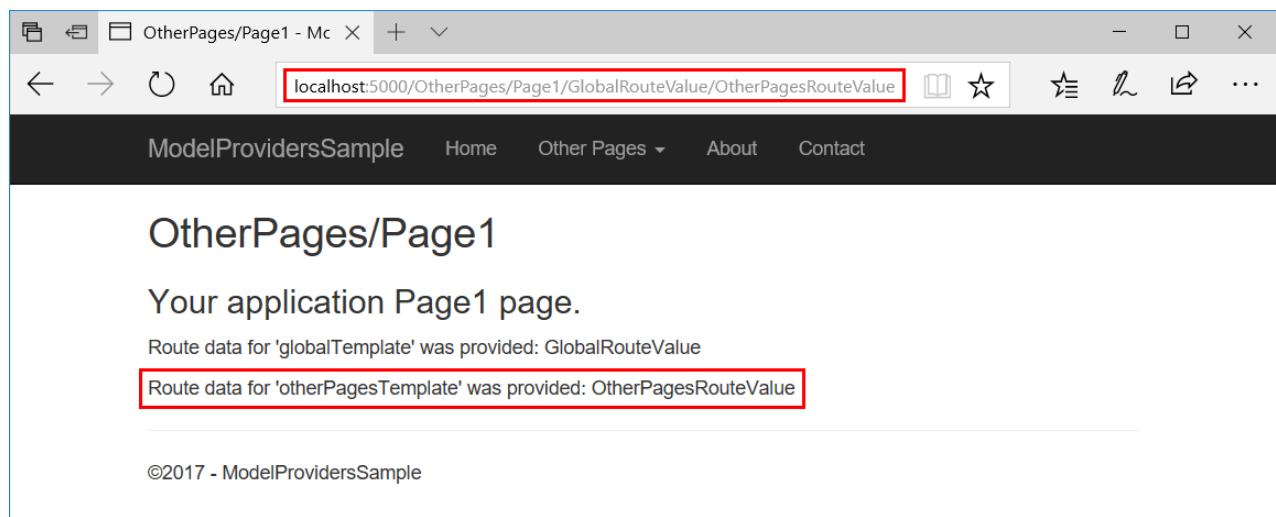
The sample app uses `AddFolderRouteModelConvention` to add an `{otherPagesTemplate?}` route template to the pages in the *OtherPages* folder:

```
options.Conventions.AddFolderRouteModelConvention("/OtherPages", model =>
{
    var selectorCount = model.Selectors.Count;
    for (var i = 0; i < selectorCount; i++)
    {
        var selector = model.Selectors[i];
        model.Selectors.Add(new SelectorModel
        {
            AttributeRouteModel = new AttributeRouteModel
            {
                Order = 1,
                Template = AttributeRouteModel.CombineTemplates(
                    selector.AttributeRouteModel.Template,
                    "{otherPagesTemplate?}"),
            }
        });
    }
});
```

### NOTE

The `Order` property for the `AttributeRouteModel` is set to `1`. This ensures that the template for `{globalTemplate?}` (set earlier in the topic) is given priority for the first route data value position when a single route value is provided. If the *Page1* page is requested at `/OtherPages/Page1/RouteHeaderValue`, "RouteHeaderValue" is loaded into `RouteData.Values["globalTemplate"]` (`Order = -1`) and not `RouteData.Values["otherPagesTemplate"]` (`Order = 1`) due to setting the `Order` property.

Request the sample's *Page1* page at `localhost:5000/OtherPages/Page1/GlobalRouteValue/OtherPagesRouteValue` and inspect the result:



## Page route model convention

Use [AddPageRouteModelConvention](#) to create and add an [IPageRouteModelConvention](#) that invokes an action on the [PageRouteModel](#) for the page with the specified name.

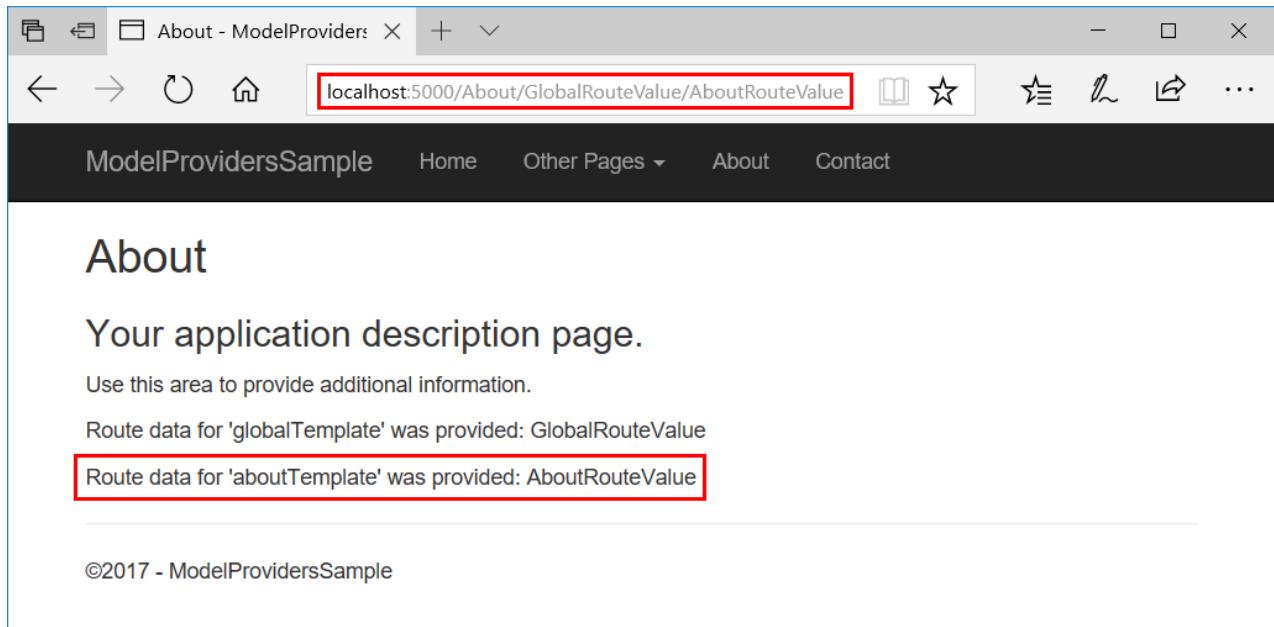
The sample app uses `AddPageRouteModelConvention` to add an `{aboutTemplate?}` route template to the About page:

```
options.Conventions.AddPageRouteModelConvention("/About", model =>
{
    var selectorCount = model.Selectors.Count;
    for (var i = 0; i < selectorCount; i++)
    {
        var selector = model.Selectors[i];
        model.Selectors.Add(new SelectorModel
        {
            AttributeRouteModel = new AttributeRouteModel
            {
                Order = 1,
                Template = AttributeRouteModel.CombineTemplates(
                    selector.AttributeRouteModel.Template,
                    "{aboutTemplate?}"),
            }
        });
    }
});
```

### NOTE

The `Order` property for the `AttributeRouteModel` is set to `1`. This ensures that the template for `{globalTemplate?}` (set earlier in the topic) is given priority for the first route data value position when a single route value is provided. If the About page is requested at `/About/RouteDataValue`, "RouteDataValue" is loaded into `RouteData.Values["globalTemplate"]` (`Order = -1`) and not `RouteData.Values["aboutTemplate"]` (`Order = 1`) due to setting the `Order` property.

Request the sample's About page at `localhost:5000/About/GlobalRouteValue/AboutRouteValue` and inspect the result:



## Configure a page route

Use [AddPageRoute](#) to configure a route to a page at the specified page path. Generated links to the page use your

specified route. `AddPageRoute` uses `AddPageRouteModelConvention` to establish the route.

The sample app creates a route to `/TheContactPage` for `Contact.cshtml`:

```
options.Conventions.AddPageRoute("/Contact", "TheContactPage/{text?}");
```

The Contact page can also be reached at `/Contact` via its default route.

The sample app's custom route to the Contact page allows for an optional `text` route segment (`{text?}`). The page also includes this optional segment in its `@page` directive in case the visitor accesses the page at its `/contact` route:

```
@page "{text?}"
@model ContactModel
 @{
    ViewData["Title"] = "Contact";
}

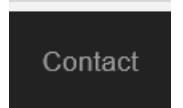
<h1>@ViewData["Title"]</h1>
<h2>@Model.Message</h2>

<address>
    One Microsoft Way<br>
    Redmond, WA 98052-6399<br>
    <abbr title="Phone">P:</abbr>
    425.555.0100
</address>

<address>
    <strong>Support:</strong> <a href="mailto:Support@example.com">Support@example.com</a><br>
    <strong>Marketing:</strong> <a href="mailto:Marketing@example.com">Marketing@example.com</a>
</address>

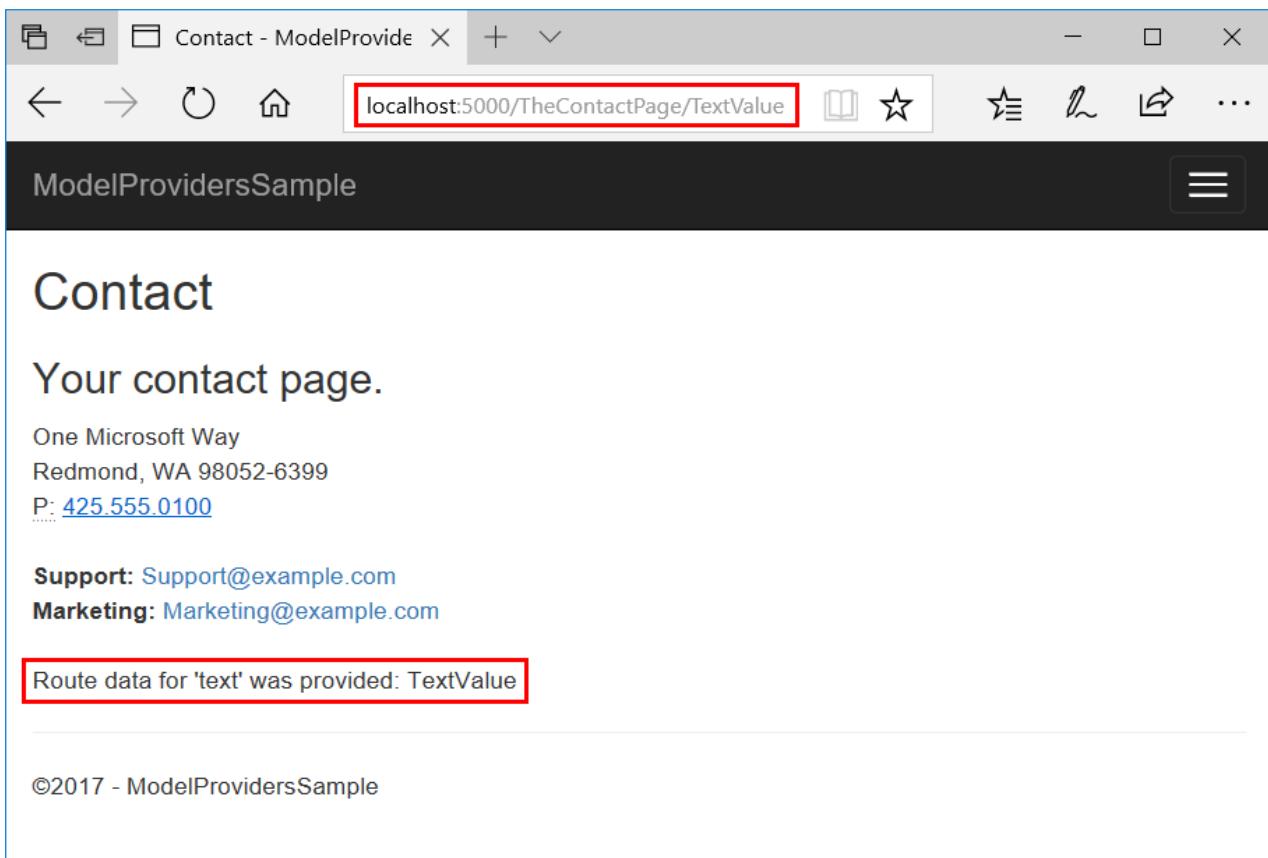
<p>@Model.RouteDataTextTemplateValue</p>
```

Note that the URL generated for the **Contact** link in the rendered page reflects the updated route:



```
▶ <li>...</li>
▼ <li>
    <a href="/TheContactPage">Contact</a>
</li>
::after
</ul>
```

Visit the Contact page at either its ordinary route, `/Contact`, or the custom route, `/TheContactPage`. If you supply an additional `text` route segment, the page shows the HTML-encoded segment that you provide:



## Page model action conventions

The default page model provider that implements [IPageApplicationModelProvider](#) invokes conventions which are designed to provide extensibility points for configuring page models. These conventions are useful when building and modifying page discovery and processing scenarios.

For the examples in this section, the sample app uses an `AddHeaderAttribute` class, which is a [ResultFilterAttribute](#), that applies a response header:

```
public class AddHeaderAttribute : ResultFilterAttribute
{
    private readonly string _name;
    private readonly string[] _values;

    public AddHeaderAttribute(string name, string[] values)
    {
        _name = name;
        _values = values;
    }

    public override void OnResultExecuting(ResultExecutingContext context)
    {
        context.HttpContext.Response.Headers.Add(_name, _values);
        base.OnResultExecuting(context);
    }
}
```

Using conventions, the sample demonstrates how to apply the attribute to all of the pages in a folder and to a single page.

### Folder app model convention

Use [AddFolderApplicationModelConvention](#) to create and add an [IPageApplicationModelConvention](#) that invokes an action on [PageApplicationModel](#) instances for all pages under the specified folder.

The sample demonstrates the use of `AddFolderApplicationModelConvention` by adding a header, `OtherPagesHeader`, to the pages inside the `OtherPages` folder of the app:

```
options.Conventions.AddFolderApplicationModelConvention("/OtherPages", model =>
{
    model.Filters.Add(new AddHeaderAttribute(
        "OtherPagesHeader", new string[] { "OtherPages Header Value" }));
});
```

Request the sample's `Page1` page at `localhost:5000/OtherPages/Page1` and inspect the headers to view the result:

▼ Response Headers [view source](#)

**Content-Type:** text/html; charset=utf-8  
**Date:** Sat, 21 Oct 2017 06:13:16 GMT  
**FilterFactoryHeader:** Filter Factory Header Value 1  
**FilterFactoryHeader:** Filter Factory Header Value 2  
**GlobalHeader:** Global Header Value  
**OtherPagesHeader:** OtherPages Header Value    
**Server:** Kestrel  
**Transfer-Encoding:** chunked

## Page app model convention

Use `AddPageApplicationModelConvention` to create and add an `IPageApplicationModelConvention` that invokes an action on the `PageApplicationModel` for the page with the specified name.

The sample demonstrates the use of `AddPageApplicationModelConvention` by adding a header, `AboutHeader`, to the `About` page:

```
options.Conventions.AddPageApplicationModelConvention("/About", model =>
{
    model.Filters.Add(new AddHeaderAttribute(
        "AboutHeader", new string[] { "About Header Value" }));
});
```

Request the sample's `About` page at `localhost:5000/About` and inspect the headers to view the result:

▼ Response Headers [view source](#)

**AboutHeader:** About Header Value    
**Content-Type:** text/html; charset=utf-8  
**Date:** Thu, 19 Oct 2017 21:09:07 GMT  
**FilterFactoryHeader:** Filter Factory Header Value 1  
**FilterFactoryHeader:** Filter Factory Header Value 2  
**GlobalHeader:** Global Header Value  
**Server:** Kestrel  
**Transfer-Encoding:** chunked

## Configure a filter

`ConfigureFilter` configures the specified filter to apply. You can implement a filter class, but the sample app shows how to implement a filter in a lambda expression, which is implemented behind-the-scenes as a factory that returns a filter:

```
options.Conventions.ConfigureFilter(model =>
{
    if (model.RelativePath.Contains("OtherPages/Page2"))
    {
        return new AddHeaderAttribute(
            "OtherPagesPage2Header",
            new string[] { "OtherPages/Page2 Header Value" });
    }
    return new EmptyFilter();
});
```

The page app model is used to check the relative path for segments that lead to the Page2 page in the *OtherPages* folder. If the condition passes, a header is added. If not, the `EmptyFilter` is applied.

`EmptyFilter` is an [Action filter](#). Since Action filters are ignored by Razor Pages, the `EmptyFilter` no-ops as intended if the path doesn't contain `OtherPages/Page2`.

Request the sample's Page2 page at `localhost:5000/OtherPages/Page2` and inspect the headers to view the result:

▼ Response Headers [view source](#)

**Content-Type:** text/html; charset=utf-8  
**Date:** Mon, 23 Oct 2017 06:06:52 GMT  
**FilterFactoryHeader:** Filter Factory Header Value 1  
**FilterFactoryHeader:** Filter Factory Header Value 2  
**GlobalHeader:** Global Header Value  
**OtherPagesHeader:** OtherPages Header Value  
**OtherPagesPage2Header:** OtherPages/Page2 Header Value  
**Server:** Kestrel  
**Transfer-Encoding:** chunked

## Configure a filter factory

[ConfigureFilter](#) configures the specified factory to apply [filters](#) to all Razor Pages.

The sample app provides an example of using a [filter factory](#) by adding a header, `FilterFactoryHeader`, with two values to the app's pages:

```
options.Conventions.ConfigureFilter(new AddHeaderWithFactory());
```

*AddHeaderWithFactory.cs:*

```

public class AddHeaderWithFactory : IFilterFactory
{
    // Implement IFilterFactory
    public IFilterMetadata CreateInstance(IServiceProvider serviceProvider)
    {
        return new AddHeaderFilter();
    }

    private class AddHeaderFilter : IResultFilter
    {
        public void OnResultExecuting(ResultExecutingContext context)
        {
            context.HttpContext.Response.Headers.Add(
                "FilterFactoryHeader",
                new string[]
                {
                    "Filter Factory Header Value 1",
                    "Filter Factory Header Value 2"
                });
        }

        public void OnResultExecuted(ResultExecutedContext context)
        {
        }
    }

    public bool IsReusable
    {
        get
        {
            return false;
        }
    }
}

```

Request the sample's About page at `localhost:5000/About` and inspect the headers to view the result:

#### ▼ Response Headers [view source](#)

**AboutHeader:** About Header Value  
**Content-Type:** text/html; charset=utf-8  
**Date:** Thu, 19 Oct 2017 21:09:07 GMT  
**FilterFactoryHeader:** Filter Factory Header Value 1  
**FilterFactoryHeader:** Filter Factory Header Value 2  
**GlobalHeader:** Global Header Value  
**Server:** Kestrel  
**Transfer-Encoding:** chunked

## Replace the default page app model provider

Razor Pages uses the `IPageApplicationModelProvider` interface to create a `DefaultPageApplicationModelProvider`. You can inherit from the default model provider to provide your own implementation logic for handler discovery and processing. The default implementation ([reference source](#)) establishes conventions for *unnamed* and *named* handler naming, which is described below.

### Default unnamed handler methods

Handler methods for HTTP verbs ("unnamed" handler methods) follow a convention: `On<HTTP verb>[Async]` (appending `Async` is optional but recommended for async methods).

UNNAMED HANDLER METHOD	OPERATION
OnGet / OnGetAsync	Initialize the page state.
OnPost / OnPostAsync	Handle POST requests.
OnDelete / OnDeleteAsync	Handle DELETE requests†.
OnPut / OnPutAsync	Handle PUT requests†.
OnPatch / OnPatchAsync	Handle PATCH requests†.

†Used for making API calls to the page.

### Default named handler methods

Handler methods provided by the developer ("named" handler methods) follow a similar convention. The handler name appears after the HTTP verb or between the HTTP verb and `Async` : `On<HTTP verb><handler name>[Async]` (appending `Async` is optional but recommended for async methods). For example, methods that process messages might take the naming shown in the table below.

EXAMPLE NAMED HANDLER METHOD	EXAMPLE OPERATION
OnGetMessage / OnGetMessageAsync	Obtain a message.
OnPostMessage / OnPostMessageAsync	POST a message.
OnDeleteMessage / OnDeleteMessageAsync	DELETE a message†.
OnPutMessage / OnPutMessageAsync	PUT a message†.
OnPatchMessage / OnPatchMessageAsync	PATCH a message†.

†Used for making API calls to the page.

### Customize handler method names

Assume that you prefer to change the way unnamed and named handler methods are named. An alternative naming scheme is to avoid starting the method names with "On" and use the first word segment to determine the HTTP verb. You can make other changes, such as converting the verbs for DELETE, PUT, and PATCH to POST. Such a scheme provides the method names shown in the following table.

HANDLER METHOD	OPERATION
Get	Initialize the page state.
Post / PostAsync	Handle POST requests.
Delete / DeleteAsync	Handle DELETE requests†.
Put / PutAsync	Handle PUT requests†.
Patch / PatchAsync	Handle PATCH requests†.

HANDLER METHOD	OPERATION
GetMessage	Obtain a message.
PostMessage / PostMessageAsync	POST a message.
DeleteMessage / DeleteMessageAsync	POST a message to delete.
PutMessage / PutMessageAsync	POST a message to put.
PatchMessage / PatchMessageAsync	POST a message to patch.

<sup>†</sup>Used for making API calls to the page.

To establish this scheme, inherit from the `DefaultPageApplicationModelProvider` class and override the `CreateHandlerModel` method to supply custom logic for resolving `PageModel` handler names. The sample app shows you how this is done in its `CustomPageApplicationModelProvider` class:

```
public class CustomPageApplicationModelProvider : DefaultPageApplicationModelProvider
{
    public CustomPageApplicationModelProvider(IModelMetadataProvider modelMetadataProvider,
        IOptions<MvcOptions> options)
        : base(modelMetadataProvider, options)
    {
    }

    protected override PageHandlerModel CreateHandlerModel(MethodInfo method)
    {
        if (method == null)
        {
            throw new ArgumentNullException(nameof(method));
        }

        if (!IsHandler(method))
        {
            return null;
        }

        if (!TryParseHandlerMethod(
            method.Name, out var httpMethod, out var handlerName))
        {
            return null;
        }

        var handlerModel = new PageHandlerModel(
            method,
            method.GetCustomAttributes(inherit: true))
        {
            Name = method.Name,
            HandlerName = handlerName,
            HttpMethod = httpMethod,
        };

        var methodParameters = handlerModel.MethodInfo.GetParameters();

        for (var i = 0; i < methodParameters.Length; i++)
        {
            var parameter = methodParameters[i];
            var parameterModel = CreateParameterModel(parameter);
            parameterModel.Handler = handlerModel;

            handlerModel.Parameters.Add(parameterModel);
        }
    }
}
```

```

        handlerModel.Parameters.Add(handlerModel),
    }

    return handlerModel;
}

private static bool TryParseHandlerMethod(
    string methodName, out string httpMethod, out string handler)
{
    httpMethod = null;
    handler = null;

    // Parse the method name according to our conventions to
    // determine the required HTTP verb and optional
    // handler name.
    //
    // Valid names look like:
    // - Get
    // - Post
    // - PostAsync
    // - GetMessage
    // - PostMessage
    // - DeleteMessage
    // - DeleteMessageAsync

    var length = methodName.Length;
    if (methodName.EndsWith("Async", StringComparison.OrdinalIgnoreCase))
    {
        length -= "Async".Length;
    }

    if (length == 0)
    {
        // The method is named "Async". Exit processing.
        return false;
    }

    // The HTTP verb is at the start of the method name. Use
    // casing to determine where it ends.
    var handlerNameStart = 1;
    for (; handlerNameStart < length; handlerNameStart++)
    {
        if (char.IsUpper(methodName[handlerNameStart]))
        {
            break;
        }
    }

    httpMethod = methodName.Substring(0, handlerNameStart);

    // The handler name follows the HTTP verb and is optional.
    // It includes everything up to the end excluding the
    // "Async" suffix, if present.
    handler = handlerNameStart == length ? null : methodName.Substring(0, length);

    if (string.Equals(httpMethod, "GET", StringComparison.OrdinalIgnoreCase) ||
        string.Equals(httpMethod, "POST", StringComparison.OrdinalIgnoreCase))
    {
        // Do nothing. The httpMethod is correct for GET and POST.
        return true;
    }
    if (string.Equals(httpMethod, "DELETE", StringComparison.OrdinalIgnoreCase) ||
        string.Equals(httpMethod, "PUT", StringComparison.OrdinalIgnoreCase) ||
        string.Equals(httpMethod, "PATCH", StringComparison.OrdinalIgnoreCase))
    {
        // Convert HTTP verbs for DELETE, PUT, and PATCH to POST
        // For example: DeleteMessage, PutMessage, PatchMessage -> POST
        httpMethod = "POST";
        return true;
    }
}

```

```
        }
        else
        {
            return false;
        }
    }
}
```

Highlights of the class include:

- The class inherits from `DefaultPageApplicationModelProvider`.
- The `TryParseHandlerMethod` processes a handler to determine the HTTP verb (`httpMethod`) and named handler name (`handlerName`) when creating the `PageHandlerModel`.
  - An `Async` postfix is ignored, if present.
  - Casing is used to parse the HTTP verb from the method name.
  - When the method name (without `Async`) is equal to the HTTP verb name, there's no named handler. The `handlerName` is set to `null`, and the method name is `Get`, `Post`, `Delete`, `Put`, or `Patch`.
  - When the method name (without `Async`) is longer than the HTTP verb name, there's a named handler. The `handlerName` is set to `<method name (less 'Async', if present)>`. For example, both "GetMessage" and "GetMessageAsync" yield a handler name of "GetMessage".
  - DELETE, PUT, and PATCH HTTP verbs are converted to POST.

Register the `CustomPageApplicationModelProvider` in the `Startup` class:

```
services.AddSingleton<IPageApplicationModelProvider,
    CustomPageApplicationModelProvider>();
```

The page model in `Index.cshtml.cs` shows how the ordinary handler method naming conventions are changed for pages in the app. The ordinary "On" prefix naming used with Razor Pages is removed. The method that initializes the page state is now named `Get`. You can see this convention used throughout the app if you open any page model for any of the pages.

Each of the other methods start with the HTTP verb that describes its processing. The two methods that start with `Delete` would normally be treated as DELETE HTTP verbs, but the logic in `TryParseHandlerMethod` explicitly sets the verb to POST for both handlers.

Note that `Async` is optional between `DeleteAllMessages` and `DeleteMessageAsync`. They're both asynchronous methods, but you can choose to use the `Async` postfix or not; we recommend that you do. `DeleteAllMessages` is used here for demonstration purposes, but we recommend that you name such a method `DeleteAllMessagesAsync`. It doesn't affect the processing of the sample's implementation, but using the `Async` postfix calls out the fact that it's an asynchronous method.

```

public async Task Get()
{
    Messages = await _db.Messages.AsNoTracking().ToListAsync();
}

public async Task<IActionResult> PostMessageAsync()
{
    _db.Messages.Add(Message);
    await _db.SaveChangesAsync();

    Result = $"{nameof(PostMessageAsync)} handler: Message '{Message.Text}' added.";

    return RedirectToPage();
}

public async Task<IActionResult> DeleteAllMessages()
{
    foreach (Message message in _db.Messages)
    {
        _db.Messages.Remove(message);
    }
    await _db.SaveChangesAsync();

    Result = $"{nameof(DeleteAllMessages)} handler: All messages deleted.";

    return RedirectToPage();
}

public async Task<IActionResult> DeleteMessageAsync(int id)
{
    var message = await _db.Messages.FindAsync(id);

    if (message != null)
    {
        _db.Messages.Remove(message);
        await _db.SaveChangesAsync();
    }

    Result = $"{nameof(DeleteMessageAsync)} handler: Message with Id: {id} deleted.";

    return RedirectToPage();
}

```

Note the handler names provided in *Index.cshtml* match the `DeleteAllMessages` and `DeleteMessageAsync` handler methods:

```

<div class="row">
    <div class="col-md-3">
        <form method="post">
            <h2>Clear all messages</h2>
            <hr>
            <div class="form-group">
                <button type="submit" asp-page-handler="DeleteAllMessages"
                    class="btn btn-danger">Clear All</button>
            </div>
        </form>
    </div>
</div>

<div class="row">
    <div class="col-md-12">
        <form method="post">
            <h2>Messages</h2>
            <hr>
            <ol>
                @foreach (var message in Model.Messages)
                {
                    <li>
                        @message.Text
                        <button type="submit" asp-page-handler="DeleteMessage"
                            class="btn btn-danger"
                            asp-route-id="@message.Id">Delete</button>
                    </li>
                }
            </ol>
        </form>
    </div>
</div>

```

`Async` in the handler method name `DeleteMessageAsync` is factored out by the `TryParseHandlerMethod` for handler matching of POST request to method. The `asp-page-handler` name of `DeleteMessage` is matched to the handler method `DeleteMessageAsync`.

## MVC Filters and the Page filter (`IPageFilter`)

MVC [Action filters](#) are ignored by Razor Pages, since Razor Pages use handler methods. Other types of MVC filters are available for you to use: [Authorization](#), [Exception](#), [Resource](#), and [Result](#). For more information, see the [Filters](#) topic.

The Page filter (`IPageFilter`) is a filter that applies to Razor Pages. For more information, see [Filter methods for Razor Pages](#).

## Additional resources

- [Razor Pages authorization conventions](#)

# Upload files to a Razor Page in ASP.NET Core

7/11/2018 • 18 minutes to read • [Edit Online](#)

By [Luke Latham](#)

This topic builds upon the [sample app](#) in [Get started with Razor Pages in ASP.NET Core](#).

This topic shows how to use simple model binding to upload files, which works well for uploading small files. For information on streaming large files, see [Uploading large files with streaming](#).

In the following steps, a movie schedule file upload feature is added to the sample app. A movie schedule is represented by a `Schedule` class. The class includes two versions of the schedule. One version is provided to customers, `PublicSchedule`. The other version is used for company employees, `PrivateSchedule`. Each version is uploaded as a separate file. The tutorial demonstrates how to perform two file uploads from a page with a single POST to the server.

## Security considerations

Caution must be taken when providing users with the ability to upload files to a server. Attackers may execute [denial of service](#) and other attacks on a system. Some security steps that reduce the likelihood of a successful attack are:

- Upload files to a dedicated file upload area on the system, which makes it easier to impose security measures on uploaded content. When permitting file uploads, make sure that execute permissions are disabled on the upload location.
- Use a safe file name determined by the app, not from user input or the file name of the uploaded file.
- Only allow a specific set of approved file extensions.
- Verify client-side checks are performed on the server. Client-side checks are easy to circumvent.
- Check the size of the upload and prevent larger uploads than expected.
- Run a virus/malware scanner on uploaded content.

### WARNING

Uploading malicious code to a system is frequently the first step to executing code that can:

- Completely takeover a system.
- Overload a system with the result that the system completely fails.
- Compromise user or system data.
- Apply graffiti to a public interface.

## Add a FileUpload class

Create a Razor Page to handle a pair of file uploads. Add a `FileUpload` class, which is bound to the page to obtain the schedule data. Right click the `Models` folder. Select **Add > Class**. Name the class **FileUpload** and add the following properties:

```

using Microsoft.AspNetCore.Http;
using System.ComponentModel.DataAnnotations;

namespace RazorPagesMovie.Models
{
    public class FileUpload
    {
        [Required]
        [Display(Name="Title")]
        [StringLength(60, MinimumLength = 3)]
        public string Title { get; set; }

        [Required]
        [Display(Name="Public Schedule")]
        public IFormFile UploadPublicSchedule { get; set; }

        [Required]
        [Display(Name="Private Schedule")]
        public IFormFile UploadPrivateSchedule { get; set; }
    }
}

```

```

using Microsoft.AspNetCore.Http;
using System.ComponentModel.DataAnnotations;

namespace RazorPagesMovie.Models
{
    public class FileUpload
    {
        [Required]
        [Display(Name="Title")]
        [StringLength(60, MinimumLength = 3)]
        public string Title { get; set; }

        [Required]
        [Display(Name="Public Schedule")]
        public IFormFile UploadPublicSchedule { get; set; }

        [Required]
        [Display(Name="Private Schedule")]
        public IFormFile UploadPrivateSchedule { get; set; }
    }
}

```

The class has a property for the schedule's title and a property for each of the two versions of the schedule. All three properties are required, and the title must be 3-60 characters long.

## Add a helper method to upload files

To avoid code duplication for processing uploaded schedule files, add a static helper method first. Create a *Utilities* folder in the app and add a *FileHelpers.cs* file with the following content. The helper method, `ProcessFormFile`, takes an `IFormFile` and `ModelStateDictionary` and returns a string containing the file's size and content. The content type and length are checked. If the file doesn't pass a validation check, an error is added to the `ModelState`.

```

using System;
using System.ComponentModel.DataAnnotations;
using System.IO;
using System.Net;
using System.Reflection;
using System.Text;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Http;

```

```
using Microsoft.AspNetCore.Mvc.ModelBinding;
using RazorPagesMovie.Models;

namespace RazorPagesMovie.Utilities
{
    public class FileHelpers
    {
        public static async Task<string> ProcessFormFile(IFormFile formFile,
            ModelStateDictionary ModelState)
        {
            var fieldDisplayName = string.Empty;

            // Use reflection to obtain the display name for the model
            // property associated with this IFormFile. If a display
            // name isn't found, error messages simply won't show
            // a display name.
            MemberInfo property =
                typeof(FileUpload).GetProperty(
                    formFile.Name.Substring(formFile.Name.IndexOf(".") + 1));

            if (property != null)
            {
                var displayAttribute =
                    property.GetCustomAttribute(typeof(DisplayAttribute))
                        as DisplayAttribute;

                if (displayAttribute != null)
                {
                    fieldDisplayName = $"{displayAttribute.Name} ";
                }
            }

            // Use Path.GetFileName to obtain the file name, which will
            // strip any path information passed as part of the
            // fileName property. HtmlEncode the result in case it must
            // be returned in an error message.
            var fileName = WebUtility.HtmlEncode(
                Path.GetFileName(formFile.FileName));

            if (formFile.ContentType.ToLower() != "text/plain")
            {
                ModelState.AddModelError(formFile.Name,
                    $"The {fieldDisplayName}file ({fileName}) must be a text file.");
            }

            // Check the file length and don't bother attempting to
            // read it if the file contains no content. This check
            // doesn't catch files that only have a BOM as their
            // content, so a content length check is made later after
            // reading the file's content to catch a file that only
            // contains a BOM.
            if (formFile.Length == 0)
            {
                ModelState.AddModelError(formFile.Name,
                    $"The {fieldDisplayName}file ({fileName}) is empty.");
            }
            else if (formFile.Length > 1048576)
            {
                ModelState.AddModelError(formFile.Name,
                    $"The {fieldDisplayName}file ({fileName}) exceeds 1 MB.");
            }
            else
            {
                try
                {
                    string fileContents;

                    // The StreamReader is created to read files that are UTF-8 encoded.
                    // If uploads require some other encoding, provide the encoding in the

```

```
// using statement. To change to 32-bit encoding, change
// new UTF8Encoding(...) to new UTF32Encoding().
using (
    var reader =
        new StreamReader(
            formFile.OpenReadStream(),
            new UTF8Encoding(encoderShouldEmitUTF8Identifier: false,
                throwOnInvalidBytes: true),
            detectEncodingFromByteOrderMarks: true))
{
    fileContents = await reader.ReadToEndAsync();

    // Check the content length in case the file's only
    // content was a BOM and the content is actually
    // empty after removing the BOM.
    if (fileContents.Length > 0)
    {
        return fileContents;
    }
    else
    {
        ModelState.AddModelError(formFile.Name,
            $"The {fieldDisplayName}file ({fileName}) is empty.");
    }
}
catch (Exception ex)
{
    ModelState.AddModelError(formFile.Name,
        $"The {fieldDisplayName}file ({fileName}) upload failed. " +
        $"Please contact the Help Desk for support. Error: {ex.Message}");
    // Log the exception
}
}

return string.Empty;
}
```

```
using System;
using System.ComponentModel.DataAnnotations;
using System.IO;
using System.Net;
using System.Reflection;
using System.Text;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Http;
using Microsoft.AspNetCore.Mvc.ModelBinding;
using RazorPagesMovie.Models;

namespace RazorPagesMovie.Utilities
{
    public class FileHelpers
    {
        public static async Task<string> ProcessFormFile(
            IFormFile formFile, ModelStateDictionary modelState)
        {
            var fieldDisplayName = string.Empty;

            // Use reflection to obtain the display name for the model
            // property associated with this IFormFile. If a display
            // name isn't found, error messages simply won't show
            // a display name.
            MemberInfo property =
                typeof(FileUpload).GetProperty(formFile.Name.Substring(
                    formFile.Name.IndexOf(".") + 1));
```

```

if (property != null)
{
    var displayAttribute =
        property.GetCustomAttribute(typeof(DisplayAttribute))
        as DisplayAttribute;

    if (displayAttribute != null)
    {
        fieldDisplayName = $"{displayAttribute.Name} ";
    }
}

// Use Path.GetFileName to obtain the file name, which will
// strip any path information passed as part of the
// FileName property. HtmlEncode the result in case it must
// be returned in an error message.
var fileName = WebUtility.HtmlEncode(
    Path.GetFileName(formFile.FileName));

if (formFile.ContentType.ToLower() != "text/plain")
{
    ModelState.AddModelError(formFile.Name,
        $"The {fieldDisplayName}file ({fileName}) must be a text file.");
}

// Check the file length and don't bother attempting to
// read it if the file contains no content. This check
// doesn't catch files that only have a BOM as their
// content, so a content length check is made later after
// reading the file's content to catch a file that only
// contains a BOM.
if (formFile.Length == 0)
{
    ModelState.AddModelError(formFile.Name,
        $"The {fieldDisplayName}file ({fileName}) is empty.");
}
else if (formFile.Length > 1048576)
{
    ModelState.AddModelError(formFile.Name,
        $"The {fieldDisplayName}file ({fileName}) exceeds 1 MB.");
}
else
{
    try
    {
        string fileContents;

        // The StreamReader is created to read files that are UTF-8 encoded.
        // If uploads require some other encoding, provide the encoding in the
        // using statement. To change to 32-bit encoding, change
        // new UTF8Encoding(...) to new UTF32Encoding().
        using (
            var reader =
                new StreamReader(
                    formFile.OpenReadStream(),
                    new UTF8Encoding(encoderShouldEmitUTF8Identifier: false,
                        throwOnInvalidBytes: true),
                    detectEncodingFromByteOrderMarks: true))
        {
            fileContents = await reader.ReadToEndAsync();

            // Check the content length in case the file's only
            // content was a BOM and the content is actually
            // empty after removing the BOM.
            if (fileContents.Length > 0)
            {
                return fileContents;
            }
        }
    }
}

```

```

        ,
        else
        {
            ModelState.AddModelError(formFile.Name,
                $"The {fieldDisplayName}file ({fileName}) is empty.");
        }
    }
}
catch (Exception ex)
{
    ModelState.AddModelError(formFile.Name,
        $"The {fieldDisplayName}file ({fileName}) upload failed. " +
        $"Please contact the Help Desk for support. Error: {ex.Message}");
    // Log the exception
}
}

return string.Empty;
}
}
}

```

## Save the file to disk

The sample app saves uploaded files into database fields. To save a file to disk, use a [FileStream](#). The following example copies a file held by `FileUpload.UploadPublicSchedule` to a `FileStream` in an `OnPostAsync` method. The `FileStream` writes the file to disk at the `<PATH-AND-FILE-NAME>` provided:

```

public async Task<IActionResult> OnPostAsync()
{
    // Perform an initial check to catch FileUpload class attribute violations.
    if (!ModelState.IsValid)
    {
        return Page();
    }

    var filePath = "<PATH-AND-FILE-NAME>";

    using (var fileStream = new FileStream(filePath, FileMode.Create))
    {
        await FileUpload.UploadPublicSchedule.CopyToAsync(fileStream);
    }

    return RedirectToPage("./Index");
}

```

The worker process must have write permissions to the location specified by `filePath`.

### NOTE

The `filePath` must include the file name. If the file name isn't provided, an [UnauthorizedAccessException](#) is thrown at runtime.

### WARNING

Never persist uploaded files in the same directory tree as the app.

The code sample provides no server-side protection against malicious file uploads. For information on reducing the attack surface area when accepting files from users, see the following resources:

- [Unrestricted File Upload](#)
- [Azure Security: Ensure appropriate controls are in place when accepting files from users](#)

## Save the file to Azure Blob Storage

To upload file content to Azure Blob Storage, see [Get started with Azure Blob Storage using .NET](#). The topic demonstrates how to use [UploadFromStream](#) to save a [FileStream](#) to blob storage.

## Add the Schedule class

Right click the *Models* folder. Select **Add > Class**. Name the class **Schedule** and add the following properties:

```
using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace RazorPagesMovie.Models
{
    public class Schedule
    {
        public int ID { get; set; }
        public string Title { get; set; }

        public string PublicSchedule { get; set; }

        [Display(Name = "Public Schedule Size (bytes)")]
        [DisplayFormat(DataFormatString = "{0:N1}")]
        public long PublicScheduleSize { get; set; }

        public string PrivateSchedule { get; set; }

        [Display(Name = "Private Schedule Size (bytes)")]
        [DisplayFormat(DataFormatString = "{0:N1}")]
        public long PrivateScheduleSize { get; set; }

        [Display(Name = "Uploaded (UTC)")]
        [DisplayFormat(DataFormatString = "{0:F}")]
        public DateTime UploadDT { get; set; }
    }
}
```

```

using System;
using System.Collections.Generic;
using System.ComponentModel.DataAnnotations;
using System.ComponentModel.DataAnnotations.Schema;

namespace RazorPagesMovie.Models
{
    public class Schedule
    {
        public int ID { get; set; }
        public string Title { get; set; }

        public string PublicSchedule { get; set; }

        [Display(Name = "Public Schedule Size (bytes)")]
        [DisplayFormat(DataFormatString = "{0:N1}")]
        public long PublicScheduleSize { get; set; }

        public string PrivateSchedule { get; set; }

        [Display(Name = "Private Schedule Size (bytes)")]
        [DisplayFormat(DataFormatString = "{0:N1}")]
        public long PrivateScheduleSize { get; set; }

        [Display(Name = "Uploaded (UTC)")]
        [DisplayFormat(DataFormatString = "{0:F}")]
        public DateTime UploadDT { get; set; }
    }
}

```

The class uses `Display` and `DisplayFormat` attributes, which produce friendly titles and formatting when the schedule data is rendered.

## Update the RazorPagesMovieContext

Specify a `DbSet` in the `RazorPagesMovieContext` (`Data/RazorPagesMovieContext.cs`) for the schedules:

```

using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.EntityFrameworkCore;

namespace RazorPagesMovie.Models
{
    public class RazorPagesMovieContext : DbContext
    {
        public RazorPagesMovieContext (DbContextOptions<RazorPagesMovieContext> options)
            : base(options)
        {

        }

        public DbSet<RazorPagesMovie.Models.Movie> Movie { get; set; }
        public DbSet<RazorPagesMovie.Models.Schedule> Schedule { get; set; }
    }
}

```

## Update the MovieContext

Specify a `DbSet` in the `MovieContext` (`Models/MovieContext.cs`) for the schedules:

```

using Microsoft.EntityFrameworkCore;

namespace RazorPagesMovie.Models
{
    public class MovieContext : DbContext
    {
        public MovieContext(DbContextOptions<MovieContext> options)
            : base(options)
        {

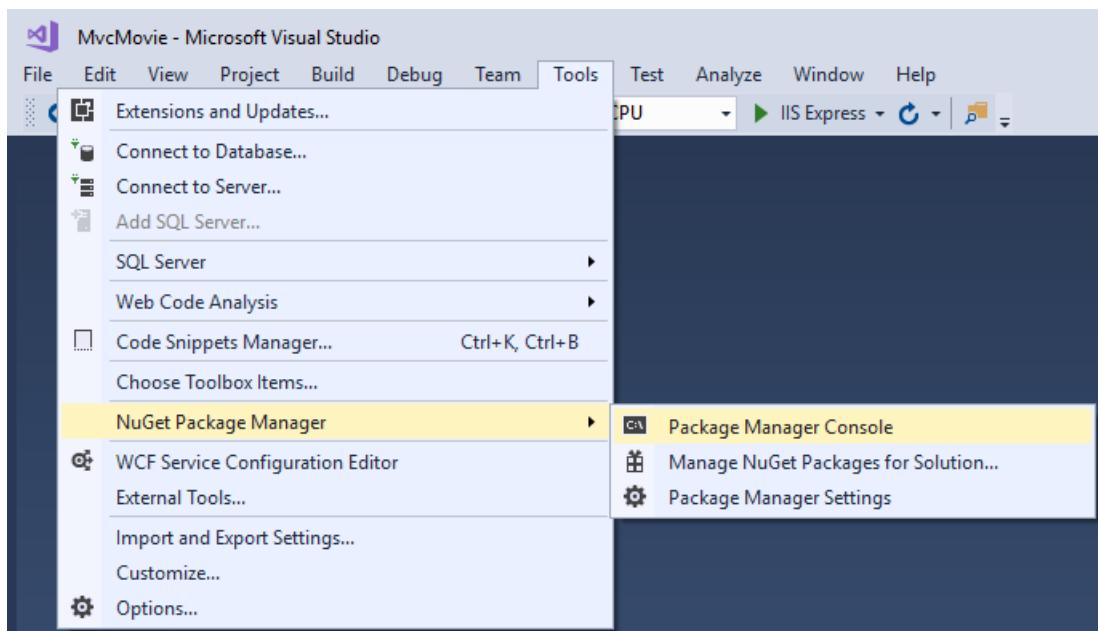
        }

        public DbSet<Movie> Movie { get; set; }
        public DbSet<Schedule> Schedule { get; set; }
    }
}

```

## Add the Schedule table to the database

Open the Package Manager Console (PMC): **Tools > NuGet Package Manager > Package Manager Console**.



In the PMC, execute the following commands. These commands add a `Schedule` table to the database:

```

Add-Migration AddScheduleTable
Update-Database

```

## Add a file upload Razor Page

In the `Pages` folder, create a `Schedules` folder. In the `Schedules` folder, create a page named `Index.cshtml` for uploading a schedule with the following content:

```

@page
@model RazorPagesMovie.Pages.Schedules.IndexModel

 @{
     ViewData["Title"] = "Schedules";
 }

<h2>Schedules</h2>
<hr />

```

```

<h3>Upload Schedules</h3>
<div class="row">
    <div class="col-md-4">
        <form method="post" enctype="multipart/form-data">
            <div class="form-group">
                <label asp-for="FileUpload.Title" class="control-label"></label>
                <input asp-for="FileUpload.Title" type="text" class="form-control" />
                <span asp-validation-for="FileUpload.Title" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="FileUpload.UploadPublicSchedule" class="control-label"></label>
                <input asp-for="FileUpload.UploadPublicSchedule" type="file" class="form-control" style="height:auto" />
                <span asp-validation-for="FileUpload.UploadPublicSchedule" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="FileUpload.UploadPrivateSchedule" class="control-label"></label>
                <input asp-for="FileUpload.UploadPrivateSchedule" type="file" class="form-control" style="height:auto" />
                <span asp-validation-for="FileUpload.UploadPrivateSchedule" class="text-danger"></span>
            </div>
            <input type="submit" value="Upload" class="btn btn-default" />
        </form>
    </div>
</div>

<h3>Loaded Schedules</h3>
<table class="table">
    <thead>
        <tr>
            <th></th>
            <th>
                @Html.DisplayNameFor(model => model.Schedule[0].Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Schedule[0].UploadDT)
            </th>
            <th class="text-center">
                @Html.DisplayNameFor(model => model.Schedule[0].PublicScheduleSize)
            </th>
            <th class="text-center">
                @Html.DisplayNameFor(model => model.Schedule[0].PrivateScheduleSize)
            </th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model.Schedule) {
            <tr>
                <td>
                    <a asp-page=".Delete" asp-route-id="@item.ID">Delete</a>
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.Title)
                </td>
                <td>
                    @Html.DisplayFor(modelItem => item.UploadDT)
                </td>
                <td class="text-center">
                    @Html.DisplayFor(modelItem => item.PublicScheduleSize)
                </td>
                <td class="text-center">
                    @Html.DisplayFor(modelItem => item.PrivateScheduleSize)
                </td>
            </tr>
        }
    </tbody>
</table>

@section Scripts {

```

```
    @await Html.RenderPartialAsync("_ValidationScriptsPartial");}
}
```

```
@page
@model RazorPagesMovie.Pages.Schedules.IndexModel

@{
    ViewData["Title"] = "Schedules";
}

<h2>Schedules</h2>
<hr />

<h3>Upload Schedules</h3>
<div class="row">
    <div class="col-md-4">
        <form method="post" enctype="multipart/form-data">
            <div class="form-group">
                <label asp-for="FileUpload.Title" class="control-label"></label>
                <input asp-for="FileUpload.Title" type="text" class="form-control" />
                <span asp-validation-for="FileUpload.Title" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="FileUpload.UploadPublicSchedule" class="control-label"></label>
                <input asp-for="FileUpload.UploadPublicSchedule" type="file" class="form-control" style="height:auto" />
                <span asp-validation-for="FileUpload.UploadPublicSchedule" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="FileUpload.UploadPrivateSchedule" class="control-label"></label>
                <input asp-for="FileUpload.UploadPrivateSchedule" type="file" class="form-control" style="height:auto" />
                <span asp-validation-for="FileUpload.UploadPrivateSchedule" class="text-danger"></span>
            </div>
            <input type="submit" value="Upload" class="btn btn-default" />
        </form>
    </div>
</div>

<h3>Loaded Schedules</h3>
<table class="table">
    <thead>
        <tr>
            <th></th>
            <th>
                @Html.DisplayNameFor(model => model.Schedule[0].Title)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Schedule[0].UploadDT)
            </th>
            <th class="text-center">
                @Html.DisplayNameFor(model => model.Schedule[0].PublicScheduleSize)
            </th>
            <th class="text-center">
                @Html.DisplayNameFor(model => model.Schedule[0].PrivateScheduleSize)
            </th>
        </tr>
    </thead>
    <tbody>
@foreach (var item in Model.Schedule) {
    <tr>
        <td>
            <a asp-page="./Delete" asp-route-id="@item.ID">Delete</a>
        </td>
        <td>
            @Html.DisplayFor(modelItem => item.Title)
        </td>
```

```

        <td>
            @Html.DisplayFor(modelItem => item.UploadDT)
        </td>
        <td class="text-center">
            @Html.DisplayFor(modelItem => item.PublicScheduleSize)
        </td>
        <td class="text-center">
            @Html.DisplayFor(modelItem => item.PrivateScheduleSize)
        </td>
    </tr>
}
</tbody>
</table>

@section Scripts {
    @{await Html.RenderPartialAsync("_ValidationScriptsPartial");}
}

```

Each form group includes a **<label>** that displays the name of each class property. The **Display** attributes in the **FileUpload** model provide the display values for the labels. For example, the **UploadPublicSchedule** property's display name is set with **[Display(Name="Public Schedule")]** and thus displays "Public Schedule" in the label when the form renders.

Each form group includes a validation **<span>**. If the user's input fails to meet the property attributes set in the **FileUpload** class or if any of the **ProcessFormFile** method file validation checks fail, the model fails to validate. When model validation fails, a helpful validation message is rendered to the user. For example, the **Title** property is annotated with **[Required]** and **[StringLength(60, MinimumLength = 3)]**. If the user fails to supply a title, they receive a message indicating that a value is required. If the user enters a value less than three characters or more than sixty characters, they receive a message indicating that the value has an incorrect length. If a file is provided that has no content, a message appears indicating that the file is empty.

## Add the page model

Add the page model (*Index.cshtml.cs*) to the *Schedules* folder:

```

using System;
using System.Collections.Generic;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using RazorPagesMovie.Models;
using RazorPagesMovie.Utilities;

namespace RazorPagesMovie.Pages.Schedules
{
    public class IndexModel : PageModel
    {
        private readonly RazorPagesMovie.Models.RazorPagesMovieContext _context;

        public IndexModel(RazorPagesMovie.Models.RazorPagesMovieContext context)
        {
            _context = context;
        }

        [BindProperty]
        public FileUpload FileUpload { get; set; }

        public IList<Schedule> Schedule { get; private set; }

        public async Task OnGetAsync()
        {
            Schedule = await context.Schedule.AsNoTracking().ToListAsync();
        }
    }
}

```

```

    }

    public async Task<IActionResult> OnPostAsync()
    {
        // Perform an initial check to catch FileUpload class
        // attribute violations.
        if (!ModelState.IsValid)
        {
            Schedule = await _context.Schedule.AsNoTracking().ToListAsync();
            return Page();
        }

        var publicScheduleData =
            await FileHelpers.ProcessFormFile(FileUpload.UploadPublicSchedule, ModelState);

        var privateScheduleData =
            await FileHelpers.ProcessFormFile(FileUpload.UploadPrivateSchedule, ModelState);

        // Perform a second check to catch ProcessFormFile method
        // violations.
        if (!ModelState.IsValid)
        {
            Schedule = await _context.Schedule.AsNoTracking().ToListAsync();
            return Page();
        }

        var schedule = new Schedule()
        {
            PublicSchedule = publicScheduleData,
            PublicScheduleSize = FileUpload.UploadPublicSchedule.Length,
            PrivateSchedule = privateScheduleData,
            PrivateScheduleSize = FileUpload.UploadPrivateSchedule.Length,
            Title = FileUpload.Title,
            UploadDT = DateTime.UtcNow
        };

        _context.Schedule.Add(schedule);
        await _context.SaveChangesAsync();

        return RedirectToPage("./Index");
    }
}
}
}

```

```

using System;
using System.Collections.Generic;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using RazorPagesMovie.Models;
using RazorPagesMovie.Utilities;

namespace RazorPagesMovie.Pages.Schedules
{
    public class IndexModel : PageModel
    {
        private readonly RazorPagesMovie.Models.MovieContext _context;

        public IndexModel(RazorPagesMovie.Models.MovieContext context)
        {
            _context = context;
        }

        [BindProperty]
        public FileUpload FileUpload { get; set; }
    }
}

```

```

public IList<Schedule> Schedule { get; private set; }

public async Task OnGetAsync()
{
    Schedule = await _context.Schedule.AsNoTracking().ToListAsync();
}

public async Task<IActionResult> OnPostAsync()
{
    // Perform an initial check to catch FileUpload class
    // attribute violations.
    if (!ModelState.IsValid)
    {
        Schedule = await _context.Schedule.AsNoTracking().ToListAsync();
        return Page();
    }

    var publicScheduleData =
        await FileHelpers.ProcessFormFile(FileUpload.UploadPublicSchedule, ModelState);

    var privateScheduleData =
        await FileHelpers.ProcessFormFile(FileUpload.UploadPrivateSchedule, ModelState);

    // Perform a second check to catch ProcessFormFile method
    // violations.
    if (!ModelState.IsValid)
    {
        Schedule = await _context.Schedule.AsNoTracking().ToListAsync();
        return Page();
    }

    var schedule = new Schedule()
    {
        PublicSchedule = publicScheduleData,
        PublicScheduleSize = FileUpload.UploadPublicSchedule.Length,
        PrivateSchedule = privateScheduleData,
        PrivateScheduleSize = FileUpload.UploadPrivateSchedule.Length,
        Title = FileUpload.Title,
        UploadDT = DateTime.UtcNow
    };

    _context.Schedule.Add(schedule);
    await _context.SaveChangesAsync();

    return RedirectToPage("./Index");
}
}
}

```

The page model (`IndexModel` in `Index.cshtml.cs`) binds the `FileUpload` class:

```

[BindProperty]
public FileUpload FileUpload { get; set; }

```

```

[BindProperty]
public FileUpload FileUpload { get; set; }

```

The model also uses a list of the schedules (`IList<Schedule>`) to display the schedules stored in the database on the page:

```

public IList<Schedule> Schedule { get; private set; }

```

```
public IList<Schedule> Schedule { get; private set; }
```

When the page loads with `OnGetAsync`, `Schedules` is populated from the database and used to generate an HTML table of loaded schedules:

```
public async Task OnGetAsync()
{
    Schedule = await _context.Schedule.AsNoTracking().ToListAsync();
}
```

```
public async Task OnGetAsync()
{
    Schedule = await _context.Schedule.AsNoTracking().ToListAsync();
}
```

When the form is posted to the server, the `ModelState` is checked. If invalid, `schedule` is rebuilt, and the page renders with one or more validation messages stating why page validation failed. If valid, the `FileUpload` properties are used in `OnPostAsync` to complete the file upload for the two versions of the schedule and to create a new `Schedule` object to store the data. The schedule is then saved to the database:

```
public async Task<IActionResult> OnPostAsync()
{
    // Perform an initial check to catch FileUpload class
    // attribute violations.
    if (!ModelState.IsValid)
    {
        Schedule = await _context.Schedule.AsNoTracking().ToListAsync();
        return Page();
    }

    var publicScheduleData =
        await FileHelpers.ProcessSchedule(FileUpload.UploadPublicSchedule, ModelState);

    var privateScheduleData =
        await FileHelpers.ProcessSchedule(FileUpload.UploadPrivateSchedule, ModelState);

    // Perform a second check to catch ProcessSchedule method
    // violations.
    if (!ModelState.IsValid)
    {
        Schedule = await _context.Schedule.AsNoTracking().ToListAsync();
        return Page();
    }

    var schedule = new Schedule()
    {
        PublicSchedule = publicScheduleData,
        PublicScheduleSize = FileUpload.UploadPublicSchedule.Length,
        PrivateSchedule = privateScheduleData,
        PrivateScheduleSize = FileUpload.UploadPrivateSchedule.Length,
        Title = FileUpload.Title,
        UploadDT = DateTime.UtcNow
    };

    _context.Schedule.Add(schedule);
    await _context.SaveChangesAsync();

    return RedirectToPage("./Index");
}
```

```

public async Task<IActionResult> OnPostAsync()
{
    // Perform an initial check to catch FileUpload class
    // attribute violations.
    if (!ModelState.IsValid)
    {
        Schedule = await _context.Schedule.AsNoTracking().ToListAsync();
        return Page();
    }

    var publicScheduleData =
        await FileHelpers.ProcessSchedule(FileUpload.UploadPublicSchedule, ModelState);

    var privateScheduleData =
        await FileHelpers.ProcessSchedule(FileUpload.UploadPrivateSchedule, ModelState);

    // Perform a second check to catch ProcessSchedule method
    // violations.
    if (!ModelState.IsValid)
    {
        Schedule = await _context.Schedule.AsNoTracking().ToListAsync();
        return Page();
    }

    var schedule = new Schedule()
    {
        PublicSchedule = publicScheduleData,
        PublicScheduleSize = FileUpload.UploadPublicSchedule.Length,
        PrivateSchedule = privateScheduleData,
        PrivateScheduleSize = FileUpload.UploadPrivateSchedule.Length,
        Title = FileUpload.Title,
        UploadDT = DateTime.UtcNow
    };

    _context.Schedule.Add(schedule);
    await _context.SaveChangesAsync();

    return RedirectToPage("./Index");
}

```

## Link the file upload Razor Page

Open *Pages/Shared/\_Layout.cshtml* and add a link to the navigation bar to reach the Schedules page:

```

<div class="navbar-collapse collapse">
    <ul class="nav navbar-nav">
        <li><a asp-page="/Index">Home</a></li>
        <li><a asp-page="/Schedules/Index">Schedules</a></li>
        <li><a asp-page="/About">About</a></li>
        <li><a asp-page="/Contact">Contact</a></li>
    </ul>
</div>

```

## Add a page to confirm schedule deletion

When the user clicks to delete a schedule, a chance to cancel the operation is provided. Add a delete confirmation page (*Delete.cshtml*) to the *Schedules* folder:

```

@page "{id:int}"
@model RazorPagesMovie.Pages.Schedules.DeleteModel

@{
    ViewData["Title"] = "Delete Schedule";
}

<h2>Delete Schedule</h2>

<h3>Are you sure you want to delete this?</h3>
<div>
    <h4>Schedule</h4>
    <hr />
    <dl class="dl-horizontal">
        <dt>
            @Html.DisplayNameFor(model => model.Schedule.Title)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Schedule.Title)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Schedule.PublicScheduleSize)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Schedule.PublicScheduleSize)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Schedule.PrivateScheduleSize)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Schedule.PrivateScheduleSize)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Schedule.UploadDT)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Schedule.UploadDT)
        </dd>
    </dl>

    <form method="post">
        <input type="hidden" asp-for="Schedule.ID" />
        <input type="submit" value="Delete" class="btn btn-default" /> |
        <a asp-page="./Index">Back to List</a>
    </form>
</div>

```

```

@page "{id:int}"
@model RazorPagesMovie.Pages.Schedules.DeleteModel

@{
    ViewData["Title"] = "Delete Schedule";
}

<h2>Delete Schedule</h2>

<h3>Are you sure you want to delete this?</h3>
<div>
    <h4>Schedule</h4>
    <hr />
    <dl class="dl-horizontal">
        <dt>
            @Html.DisplayNameFor(model => model.Schedule.Title)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Schedule.Title)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Schedule.PublicScheduleSize)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Schedule.PublicScheduleSize)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Schedule.PrivateScheduleSize)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Schedule.PrivateScheduleSize)
        </dd>
        <dt>
            @Html.DisplayNameFor(model => model.Schedule.UploadDT)
        </dt>
        <dd>
            @Html.DisplayFor(model => model.Schedule.UploadDT)
        </dd>
    </dl>

    <form method="post">
        <input type="hidden" asp-for="Schedule.ID" />
        <input type="submit" value="Delete" class="btn btn-default" /> |
        <a asp-page="./Index">Back to List</a>
    </form>
</div>

```

The page model (*Delete.cshtml.cs*) loads a single schedule identified by `id` in the request's route data. Add the *Delete.cshtml.cs* file to the *Schedules* folder:

```
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using RazorPagesMovie.Models;

namespace RazorPagesMovie.Pages.Schedules
{
    public class DeleteModel : PageModel
    {
        private readonly RazorPagesMovie.Models.RazorPagesMovieContext _context;

        public DeleteModel(RazorPagesMovie.Models.RazorPagesMovieContext context)
        {
            _context = context;
        }

        [BindProperty]
        public Schedule Schedule { get; set; }

        public async Task<IActionResult> OnGetAsync(int? id)
        {
            if (id == null)
            {
                return NotFound();
            }

            Schedule = await _context.Schedule.SingleOrDefaultAsync(m => m.ID == id);

            if (Schedule == null)
            {
                return NotFound();
            }
            return Page();
        }

        public async Task<IActionResult> OnPostAsync(int? id)
        {
            if (id == null)
            {
                return NotFound();
            }

            Schedule = await _context.Schedule.FindAsync(id);

            if (Schedule != null)
            {
                _context.Schedule.Remove(Schedule);
                await _context.SaveChangesAsync();
            }

            return RedirectToPage("./Index");
        }
    }
}
```

```

using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.RazorPages;
using Microsoft.EntityFrameworkCore;
using RazorPagesMovie.Models;

namespace RazorPagesMovie.Pages.Schedules
{
    public class DeleteModel : PageModel
    {
        private readonly RazorPagesMovie.Models.MovieContext _context;

        public DeleteModel(RazorPagesMovie.Models.MovieContext context)
        {
            _context = context;
        }

        [BindProperty]
        public Schedule Schedule { get; set; }

        public async Task<IActionResult> OnGetAsync(int? id)
        {
            if (id == null)
            {
                return NotFound();
            }

            Schedule = await _context.Schedule.SingleOrDefaultAsync(m => m.ID == id);

            if (Schedule == null)
            {
                return NotFound();
            }
            return Page();
        }

        public async Task<IActionResult> OnPostAsync(int? id)
        {
            if (id == null)
            {
                return NotFound();
            }

            Schedule = await _context.Schedule.FindAsync(id);

            if (Schedule != null)
            {
                _context.Schedule.Remove(Schedule);
                await _context.SaveChangesAsync();
            }

            return RedirectToPage("./Index");
        }
    }
}

```

The `OnPostAsync` method handles deleting the schedule by its `id`:

```

public async Task<IActionResult> OnPostAsync(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    Schedule = await _context.Schedule.FindAsync(id);

    if (Schedule != null)
    {
        _context.Schedule.Remove(Schedule);
        await _context.SaveChangesAsync();
    }

    return RedirectToPage("./Index");
}

```

```

public async Task<IActionResult> OnPostAsync(int? id)
{
    if (id == null)
    {
        return NotFound();
    }

    Schedule = await _context.Schedule.FindAsync(id);

    if (Schedule != null)
    {
        _context.Schedule.Remove(Schedule);
        await _context.SaveChangesAsync();
    }

    return RedirectToPage("./Index");
}

```

After successfully deleting the schedule, the `RedirectToPage` sends the user back to the schedules *Index.cshtml* page.

## The working Schedules Razor Page

When the page loads, labels and inputs for schedule title, public schedule, and private schedule are rendered with a submit button:

## Upload Schedules

### Title

### Public Schedule

Choose File No file chosen

### Private Schedule

Choose File No file chosen

Upload

Selecting the **Upload** button without populating any of the fields violates the `[Required]` attributes on the model. The `ModelState` is invalid. The validation error messages are displayed to the user:

## Upload Schedules

### Title

The Title field is required.

### Public Schedule

Choose File No file chosen

The Public Schedule field is required.

### Private Schedule

Choose File No file chosen

The Private Schedule field is required.

Upload

Type two letters into the **Title** field. The validation message changes to indicate that the title must be between 3-60 characters:

### Title

ab

The field Title must be a string with a minimum length of 3 and a maximum length of 60.

When one or more schedules are uploaded, the **Loaded Schedules** section renders the loaded schedules:

## Loaded Schedules

Title	Uploaded (UTC)	Public Schedule Size (bytes)	Private Schedule Size (bytes)
<a href="#">Delete</a> Schedule #1	Monday, September 11, 2017 9:09:22 PM	3,805.0	2,417.0
<a href="#">Delete</a> Schedule #2	Monday, September 11, 2017 9:09:35 PM	2,023.0	997.0

The user can click the **Delete** link from there to reach the delete confirmation view, where they have an opportunity to confirm or cancel the delete operation.

## Troubleshooting

For troubleshooting information with `IFormFile` uploading, see the [File uploads in ASP.NET Core](#):

[Troubleshooting](#).

# ASP.NET Core Razor SDK

6/21/2018 • 3 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

The [.NET Core 2.1 SDK or later](#) includes the `Microsoft.NET.Sdk.Razor` MSBuild SDK (Razor SDK). The Razor SDK:

- Standardizes the experience around building, packaging, and publishing projects containing [Razor](#) files for ASP.NET Core MVC-based projects.
- Includes a set of predefined targets, properties, and items that allow customizing the compilation of Razor files.

## Prerequisites

[.NET Core 2.1 SDK or later](#)

## Using the Razor SDK

Most web apps don't need to expressly reference the Razor SDK.

To use the Razor SDK to build class libraries containing Razor views or Razor Pages:

- Use `Microsoft.NET.Sdk.Razor` instead of `Microsoft.NET.Sdk`:

```
<Project Sdk="Microsoft.NET.Sdk.Razor">
  ...
</Project>
```

- Typically a package reference to `Microsoft.AspNetCore.Mvc` is required to bring in additional dependencies required to build and compile Razor Pages and Razor views. At minimum, your project needs to add package references to:
  - `Microsoft.AspNetCore.Razor.Design`
  - `Microsoft.AspNetCore.Mvc.Razor.Extensions`

The preceding packages are included in `Microsoft.AspNetCore.Mvc`. The following markup shows a basic `.csproj` file that uses the Razor SDK to build Razor files for an ASP.NET Core Razor Pages app:

```
<Project Sdk="Microsoft.NET.Sdk.Razor">

  <PropertyGroup>
    <TargetFramework>netcoreapp2.1</TargetFramework>
  </PropertyGroup>

  <ItemGroup>
    <PackageReference Include="Microsoft.AspNetCore.Mvc" Version="2.1.0" />
  </ItemGroup>

</Project>
```

## Properties

The following properties control the Razor's SDK behavior as part of a project build:

- `RazorCompileOnBuild`: When `true`, compiles and emits the Razor assembly as part of building the project.

- Defaults to `true`.
- `RazorCompileOnPublish` : When `true`, compiles and emits the Razor assembly as part of publishing the project.  
Defaults to `true`.

The following properties and items are used to configure inputs and output to the Razor SDK:

ITEMS	DESCRIPTION
<code>RazorGenerate</code>	Item elements ( <code>.cshtml</code> files) that are inputs to code generation targets.
<code>RazorCompile</code>	Item elements ( <code>.cs</code> files) that are inputs to Razor compilation targets. Use this ItemGroup to specify additional files to be compiled into the Razor assembly.
<code>RazorTargetAssemblyAttribute</code>	Item elements used to code generate attributes for the Razor assembly. For example: <pre>&lt;RazorAssemblyAttribute Include="System.Reflection.AssemblyMetadataAttribute" _Parameter1="BuildSource" _Parameter2="https://docs.asp.net/"&gt;</pre>
<code>RazorEmbeddedResource</code>	Item elements added as embedded resources to the generated Razor assembly
PROPERTY	DESCRIPTION
<code>RazorTargetName</code>	File name (without extension) of the assembly produced by Razor.
<code>RazorOutputPath</code>	The Razor output directory.
<code>RazorCompileToolset</code>	Used to determine the toolset used to build the Razor assembly. Valid values are <code>Implicit</code> , and <code>PrecompilationTool</code> .
<code>EnableDefaultContentItems</code>	When <code>true</code> , includes certain file types, such as <code>.cshtml</code> files, as content in the project. When referenced via Microsoft.NET.Sdk.Web, also includes all files under <code>wwwroot</code> , and config files.
<code>EnableDefaultRazorGenerateItems</code>	When <code>true</code> , includes <code>.cshtml</code> files from <code>Content</code> items in <code>RazorGenerate</code> items.
<code>GenerateRazorTargetAssemblyInfo</code>	When <code>true</code> , generates a <code>.cs</code> file containing attributes specified by <code>RazorAssemblyAttribute</code> and includes it in the compile output.
<code>EnableDefaultRazorTargetAssemblyInfoAttributes</code>	When <code>true</code> , adds a default set of assembly attributes to <code>RazorAssemblyAttribute</code> .
<code>CopyRazorGenerateFilesToPublishDirectory</code>	When <code>true</code> , copies <code>RazorGenerate</code> items ( <code>.cshtml</code> ) files to the publish directory. Typically Razor files are not needed for a published application if they participate in compilation at build-time or publish-time. Defaults to <code>false</code> .

PROPERTY	DESCRIPTION
CopyRefAssembliesToPublishDirectory	When <code>true</code> , copy reference assembly items to the publish directory. Typically reference assemblies are not needed for a published application if Razor compilation occurs at build-time or publish-time. Set to <code>true</code> , if your published application requires runtime compilation, for example, modifies cshtml files at runtime, or uses embedded views. Defaults to <code>false</code> .
IncludeRazorContentInPack	When <code>true</code> , all Razor content items (.cshtml files) will be marked for inclusion in the generated NuGet package. Defaults to <code>false</code> .
EmbedRazorGenerateSources	When <code>true</code> , adds RazorGenerate (.cshtml) items as embedded files to the generated Razor assembly. Defaults to <code>false</code> .
UseRazorBuildServer	When <code>true</code> , uses a persistent build server process to offload code generation work. Defaults to the value of <code>UseSharedCompilation</code> .

## Targets

The Razor SDK defines two primary targets:

- `RazorGenerate` - Code generates .cs files from RazorGenerate item elements. Use `RazorGenerateDependsOn` property to specify additional targets that can run before or after this target.
- `RazorCompile` - Compiles generated .cs files in to a Razor assembly. Use `RazorCompileDependsOn` to specify additional targets that can run before or after this target.

## Runtime compilation of Razor views

- By default, the Razor SDK doesn't publish reference assemblies that are required to perform runtime compilation. This results in compilation failures when the application model relies on runtime compilation—for example, the app uses embedded views or changes views after the app is published. Set `CopyRefAssembliesToPublishDirectory` to `true` to continue publishing reference assemblies.
- For web applications, ensure your app is targeting `Microsoft.NET.Sdk.Web` SDK.

# Overview of ASP.NET Core MVC

6/21/2018 • 9 minutes to read • [Edit Online](#)

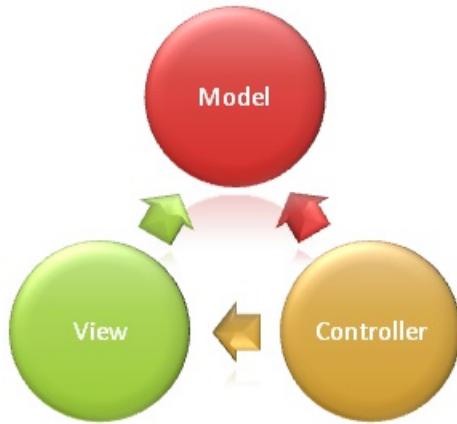
By [Steve Smith](#)

ASP.NET Core MVC is a rich framework for building web apps and APIs using the Model-View-Controller design pattern.

## What is the MVC pattern?

The Model-View-Controller (MVC) architectural pattern separates an application into three main groups of components: Models, Views, and Controllers. This pattern helps to achieve [separation of concerns](#). Using this pattern, user requests are routed to a Controller which is responsible for working with the Model to perform user actions and/or retrieve results of queries. The Controller chooses the View to display to the user, and provides it with any Model data it requires.

The following diagram shows the three main components and which ones reference the others:



This delineation of responsibilities helps you scale the application in terms of complexity because it's easier to code, debug, and test something (model, view, or controller) that has a single job (and follows the [Single Responsibility Principle](#)). It's more difficult to update, test, and debug code that has dependencies spread across two or more of these three areas. For example, user interface logic tends to change more frequently than business logic. If presentation code and business logic are combined in a single object, an object containing business logic must be modified every time the user interface is changed. This often introduces errors and requires the retesting of business logic after every minimal user interface change.

### NOTE

Both the view and the controller depend on the model. However, the model depends on neither the view nor the controller. This is one of the key benefits of the separation. This separation allows the model to be built and tested independent of the visual presentation.

## Model Responsibilities

The Model in an MVC application represents the state of the application and any business logic or operations that should be performed by it. Business logic should be encapsulated in the model, along with any implementation logic for persisting the state of the application. Strongly-typed views typically use ViewModel types designed to

contain the data to display on that view. The controller creates and populates these ViewModel instances from the model.

#### NOTE

There are many ways to organize the model in an app that uses the MVC architectural pattern. Learn more about some [different kinds of model types](#).

## View Responsibilities

Views are responsible for presenting content through the user interface. They use the [Razor view engine](#) to embed .NET code in HTML markup. There should be minimal logic within views, and any logic in them should relate to presenting content. If you find the need to perform a great deal of logic in view files in order to display data from a complex model, consider using a [View Component](#), ViewModel, or view template to simplify the view.

## Controller Responsibilities

Controllers are the components that handle user interaction, work with the model, and ultimately select a view to render. In an MVC application, the view only displays information; the controller handles and responds to user input and interaction. In the MVC pattern, the controller is the initial entry point, and is responsible for selecting which model types to work with and which view to render (hence its name - it controls how the app responds to a given request).

#### NOTE

Controllers shouldn't be overly complicated by too many responsibilities. To keep controller logic from becoming overly complex, use the [Single Responsibility Principle](#) to push business logic out of the controller and into the domain model.

#### TIP

If you find that your controller actions frequently perform the same kinds of actions, you can follow the [Don't Repeat Yourself principle](#) by moving these common actions into [filters](#).

## What is ASP.NET Core MVC

The ASP.NET Core MVC framework is a lightweight, open source, highly testable presentation framework optimized for use with ASP.NET Core.

ASP.NET Core MVC provides a patterns-based way to build dynamic websites that enables a clean separation of concerns. It gives you full control over markup, supports TDD-friendly development and uses the latest web standards.

## Features

ASP.NET Core MVC includes the following:

- [Routing](#)
- [Model binding](#)
- [Model validation](#)
- [Dependency injection](#)
- [Filters](#)
- [Areas](#)
- [Web APIs](#)

- [Testability](#)
- [Razor view engine](#)
- [Strongly typed views](#)
- [Tag Helpers](#)
- [View Components](#)

## Routing

ASP.NET Core MVC is built on top of [ASP.NET Core's routing](#), a powerful URL-mapping component that lets you build applications that have comprehensible and searchable URLs. This enables you to define your application's URL naming patterns that work well for search engine optimization (SEO) and for link generation, without regard for how the files on your web server are organized. You can define your routes using a convenient route template syntax that supports route value constraints, defaults and optional values.

*Convention-based routing* enables you to globally define the URL formats that your application accepts and how each of those formats maps to a specific action method on given controller. When an incoming request is received, the routing engine parses the URL and matches it to one of the defined URL formats, and then calls the associated controller's action method.

```
routes.MapRoute(name: "Default", template: "{controller=Home}/{action=Index}/{id?}");
```

*Attribute routing* enables you to specify routing information by decorating your controllers and actions with attributes that define your application's routes. This means that your route definitions are placed next to the controller and action with which they're associated.

```
[Route("api/[controller]")]
public class ProductsController : Controller
{
    [HttpGet("{id}")]
    public IActionResult GetProduct(int id)
    {
        ...
    }
}
```

## Model binding

ASP.NET Core MVC [model binding](#) converts client request data (form values, route data, query string parameters, HTTP headers) into objects that the controller can handle. As a result, your controller logic doesn't have to do the work of figuring out the incoming request data; it simply has the data as parameters to its action methods.

```
public async Task<IActionResult> Login(LoginViewModel model, string returnUrl = null) { ... }
```

## Model validation

ASP.NET Core MVC supports [validation](#) by decorating your model object with data annotation validation attributes. The validation attributes are checked on the client side before values are posted to the server, as well as on the server before the controller action is called.

```

using System.ComponentModel.DataAnnotations;
public class LoginViewModel
{
    [Required]
    [EmailAddress]
    public string Email { get; set; }

    [Required]
    [DataType(DataType.Password)]
    public string Password { get; set; }

    [Display(Name = "Remember me?")]
    public bool RememberMe { get; set; }
}

```

A controller action:

```

public async Task<IActionResult> Login(LoginViewModel model, string returnUrl = null)
{
    if (ModelState.IsValid)
    {
        // work with the model
    }
    // At this point, something failed, redisplay form
    return View(model);
}

```

The framework handles validating request data both on the client and on the server. Validation logic specified on model types is added to the rendered views as unobtrusive annotations and is enforced in the browser with [jQuery Validation](#).

## Dependency injection

ASP.NET Core has built-in support for [dependency injection \(DI\)](#). In ASP.NET Core MVC, [controllers](#) can request needed services through their constructors, allowing them to follow the [Explicit Dependencies Principle](#).

Your app can also use [dependency injection in view files](#), using the `@inject` directive:

```

@inject SomeService ServiceName
<!DOCTYPE html>
<html lang="en">
<head>
    <title>@ServiceName.GetTitle</title>
</head>
<body>
    <h1>@ServiceName.GetTitle</h1>
</body>
</html>

```

## Filters

[Filters](#) help developers encapsulate cross-cutting concerns, like exception handling or authorization. Filters enable running custom pre- and post-processing logic for action methods, and can be configured to run at certain points within the execution pipeline for a given request. Filters can be applied to controllers or actions as attributes (or can be run globally). Several filters (such as `Authorize`) are included in the framework.

```

[Authorize]
public class AccountController : Controller
{

```

## Areas

Areas provide a way to partition a large ASP.NET Core MVC Web app into smaller functional groupings. An area is an MVC structure inside an application. In an MVC project, logical components like Model, Controller, and View are kept in different folders, and MVC uses naming conventions to create the relationship between these components. For a large app, it may be advantageous to partition the app into separate high level areas of functionality. For instance, an e-commerce app with multiple business units, such as checkout, billing, and search etc. Each of these units have their own logical component views, controllers, and models.

## Web APIs

In addition to being a great platform for building web sites, ASP.NET Core MVC has great support for building Web APIs. You can build services that reach a broad range of clients including browsers and mobile devices.

The framework includes support for HTTP content-negotiation with built-in support to [format data](#) as JSON or XML. Write [custom formatters](#) to add support for your own formats.

Use link generation to enable support for hypermedia. Easily enable support for [cross-origin resource sharing \(CORS\)](#) so that your Web APIs can be shared across multiple Web applications.

## Testability

The framework's use of interfaces and dependency injection make it well-suited to unit testing, and the framework includes features (like a TestHost and InMemory provider for Entity Framework) that make [integration tests](#) quick and easy as well. Learn more about [how to test controller logic](#).

## Razor view engine

ASP.NET Core MVC views use the [Razor view engine](#) to render views. Razor is a compact, expressive and fluid template markup language for defining views using embedded C# code. Razor is used to dynamically generate web content on the server. You can cleanly mix server code with client side content and code.

```
<ul>
    @for (int i = 0; i < 5; i++) {
        <li>List item @i</li>
    }
</ul>
```

Using the Razor view engine you can define [layouts](#), [partial views](#) and replaceable sections.

## Strongly typed views

Razor views in MVC can be strongly typed based on your model. Controllers can pass a strongly typed model to views enabling your views to have type checking and IntelliSense support.

For example, the following view renders a model of type `IEnumerable<Product>` :

```
@model IEnumerable<Product>
<ul>
    @foreach (Product p in Model)
    {
        <li>@p.Name</li>
    }
</ul>
```

## Tag Helpers

[Tag Helpers](#) enable server side code to participate in creating and rendering HTML elements in Razor files. You can use tag helpers to define custom tags (for example, `<environment>`) or to modify the behavior of existing tags (for example, `<label>`). Tag Helpers bind to specific elements based on the element name and its attributes. They provide the benefits of server-side rendering while still preserving an HTML editing experience.

There are many built-in Tag Helpers for common tasks - such as creating forms, links, loading assets and more - and even more available in public GitHub repositories and as NuGet packages. Tag Helpers are authored in C#, and they target HTML elements based on element name, attribute name, or parent tag. For example, the built-in `LinkTagHelper` can be used to create a link to the `Login` action of the `AccountsController`:

```
<p>
    Thank you for confirming your email.
    Please <a asp-controller="Account" asp-action="Login">Click here to Log in</a>.
</p>
```

The `EnvironmentTagHelper` can be used to include different scripts in your views (for example, raw or minified) based on the runtime environment, such as Development, Staging, or Production:

```
<environment names="Development">
    <script src="~/lib/jquery/dist/jquery.js"></script>
</environment>
<environment names="Staging,Production">
    <script src="https://ajax.aspnetcdn.com/ajax/jquery/jquery-2.1.4.min.js"
        asp-fallback-src="~/lib/jquery/dist/jquery.min.js"
        asp-fallback-test="window.jQuery">
    </script>
</environment>
```

Tag Helpers provide an HTML-friendly development experience and a rich IntelliSense environment for creating HTML and Razor markup. Most of the built-in Tag Helpers target existing HTML elements and provide server-side attributes for the element.

## View Components

[View Components](#) allow you to package rendering logic and reuse it throughout the application. They're similar to [partial views](#), but with associated logic.

# Model Binding in ASP.NET Core

6/21/2018 • 7 minutes to read • [Edit Online](#)

By [Rachel Appel](#)

## Introduction to model binding

Model binding in ASP.NET Core MVC maps data from HTTP requests to action method parameters. The parameters may be simple types such as strings, integers, or floats, or they may be complex types. This is a great feature of MVC because mapping incoming data to a counterpart is an often repeated scenario, regardless of size or complexity of the data. MVC solves this problem by abstracting binding away so developers don't have to keep rewriting a slightly different version of that same code in every app. Writing your own text to type converter code is tedious, and error prone.

## How model binding works

When MVC receives an HTTP request, it routes it to a specific action method of a controller. It determines which action method to run based on what is in the route data, then it binds values from the HTTP request to that action method's parameters. For example, consider the following URL:

```
http://contoso.com/movies/edit/2
```

Since the route template looks like this, `{controller=Home}/{action=Index}/{id?}`, `movies/edit/2` routes to the `Movies` controller, and its `Edit` action method. It also accepts an optional parameter called `id`. The code for the action method should look something like this:

```
public IActionResult Edit(int? id)
```

Note: The strings in the URL route are not case sensitive.

MVC will try to bind request data to the action parameters by name. MVC will look for values for each parameter using the parameter name and the names of its public settable properties. In the above example, the only action parameter is named `id`, which MVC binds to the value with the same name in the route values. In addition to route values MVC will bind data from various parts of the request and it does so in a set order. Below is a list of the data sources in the order that model binding looks through them:

1. `Form values`: These are form values that go in the HTTP request using the POST method. (including jQuery POST requests).
2. `Route values`: The set of route values provided by [Routing](#)
3. `Query strings`: The query string part of the URI.

Note: Form values, route data, and query strings are all stored as name-value pairs.

Since model binding asked for a key named `id` and there's nothing named `id` in the form values, it moved on to the route values looking for that key. In our example, it's a match. Binding happens, and the value is converted to the integer 2. The same request using `Edit(string id)` would convert to the string "2".

So far the example uses simple types. In MVC simple types are any .NET primitive type or type with a string type converter. If the action method's parameter were a class such as the `Movie` type, which

contains both simple and complex types as properties, MVC's model binding will still handle it nicely. It uses reflection and recursion to traverse the properties of complex types looking for matches. Model binding looks for the pattern `parameter_name.property_name` to bind values to properties. If it doesn't find matching values of this form, it will attempt to bind using just the property name. For those types such as `Collection` types, model binding looks for matches to `parameter_name[index]` or just `[index]`. Model binding treats `Dictionary` types similarly, asking for `parameter_name[key]` or just `[key]`, as long as the keys are simple types. Keys that are supported match the field names HTML and tag helpers generated for the same model type. This enables round-tripping values so that the form fields remain filled with the user's input for their convenience, for example, when bound data from a create or edit didn't pass validation.

In order for binding to happen the class must have a public default constructor and member to be bound must be public writable properties. When model binding happens the class will only be instantiated using the public default constructor, then the properties can be set.

When a parameter is bound, model binding stops looking for values with that name and it moves on to bind the next parameter. Otherwise, the default model binding behavior sets parameters to their default values depending on their type:

- `T[]` : With the exception of arrays of type `byte[]`, binding sets parameters of type `T[]` to `Array.Empty<T>()`. Arrays of type `byte[]` are set to `null`.
- Reference Types: Binding creates an instance of a class with the default constructor without setting properties. However, model binding sets `string` parameters to `null`.
- Nullable Types: Nullable types are set to `null`. In the above example, model binding sets `id` to `null` since it's of type `int?`.
- Value Types: Non-nullable value types of type `T` are set to `default(T)`. For example, model binding will set a parameter `int id` to 0. Consider using model validation or nullable types rather than relying on default values.

If binding fails, MVC doesn't throw an error. Every action which accepts user input should check the `ModelState.IsValid` property.

Note: Each entry in the controller's `ModelState` property is a `ModelStateEntry` containing an `Errors` property. It's rarely necessary to query this collection yourself. Use `ModelState.IsValid` instead.

Additionally, there are some special data types that MVC must consider when performing model binding:

- `IFormFile` , `IEnumerable<IFormFile>` : One or more uploaded files that are part of the HTTP request.
- `CancellationToken` : Used to cancel activity in asynchronous controllers.

These types can be bound to action parameters or to properties on a class type.

Once model binding is complete, [Validation](#) occurs. Default model binding works great for the vast majority of development scenarios. It's also extensible so if you have unique needs you can customize the built-in behavior.

## Customize model binding behavior with attributes

MVC contains several attributes that you can use to direct its default model binding behavior to a different source. For example, you can specify whether binding is required for a property, or if it should never happen at all by using the `[BindRequired]` or `[BindNever]` attributes. Alternatively, you can override the default data source, and specify the model binder's data source. Below is a list of model binding attributes:

- `[BindRequired]` : This attribute adds a model state error if binding cannot occur.
- `[BindNever]` : Tells the model binder to never bind to this parameter.
- `[FromHeader]` , `[FromQuery]` , `[FromRoute]` , `[FromForm]` : Use these to specify the exact binding source you want to apply.
- `[FromServices]` : This attribute uses [dependency injection](#) to bind parameters from services.
- `[FromBody]` : Use the configured formatters to bind data from the request body. The formatter is selected based on content type of the request.
- `[ModelBinder]` : Used to override the default model binder, binding source and name.

Attributes are very helpful tools when you need to override the default behavior of model binding.

## Bind formatted data from the request body

Request data can come in a variety of formats including JSON, XML and many others. When you use the `[FromBody]` attribute to indicate that you want to bind a parameter to data in the request body, MVC uses a configured set of formatters to handle the request data based on its content type. By default MVC includes a `JsonInputFormatter` class for handling JSON data, but you can add additional formatters for handling XML and other custom formats.

### NOTE

There can be at most one parameter per action decorated with `[FromBody]`. The ASP.NET Core MVC run-time delegates the responsibility of reading the request stream to the formatter. Once the request stream is read for a parameter, it's generally not possible to read the request stream again for binding other `[FromBody]` parameters.

### NOTE

The `JsonInputFormatter` is the default formatter and is based on [Json.NET](#).

ASP.NET selects input formatters based on the [Content-Type](#) header and the type of the parameter, unless there's an attribute applied to it specifying otherwise. If you'd like to use XML or another format you must configure it in the *Startup.cs* file, but you may first have to obtain a reference to

`Microsoft.AspNetCore.Mvc.Formatters.Xml` using NuGet. Your startup code should look something like this:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc()
        .AddXmlSerializerFormatters();
}
```

Code in the *Startup.cs* file contains a `ConfigureServices` method with a `services` argument you can use to build up services for your ASP.NET app. In the sample, we are adding an XML formatter as a service that MVC will provide for this app. The `options` argument passed into the `AddMvc` method allows you to add and manage filters, formatters, and other system options from MVC upon app startup. Then apply the `Consumes` attribute to controller classes or action methods to work with the format you want.

## Custom Model Binding

You can extend model binding by writing your own custom model binders. Learn more about [custom model binding](#).

# Model validation in ASP.NET Core MVC

6/21/2018 • 15 minutes to read • [Edit Online](#)

By [Rachel Appel](#)

## Introduction to model validation

Before an app stores data in a database, the app must validate the data. Data must be checked for potential security threats, verified that it's appropriately formatted by type and size, and it must conform to your rules. Validation is necessary although it can be redundant and tedious to implement. In MVC, validation happens on both the client and server.

Fortunately, .NET has abstracted validation into validation attributes. These attributes contain validation code, thereby reducing the amount of code you must write.

[View or download sample from GitHub.](#)

## Validation Attributes

Validation attributes are a way to configure model validation so it's similar conceptually to validation on fields in database tables. This includes constraints such as assigning data types or required fields. Other types of validation include applying patterns to data to enforce business rules, such as a credit card, phone number, or email address. Validation attributes make enforcing these requirements much simpler and easier to use.

Below is an annotated `Movie` model from an app that stores information about movies and TV shows. Most of the properties are required and several string properties have length requirements. Additionally, there's a numeric range restriction in place for the `Price` property from 0 to \$999.99, along with a custom validation attribute.

```
public class Movie
{
    public int Id { get; set; }

    [Required]
    [StringLength(100)]
    public string Title { get; set; }

    [ClassicMovie(1960)]
    [DataType(DataType.Date)]
    public DateTime ReleaseDate { get; set; }

    [Required]
    [StringLength(1000)]
    public string Description { get; set; }

    [Range(0, 999.99)]
    public decimal Price { get; set; }

    [Required]
    public Genre Genre { get; set; }

    public bool Preorder { get; set; }
}
```

Simply reading through the model reveals the rules about data for this app, making it easier to maintain the code. Below are several popular built-in validation attributes:

- `[CreditCard]` : Validates the property has a credit card format.
- `[Compare]` : Validates two properties in a model match.
- `[EmailAddress]` : Validates the property has an email format.
- `[Phone]` : Validates the property has a telephone format.
- `[Range]` : Validates the property value falls within the given range.
- `[RegularExpression]` : Validates that the data matches the specified regular expression.
- `[Required]` : Makes a property required.
- `[StringLength]` : Validates that a string property has at most the given maximum length.
- `[Url]` : Validates the property has a URL format.

MVC supports any attribute that derives from `ValidationAttribute` for validation purposes. Many useful validation attributes can be found in the [System.ComponentModel.DataAnnotations](#) namespace.

There may be instances where you need more features than built-in attributes provide. For those times, you can create custom validation attributes by deriving from `ValidationAttribute` or changing your model to implement `IValidatableObject`.

## Notes on the use of the Required attribute

Non-nullable [value types](#) (such as `decimal`, `int`, `float`, and `DateTime`) are inherently required and don't need the `Required` attribute. The app performs no server-side validation checks for non-nullable types that are marked `Required`.

MVC model binding, which isn't concerned with validation and validation attributes, rejects a form field submission containing a missing value or whitespace for a non-nullable type. In the absence of a `BindRequired` attribute on the target property, model binding ignores missing data for non-nullable types, where the form field is absent from the incoming form data.

The [BindRequired attribute](#) (also see [Customize model binding behavior with attributes](#)) is useful to ensure form data is complete. When applied to a property, the model binding system requires a value for that property. When applied to a type, the model binding system requires values for all of the properties of that type.

When you use a [Nullable<T> type](#) (for example, `decimal?` or `System.Nullable<decimal>`) and mark it `Required`, a server-side validation check is performed as if the property were a standard nullable type (for example, a `string`).

Client-side validation requires a value for a form field that corresponds to a model property that you've marked `Required` and for a non-nullable type property that you haven't marked `Required`. `Required` can be used to control the client-side validation error message.

## Model State

Model state represents validation errors in submitted HTML form values.

MVC will continue validating fields until reaches the maximum number of errors (200 by default). You can configure this number by inserting the following code into the `ConfigureServices` method in the `Startup.cs`

file:

```
services.AddMvc(options => options.MaxModelValidationErrors = 50);
```

## Handling Model State Errors

Model validation occurs prior to each controller action being invoked, and it's the action method's responsibility to inspect `ModelState.IsValid` and react appropriately. In many cases, the appropriate reaction is to return an error response, ideally detailing the reason why model validation failed.

Some apps will choose to follow a standard convention for dealing with model validation errors, in which case a filter may be an appropriate place to implement such a policy. You should test how your actions behave with valid and invalid model states.

## Manual validation

After model binding and validation are complete, you may want to repeat parts of it. For example, a user may have entered text in a field expecting an integer, or you may need to compute a value for a model's property.

You may need to run validation manually. To do so, call the `TryValidateModel` method, as shown here:

```
TryValidateModel(movie);
```

## Custom validation

Validation attributes work for most validation needs. However, some validation rules are specific to your business. Your rules might not be common data validation techniques such as ensuring a field is required or that it conforms to a range of values. For these scenarios, custom validation attributes are a great solution. Creating your own custom validation attributes in MVC is easy. Just inherit from the `ValidationAttribute`, and override the `IsValid` method. The `IsValid` method accepts two parameters, the first is an object named `value` and the second is a `ValidationContext` object named `validationContext`. `Value` refers to the actual value from the field that your custom validator is validating.

In the following sample, a business rule states that users may not set the genre to *Classic* for a movie released after 1960. The `[ClassicMovie]` attribute checks the genre first, and if it's a classic, then it checks the release date to see that it's later than 1960. If it's released after 1960, validation fails. The attribute accepts an integer parameter representing the year that you can use to validate data. You can capture the value of the parameter in the attribute's constructor, as shown here:

```

public class ClassicMovieAttribute : ValidationAttribute, IClientModelValidator
{
    private int _year;

    public ClassicMovieAttribute(int Year)
    {
        _year = Year;
    }

    protected override ValidationResult IsValid(object value, ValidationContext validationContext)
    {
        Movie movie = (Movie)validationContext.ObjectInstance;

        if (movie.Genre == Genre.Classic && movie.ReleaseDate.Year > _year)
        {
            return new ValidationResult(GetErrorMessage());
        }

        return ValidationResult.Success;
    }
}

```

The `movie` variable above represents a `Movie` object that contains the data from the form submission to validate. In this case, the validation code checks the date and genre in the `IsValid` method of the `ClassicMovieAttribute` class as per the rules. Upon successful validation, `IsValid` returns a `ValidationResult.Success` code. When validation fails, a `ValidationResult` with an error message is returned:

```

private string GetErrorMessage()
{
    return $"Classic movies must have a release year earlier than {_year}.";
```

When a user modifies the `Genre` field and submits the form, the `IsValid` method of the `ClassicMovieAttribute` will verify whether the movie is a classic. Like any built-in attribute, apply the `ClassicMovieAttribute` to a property such as `ReleaseDate` to ensure validation happens, as shown in the previous code sample. Since the example works only with `Movie` types, a better option is to use `IValidatableObject` as shown in the following paragraph.

Alternatively, this same code could be placed in the model by implementing the `Validate` method on the `IValidatableObject` interface. While custom validation attributes work well for validating individual properties, implementing `IValidatableObject` can be used to implement class-level validation as seen here.

```

public IEnumerable<ValidationResult> Validate(ValidationContext validationContext)
{
    if (Genre == Genre.Classic && ReleaseDate.Year > _classicYear)
    {
        yield return new ValidationResult(
            $"Classic movies must have a release year earlier than {_classicYear}.",
            new[] { "ReleaseDate" });
    }
}
```

## Client side validation

Client side validation is a great convenience for users. It saves time they would otherwise spend waiting for a round trip to the server. In business terms, even a few fractions of seconds multiplied hundreds of times each day adds up to be a lot of time, expense, and frustration. Straightforward and immediate validation

enables users to work more efficiently and produce better quality input and output.

You must have a view with the proper JavaScript script references in place for client side validation to work as you see here.

```
<script src="https://ajax.aspnetcdn.com/ajax/jquery/jquery-2.2.0.min.js"></script>
```

```
<script src="https://ajax.aspnetcdn.com/ajax/jquery.validate/1.16.0/jquery.validate.min.js"></script>
<script
src="https://ajax.aspnetcdn.com/ajax/jquery.validation.unobtrusive/3.2.6/jquery.validate.unobtrusive.mi
n.js"></script>
```

The [jQuery Unobtrusive Validation](#) script is a custom Microsoft front-end library that builds on the popular [jQuery Validate](#) plugin. Without jQuery Unobtrusive Validation, you would have to code the same validation logic in two places: once in the server side validation attributes on model properties, and then again in client side scripts (the examples for jQuery Validate's [validate\(\)](#) method shows how complex this could become). Instead, MVC's [Tag Helpers](#) and [HTML helpers](#) are able to use the validation attributes and type metadata from model properties to render HTML 5 [data- attributes](#) in the form elements that need validation. MVC generates the [data-](#) attributes for both built-in and custom attributes. jQuery Unobtrusive Validation then parses the [data-](#) attributes and passes the logic to jQuery Validate, effectively "copying" the server side validation logic to the client. You can display validation errors on the client using the relevant tag helpers as shown here:

```
<div class="form-group">
    <label asp-for="ReleaseDate" class="col-md-2 control-label"></label>
    <div class="col-md-10">
        <input asp-for="ReleaseDate" class="form-control" />
        <span asp-validation-for="ReleaseDate" class="text-danger"></span>
    </div>
</div>
```

The tag helpers above render the HTML below. Notice that the [data-](#) attributes in the HTML output correspond to the validation attributes for the [ReleaseDate](#) property. The [data-val-required](#) attribute below contains an error message to display if the user doesn't fill in the release date field. jQuery Unobtrusive Validation passes this value to the jQuery Validate [required\(\)](#) method, which then displays that message in the accompanying [<span>](#) element.

```
<form action="/Movies/Create" method="post">
    <div class="form-horizontal">
        <h4>Movie</h4>
        <div class="text-danger"></div>
        <div class="form-group">
            <label class="col-md-2 control-label" for="ReleaseDate">ReleaseDate</label>
            <div class="col-md-10">
                <input class="form-control" type="datetime"
                    data-val="true" data-val-required="The ReleaseDate field is required."
                    id="ReleaseDate" name="ReleaseDate" value="" />
                <span class="text-danger field-validation-valid"
                    data-valmsg-for="ReleaseDate" data-valmsg-replace="true"></span>
            </div>
        </div>
    </div>
</form>
```

Client-side validation prevents submission until the form is valid. The Submit button runs JavaScript that either submits the form or displays error messages.

MVC determines type attribute values based on the .NET data type of a property, possibly overridden using `[DataType]` attributes. The base `[DataType]` attribute does no real server-side validation. Browsers choose their own error messages and display those errors as they wish, however the jQuery Validation Unobtrusive package can override the messages and display them consistently with others. This happens most obviously when users apply `[DataType]` subclasses such as `[EmailAddress]`.

### Add Validation to Dynamic Forms

Because jQuery Unobtrusive Validation passes validation logic and parameters to jQuery Validate when the page first loads, dynamically generated forms won't automatically exhibit validation. Instead, you must tell jQuery Unobtrusive Validation to parse the dynamic form immediately after creating it. For example, the code below shows how you might set up client side validation on a form added via AJAX.

```
$.get({
    url: "https://url/that/returns/a/form",
    dataType: "html",
    error: function(jqXHR, textStatus, errorThrown) {
        alert(textStatus + ": Couldn't add form. " + errorThrown);
    },
    success: function(newFormHTML) {
        var container = document.getElementById("form-container");
        container.insertAdjacentHTML("beforeend", newFormHTML);
        var forms = container.getElementsByTagName("form");
        var newForm = forms[forms.length - 1];
        $.validator.unobtrusive.parse(newForm);
    }
})
```

The `$.validator.unobtrusive.parse()` method accepts a jQuery selector for its one argument. This method tells jQuery Unobtrusive Validation to parse the `data-` attributes of forms within that selector. The values of those attributes are then passed to the jQuery Validate plugin so that the form exhibits the desired client side validation rules.

### Add Validation to Dynamic Controls

You can also update the validation rules on a form when individual controls, such as `<input/>`s and `<select/>`s, are dynamically generated. You cannot pass selectors for these elements to the `parse()` method directly because the surrounding form has already been parsed and won't update. Instead, you first remove the existing validation data, then reparse the entire form, as shown below:

```
$.get({
    url: "https://url/that/returns/a/control",
    dataType: "html",
    error: function(jqXHR, textStatus, errorThrown) {
        alert(textStatus + ": Couldn't add control. " + errorThrown);
    },
    success: function(newInputHTML) {
        var form = document.getElementById("my-form");
        form.insertAdjacentHTML("beforeend", newInputHTML);
        $(form).removeData("validator") // Added by jQuery Validate
            .removeData("unobtrusiveValidation"); // Added by jQuery Unobtrusive Validation
        $.validator.unobtrusive.parse(form);
    }
})
```

## IClientModelValidator

You may create client side logic for your custom attribute, and [unobtrusive validation](#) which creates an adapter to [jquery validation](#) will execute it on the client for you automatically as part of validation. The first

step is to control what data- attributes are added by implementing the `IClientModelValidator` interface as shown here:

```
public void AddValidation(ClientModelValidationContext context)
{
    if (context == null)
    {
        throw new ArgumentNullException(nameof(context));
    }

    MergeAttribute(context.Attributes, "data-val", "true");
    MergeAttribute(context.Attributes, "data-val-classicmovie", GetErrorMessage());

    var year = _year.ToString(CultureInfo.InvariantCulture);
    MergeAttribute(context.Attributes, "data-val-classicmovie-year", year);
}
```

Attributes that implement this interface can add HTML attributes to generated fields. Examining the output for the `ReleaseDate` element reveals HTML that's similar to the previous example, except now there's a `data-val-classicmovie` attribute that was defined in the `AddValidation` method of `IClientModelValidator`.

```
<input class="form-control" type="datetime"
      data-val="true"
      data-val-classicmovie="Classic movies must have a release year earlier than 1960."
      data-val-classicmovie-year="1960"
      data-val-required="The ReleaseDate field is required."
      id="ReleaseDate" name="ReleaseDate" value="" />
```

Unobtrusive validation uses the data in the `data-` attributes to display error messages. However, jQuery doesn't know about rules or messages until you add them to jQuery's `validator` object. This is shown in the example below that adds a method named `classicmovie` containing custom client validation code to the jQuery `validator` object. An explanations of the unobtrusive.adapters.add method can be found [here](#)

```
$(function () {
    $.validator.addMethod('classicmovie',
        function (value, element, params) {
            // Get element value. Classic genre has value '0'.
            var genre = $(params[0]).val(),
                year = params[1],
                date = new Date(value);
            if (genre && genre.length > 0 && genre[0] === '0') {
                // Since this is a classic movie, invalid if release date is after given year.
                return date.getFullYear() <= year;
            }

            return true;
        });

    $.validator.unobtrusive.adapters.add('classicmovie',
        ['year'],
        function (options) {
            var element = $(options.form).find('select#Genre')[0];
            options.rules['classicmovie'] = [element, parseInt(options.params['year'])];
            options.messages['classicmovie'] = options.message;
        });
});
```

Now jQuery has the information to execute the custom JavaScript validation as well as the error message to display if that validation code returns false.

## Remote validation

Remote validation is a great feature to use when you need to validate data on the client against data on the server. For example, your app may need to verify whether an email or user name is already in use, and it must query a large amount of data to do so. Downloading large sets of data for validating one or a few fields consumes too many resources. It may also expose sensitive information. An alternative is to make a round-trip request to validate a field.

You can implement remote validation in a two step process. First, you must annotate your model with the `[Remote]` attribute. The `[Remote]` attribute accepts multiple overloads you can use to direct client side JavaScript to the appropriate code to call. The example below points to the `VerifyEmail` action method of the `Users` controller.

```
[Remote(action: "VerifyEmail", controller: "Users")]
public string Email { get; set; }
```

The second step is putting the validation code in the corresponding action method as defined in the `[Remote]` attribute. According to the jQuery Validate `remote()` method documentation:

The serverside response must be a JSON string that must be `"true"` for valid elements, and can be `"false"`, `undefined`, or `null` for invalid elements, using the default error message. If the serverside response is a string, eg. `"That name is already taken, try peter123 instead"`, this string will be displayed as a custom error message in place of the default.

The definition of the `VerifyEmail()` method follows these rules, as shown below. It returns a validation error message if the email is taken, or `true` if the email is free, and wraps the result in a `JsonResult` object. The client side can then use the returned value to proceed or display the error if needed.

```
[AcceptVerbs("Get", "Post")]
public IActionResult VerifyEmail(string email)
{
    if (!_userRepository.VerifyEmail(email))
    {
        return Json($"Email {email} is already in use.");
    }

    return Json(true);
}
```

Now when users enter an email, JavaScript in the view makes a remote call to see if that email has been taken and, if so, displays the error message. Otherwise, the user can submit the form as usual.

The `AdditionalFields` property of the `[Remote]` attribute is useful for validating combinations of fields against data on the server. For example, if the `User` model from above had two additional properties called `FirstName` and `LastName`, you might want to verify that no existing users already have that pair of names. You define the new properties as shown in the following code:

```
[Remote(action: "VerifyName", controller: "Users", AdditionalFields = nameof.LastName)]
public string FirstName { get; set; }
[Remote(action: "VerifyName", controller: "Users", AdditionalFields = nameof.FirstName)]
public string LastName { get; set; }
```

`AdditionalFields` could've been set explicitly to the strings `"FirstName"` and `"LastName"`, but using the `nameof` operator like this simplifies later refactoring. The action method to perform the validation must

then accept two arguments, one for the value of `FirstName` and one for the value of `LastName`.

```
[AcceptVerbs("Get", "Post")]
public IActionResult VerifyName(string firstName, string lastName)
{
    if (!_userRepository.VerifyName(firstName, lastName))
    {
        return Json(data: $"A user named {firstName} {lastName} already exists.");
    }

    return Json(data: true);
}
```

Now when users enter a first and last name, JavaScript:

- Makes a remote call to see if that pair of names has been taken.
- If the pair has been taken, an error message is displayed.
- If not taken, the user can submit the form.

If you need to validate two or more additional fields with the `[Remote]` attribute, you provide them as a comma-delimited list. For example, to add a `MiddleName` property to the model, set the `[Remote]` attribute as shown in the following code:

```
[Remote(action: "VerifyName", controller: "Users", AdditionalFields = nameof(FirstName) + "," + 
nameof(LastName))]
public string MiddleName { get; set; }
```

`AdditionalFields`, like all attribute arguments, must be a constant expression. Therefore, you must not use an [interpolated string](#) or call `string.Join()` to initialize `AdditionalFields`. For every additional field that you add to the `[Remote]` attribute, you must add another argument to the corresponding controller action method.

# Views in ASP.NET Core MVC

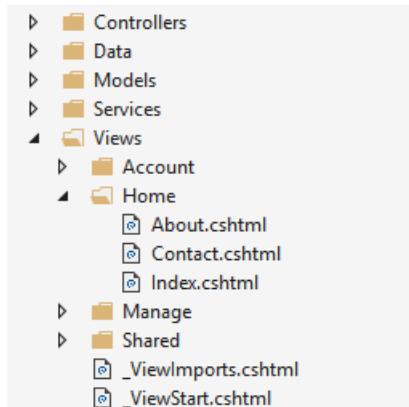
6/21/2018 • 13 minutes to read • [Edit Online](#)

By [Steve Smith](#) and [Luke Latham](#)

This document explains views used in ASP.NET Core MVC applications. For information on Razor Pages, see [Introduction to Razor Pages](#).

In the Model-View-Controller (MVC) pattern, the *view* handles the app's data presentation and user interaction. A view is an HTML template with embedded [Razor markup](#). Razor markup is code that interacts with HTML markup to produce a webpage that's sent to the client.

In ASP.NET Core MVC, views are `.cshtml` files that use the [C# programming language](#) in Razor markup. Usually, view files are grouped into folders named for each of the app's [controllers](#). The folders are stored in a *Views* folder at the root of the app:



The *Home* controller is represented by a *Home* folder inside the *Views* folder. The *Home* folder contains the views for the *About*, *Contact*, and *Index* (homepage) webpages. When a user requests one of these three webpages, controller actions in the *Home* controller determine which of the three views is used to build and return a webpage to the user.

Use [layouts](#) to provide consistent webpage sections and reduce code repetition. Layouts often contain the header, navigation and menu elements, and the footer. The header and footer usually contain boilerplate markup for many metadata elements and links to script and style assets. Layouts help you avoid this boilerplate markup in your views.

[Partial views](#) reduce code duplication by managing reusable parts of views. For example, a partial view is useful for an author biography on a blog website that appears in several views. An author biography is ordinary view content and doesn't require code to execute in order to produce the content for the webpage. Author biography content is available to the view by model binding alone, so using a partial view for this type of content is ideal.

[View components](#) are similar to partial views in that they allow you to reduce repetitive code, but they're appropriate for view content that requires code to run on the server in order to render the webpage. View components are useful when the rendered content requires database interaction, such as for a website shopping cart. View components aren't limited to model binding in order to produce webpage output.

## Benefits of using views

Views help to establish a [Separation of Concerns \(SoC\) design](#) within an MVC app by separating the user interface markup from other parts of the app. Following SoC design makes your app modular, which provides several benefits:

- The app is easier to maintain because it's better organized. Views are generally grouped by app feature. This makes it easier to find related views when working on a feature.
- The parts of the app are loosely coupled. You can build and update the app's views separately from the business logic and data access components. You can modify the views of the app without necessarily having to update other parts of the app.
- It's easier to test the user interface parts of the app because the views are separate units.
- Due to better organization, it's less likely that you'll accidentally repeat sections of the user interface.

## Creating a view

Views that are specific to a controller are created in the `Views/[ControllerName]` folder. Views that are shared among controllers are placed in the `Views/Shared` folder. To create a view, add a new file and give it the same name as its associated controller action with the `.cshtml` file extension. To create a view that corresponds with the `About` action in the `Home` controller, create an `About.cshtml` file in the `Views/Home` folder:

```
@{
    ViewData["Title"] = "About";
}
<h2>@ViewData["Title"].</h2>
<h3>@ViewData["Message"]</h3>

<p>Use this area to provide additional information.</p>
```

Razor markup starts with the `@` symbol. Run C# statements by placing C# code within [Razor code blocks](#) set off by curly braces (`{ ... }`). For example, see the assignment of "About" to `ViewData["Title"]` shown above. You can display values within HTML by simply referencing the value with the `@` symbol. See the contents of the `<h2>` and `<h3>` elements above.

The view content shown above is only part of the entire webpage that's rendered to the user. The rest of the page's layout and other common aspects of the view are specified in other view files. To learn more, see the [Layout topic](#).

## How controllers specify views

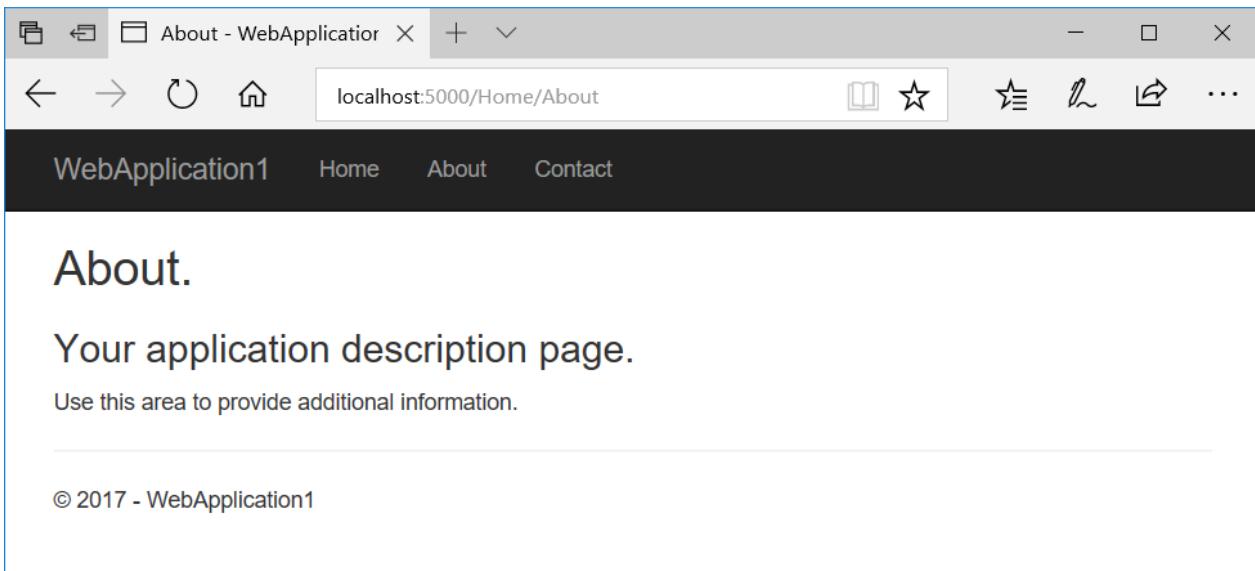
Views are typically returned from actions as a [ViewResult](#), which is a type of [ActionResult](#). Your action method can create and return a `ViewResult` directly, but that isn't commonly done. Since most controllers inherit from [Controller](#), you simply use the `View` helper method to return the `ViewResult`:

`HomeController.cs`

```
public IActionResult About()
{
    ViewData["Message"] = "Your application description page.";

    return View();
}
```

When this action returns, the `About.cshtml` view shown in the last section is rendered as the following webpage:



The `View` helper method has several overloads. You can optionally specify:

- An explicit view to return:

```
return View("Orders");
```

- A `model` to pass to the view:

```
return View(Orders);
```

- Both a view and a model:

```
return View("Orders", Orders);
```

## View discovery

When an action returns a view, a process called *view discovery* takes place. This process determines which view file is used based on the view name.

The default behavior of the `View` method (`return View();`) is to return a view with the same name as the action method from which it's called. For example, the `About ActionResult` method name of the controller is used to search for a view file named `About.cshtml`. First, the runtime looks in the `Views/[ControllerName]` folder for the view. If it doesn't find a matching view there, it searches the `Shared` folder for the view.

It doesn't matter if you implicitly return the `ViewResult` with `return View();` or explicitly pass the view name to the `View` method with `return View("<ViewName>");`. In both cases, view discovery searches for a matching view file in this order:

1. `Views/[ControllerName]/[ViewName].cshtml`
2. `Views/Shared/[ViewName].cshtml`

A view file path can be provided instead of a view name. If using an absolute path starting at the app root (optionally starting with "/" or "~/"), the `.cshtml` extension must be specified:

```
return View("Views/Home/About.cshtml");
```

You can also use a relative path to specify views in different directories without the `.cshtml` extension. Inside the `HomeController`, you can return the `Index` view of your `Manage` views with a relative path:

```
return View("../Manage/Index");
```

Similarly, you can indicate the current controller-specific directory with the "./" prefix:

```
return View("./About");
```

Partial views and view components use similar (but not identical) discovery mechanisms.

You can customize the default convention for how views are located within the app by using a custom [IViewLocationExpander](#).

View discovery relies on finding view files by file name. If the underlying file system is case sensitive, view names are probably case sensitive. For compatibility across operating systems, match case between controller and action names and associated view folders and file names. If you encounter an error that a view file can't be found while working with a case-sensitive file system, confirm that the casing matches between the requested view file and the actual view file name.

Follow the best practice of organizing the file structure for your views to reflect the relationships among controllers, actions, and views for maintainability and clarity.

## Passing data to views

Pass data to views using several approaches:

- Strongly-typed data: viewmodel
- Weakly-typed data
  - `ViewData` (  `ViewDataAttribute` )
  - `ViewBag`

### Strongly-typed data (.viewmodel)

The most robust approach is to specify a `model` type in the view. This model is commonly referred to as a *viewmodel*. You pass an instance of the viewmodel type to the view from the action.

Using a viewmodel to pass data to a view allows the view to take advantage of *strong* type checking. *Strong typing* (or *strongly-typed*) means that every variable and constant has an explicitly defined type (for example, `string`, `int`, or `DateTime`). The validity of types used in a view is checked at compile time.

[Visual Studio](#) and [Visual Studio Code](#) list strongly-typed class members using a feature called [IntelliSense](#). When you want to see the properties of a viewmodel, type the variable name for the viewmodel followed by a period ( `.` ). This helps you write code faster with fewer errors.

Specify a model using the `@model` directive. Use the model with `@Model`:

```
@model WebApplication1.ViewModels.Address

<h2>Contact</h2>
<address>
    @Model.Street<br>
    @Model.City, @Model.State @Model.PostalCode<br>
    <abbr title="Phone">P:</abbr> 425.555.0100
</address>
```

To provide the model to the view, the controller passes it as a parameter:

```

public IActionResult Contact()
{
    ViewData["Message"] = "Your contact page.";

    var viewModel = new Address()
    {
        Name = "Microsoft",
        Street = "One Microsoft Way",
        City = "Redmond",
        State = "WA",
        PostalCode = "98052-6399"
    };

    return View(viewModel);
}

```

There are no restrictions on the model types that you can provide to a view. We recommend using Plain Old CLR Object (POCO) viewmodels with little or no behavior (methods) defined. Usually,.viewmodel classes are either stored in the *Models* folder or a separate *ViewModels* folder at the root of the app. The *Address*.viewmodel used in the example above is a POCO.viewmodel stored in a file named *Address.cs*:

```

namespace WebApplication1.ViewModels
{
    public class Address
    {
        public string Name { get; set; }
        public string Street { get; set; }
        public string City { get; set; }
        public string State { get; set; }
        public string PostalCode { get; set; }
    }
}

```

Nothing prevents you from using the same classes for both your.viewmodel types and your business.model types. However, using separate models allows your.views to vary independently from the business logic and data access parts of your.app. Separation of models and.viewmodels also offers security benefits when models use [model binding](#) and [validation](#) for data sent to the app by the user.

## Weakly-typed data (ViewData, ViewData attribute, and ViewBag)

`ViewBag` isn't available in Razor Pages.

In addition to strongly-typed views, views have access to a *weakly-typed* (also called *loosely-typed*) collection of data. Unlike strong types, *weak types* (or *loose types*) means that you don't explicitly declare the type of data you're using. You can use the collection of weakly-typed data for passing small amounts of data in and out of controllers and views.

PASSING DATA BETWEEN A ...	EXAMPLE
Controller and a view	Populating a dropdown list with data.
View and a <a href="#">layout view</a>	Setting the <code>&lt;title&gt;</code> element content in the layout view from a view file.
<a href="#">Partial view</a> and a view	A widget that displays data based on the webpage that the user requested.

This collection can be referenced through either the `ViewData` or `ViewBag` properties on controllers and views. The `ViewData` property is a dictionary of weakly-typed objects. The `ViewBag` property is a wrapper around

`ViewData` that provides dynamic properties for the underlying `ViewData` collection.

`ViewData` and `ViewBag` are dynamically resolved at runtime. Since they don't offer compile-time type checking, both are generally more error-prone than using a viewmodel. For that reason, some developers prefer to minimally or never use `ViewData` and `ViewBag`.

## ViewData

`ViewData` is a [ViewDataDictionary](#) object accessed through `string` keys. String data can be stored and used directly without the need for a cast, but you must cast other `ViewData` object values to specific types when you extract them. You can use `ViewData` to pass data from controllers to views and within views, including [partial views](#) and [layouts](#).

The following is an example that sets values for a greeting and an address using `ViewData` in an action:

```
public IActionResult SomeAction()
{
    ViewData["Greeting"] = "Hello";
    ViewData["Address"] = new Address()
    {
        Name = "Steve",
        Street = "123 Main St",
        City = "Hudson",
        State = "OH",
        PostalCode = "44236"
    };

    return View();
}
```

Work with the data in a view:

```
@{
    // Since Address isn't a string, it requires a cast.
    var address = ViewData["Address"] as Address;
}

@ ViewData["Greeting"] World!

<address>
    @address.Name<br>
    @address.Street<br>
    @address.City, @address.State @address.PostalCode
</address>
```

## ViewData attribute

Another approach that uses the [ViewDataDictionary](#) is [ViewDataAttribute](#). Properties on controllers or Razor Page models decorated with `[ViewData]` have their values stored and loaded from the dictionary.

In the following example, the Home controller contains a `Title` property decorated with `[ViewData]`. The `About` method sets the title for the About view:

```
public class HomeController : Controller
{
    [ViewData]
    public string Title { get; set; }

    public IActionResult About()
    {
        Title = "About Us";
        ViewData["Message"] = "Your application description page.";

        return View();
    }
}
```

In the About view, access the `Title` property as a model property:

```
<h1>@Model.Title</h1>
```

In the layout, the title is read from the ViewData dictionary:

```
<!DOCTYPE html>
<html lang="en">
<head>
<title>@ViewData["Title"] - WebApplication</title>
...
```

## ViewBag

`ViewBag` isn't available in Razor Pages.

`ViewBag` is a [DynamicViewData](#) object that provides dynamic access to the objects stored in `ViewData`. `ViewBag` can be more convenient to work with, since it doesn't require casting. The following example shows how to use `ViewBag` with the same result as using `ViewData` above:

```
public IActionResult SomeAction()
{
    ViewBag.Greeting = "Hello";
    ViewBag.Address = new Address()
    {
        Name = "Steve",
        Street = "123 Main St",
        City = "Hudson",
        State = "OH",
        PostalCode = "44236"
    };

    return View();
}
```

```
@ViewBag.Greeting World!

<address>
    @ViewBag.Address.Name<br>
    @ViewBag.Address.Street<br>
    @ViewBag.Address.City, @ViewBag.Address.State @ViewBag.Address.PostalCode
</address>
```

## Using ViewData and ViewBag simultaneously

`ViewBag` isn't available in Razor Pages.

Since `ViewData` and `ViewBag` refer to the same underlying `ViewData` collection, you can use both `ViewData` and `ViewBag` and mix and match between them when reading and writing values.

Set the title using `ViewBag` and the description using `ViewData` at the top of an `About.cshtml` view:

```
@{
    Layout = "/Views/Shared/_Layout.cshtml";
    ViewBag.Title = "About Contoso";
    ViewData["Description"] = "Let us tell you about Contoso's philosophy and mission.";
}
```

Read the properties but reverse the use of `ViewData` and `ViewBag`. In the `_Layout.cshtml` file, obtain the title using `ViewData` and obtain the description using `ViewBag`:

```
<!DOCTYPE html>
<html lang="en">
<head>
    <title>@ViewData["Title"]</title>
    <meta name="description" content="@ViewBag.Description">
    ...

```

Remember that strings don't require a cast for `ViewData`. You can use `@ViewData["Title"]` without casting.

Using both `ViewData` and `ViewBag` at the same time works, as does mixing and matching reading and writing the properties. The following markup is rendered:

```
<!DOCTYPE html>
<html lang="en">
<head>
    <title>About Contoso</title>
    <meta name="description" content="Let us tell you about Contoso's philosophy and mission.">
    ...

```

## Summary of the differences between `ViewData` and `ViewBag`

`ViewBag` isn't available in the Razor Pages.

- `ViewData`
  - Derives from [ViewDataDictionary](#), so it has dictionary properties that can be useful, such as `ContainsKey`, `Add`, `Remove`, and `Clear`.
  - Keys in the dictionary are strings, so whitespace is allowed. Example:  
`ViewData["Some Key With Whitespace"]`
  - Any type other than a `string` must be cast in the view to use `ViewData`.
- `ViewBag`
  - Derives from [Dynamic ViewData](#), so it allows the creation of dynamic properties using dot notation (`@ViewBag.SomeKey = <value or object>`), and no casting is required. The syntax of `ViewBag` makes it quicker to add to controllers and views.
  - Simpler to check for null values. Example: `@ViewBag.Person?.Name`

## When to use `ViewData` or `ViewBag`

Both `ViewData` and `ViewBag` are equally valid approaches for passing small amounts of data among controllers and views. The choice of which one to use is based on preference. You can mix and match `ViewData` and `ViewBag` objects, however, the code is easier to read and maintain with one approach used consistently. Both approaches

are dynamically resolved at runtime and thus prone to causing runtime errors. Some development teams avoid them.

### Dynamic views

Views that don't declare a model type using `@model` but that have a model instance passed to them (for example, `return View(Address);`) can reference the instance's properties dynamically:

```
<address>
    @Model.Street<br>
    @Model.City, @Model.State @Model.PostalCode<br>
    <abbr title="Phone">P:</abbr> 425.555.0100
</address>
```

This feature offers flexibility but doesn't offer compilation protection or IntelliSense. If the property doesn't exist, webpage generation fails at runtime.

## More view features

[Tag Helpers](#) make it easy to add server-side behavior to existing HTML tags. Using Tag Helpers avoids the need to write custom code or helpers within your views. Tag helpers are applied as attributes to HTML elements and are ignored by editors that can't process them. This allows you to edit and render view markup in a variety of tools.

Generating custom HTML markup can be achieved with many built-in HTML Helpers. More complex user interface logic can be handled by [View Components](#). View components provide the same SoC that controllers and views offer. They can eliminate the need for actions and views that deal with data used by common user interface elements.

Like many other aspects of ASP.NET Core, views support [dependency injection](#), allowing services to be [injected into views](#).

# Razor syntax reference for ASP.NET Core

6/21/2018 • 11 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [Luke Latham](#), [Taylor Mullen](#), and [Dan Vicarel](#)

Razor is a markup syntax for embedding server-based code into webpages. The Razor syntax consists of Razor markup, C#, and HTML. Files containing Razor generally have a *.cshtml* file extension.

## Rendering HTML

The default Razor language is HTML. Rendering HTML from Razor markup is no different than rendering HTML from an HTML file. HTML markup in *.cshtml* Razor files is rendered by the server unchanged.

## Razor syntax

Razor supports C# and uses the `@` symbol to transition from HTML to C#. Razor evaluates C# expressions and renders them in the HTML output.

When an `@` symbol is followed by a [Razor reserved keyword](#), it transitions into Razor-specific markup. Otherwise, it transitions into plain C#.

To escape an `@` symbol in Razor markup, use a second `@` symbol:

```
<p>@@Username</p>
```

The code is rendered in HTML with a single `@` symbol:

```
<p>@Username</p>
```

HTML attributes and content containing email addresses don't treat the `@` symbol as a transition character. The email addresses in the following example are untouched by Razor parsing:

```
<a href="mailto:Support@contoso.com">Support@contoso.com</a>
```

## Implicit Razor expressions

Implicit Razor expressions start with `@` followed by C# code:

```
<p>@DateTime.Now</p>
<p>@DateTime.IsLeapYear(2016)</p>
```

With the exception of the C# `await` keyword, implicit expressions must not contain spaces. If the C# statement has a clear ending, spaces can be intermingled:

```
<p>@await DoSomething("hello", "world")</p>
```

Implicit expressions **cannot** contain C# generics, as the characters inside the brackets (`<>`) are interpreted as an HTML tag. The following code is **not** valid:

```
<p>@GenericMethod<int>()</p>
```

The preceding code generates a compiler error similar to one of the following:

- The "int" element wasn't closed. All elements must be either self-closing or have a matching end tag.
- Cannot convert method group 'GenericMethod' to non-delegate type 'object'. Did you intend to invoke the method?'

Generic method calls must be wrapped in an [explicit Razor expression](#) or a [Razor code block](#).

## Explicit Razor expressions

Explicit Razor expressions consist of an `@` symbol with balanced parenthesis. To render last week's time, the following Razor markup is used:

```
<p>Last week this time: @(DateTime.Now - TimeSpan.FromDays(7))</p>
```

Any content within the `@()` parenthesis is evaluated and rendered to the output.

Implicit expressions, described in the previous section, generally can't contain spaces. In the following code, one week isn't subtracted from the current time:

```
<p>Last week: @DateTime.Now - TimeSpan.FromDays(7)</p>
```

The code renders the following HTML:

```
<p>Last week: 7/7/2016 4:39:52 PM - TimeSpan.FromDays(7)</p>
```

Explicit expressions can be used to concatenate text with an expression result:

```
@{  
    var joe = new Person("Joe", 33);  
}  
  
<p>Age@(joe.Age)</p>
```

Without the explicit expression, `<p>Age@joe.Age</p>` is treated as an email address, and `<p>Age@joe.Age</p>` is rendered. When written as an explicit expression, `<p>Age33</p>` is rendered.

Explicit expressions can be used to render output from generic methods in `.cshtml` files. The following markup shows how to correct the error shown earlier caused by the brackets of a C# generic. The code is written as an explicit expression:

```
<p>@{GenericMethod<int>}</p>
```

## Expression encoding

C# expressions that evaluate to a string are HTML encoded. C# expressions that evaluate to `IHtmlContent` are rendered directly through `IHtmlContent.WriteTo`. C# expressions that don't evaluate to `IHtmlContent` are converted to a string by `ToString` and encoded before they're rendered.

```
@("<span>Hello World</span>")
```

The code renders the following HTML:

```
&lt;span&gt;Hello World&lt;/span&gt;
```

The HTML is shown in the browser as:

```
<span>Hello World</span>
```

`HtmlHelper.Raw` output isn't encoded but rendered as HTML markup.

#### WARNING

Using `HtmlHelper.Raw` on unsanitized user input is a security risk. User input might contain malicious JavaScript or other exploits. Sanitizing user input is difficult. Avoid using `HtmlHelper.Raw` with user input.

```
@Html.Raw("<span>Hello World</span>")
```

The code renders the following HTML:

```
<span>Hello World</span>
```

## Razor code blocks

Razor code blocks start with `@` and are enclosed by `{}`. Unlike expressions, C# code inside code blocks isn't rendered. Code blocks and expressions in a view share the same scope and are defined in order:

```
@{  
    var quote = "The future depends on what you do today. - Mahatma Gandhi";  
}  
  
<p>@quote</p>  
  
{@  
    quote = "Hate cannot drive out hate, only love can do that. - Martin Luther King, Jr.";  
}  
  
<p>@quote</p>
```

The code renders the following HTML:

```
<p>The future depends on what you do today. - Mahatma Gandhi</p>  
<p>Hate cannot drive out hate, only love can do that. - Martin Luther King, Jr.</p>
```

### Implicit transitions

The default language in a code block is C#, but the Razor Page can transition back to HTML:

```
@{
    var inCSharp = true;
    <p>Now in HTML, was in C# @inCSharp</p>
}
```

## Explicit delimited transition

To define a subsection of a code block that should render HTML, surround the characters for rendering with the Razor `<text>` tag:

```
@for (var i = 0; i < people.Length; i++)
{
    var person = people[i];
    <text>Name: @person.Name</text>
}
```

Use this approach to render HTML that isn't surrounded by an HTML tag. Without an HTML or Razor tag, a Razor runtime error occurs.

The `<text>` tag is useful to control whitespace when rendering content:

- Only the content between the `<text>` tag is rendered.
- No whitespace before or after the `<text>` tag appears in the HTML output.

## Explicit Line Transition with `@:`

To render the rest of an entire line as HTML inside a code block, use the `@:` syntax:

```
@for (var i = 0; i < people.Length; i++)
{
    var person = people[i];
    @:Name: @person.Name
}
```

Without the `@:` in the code, a Razor runtime error is generated.

Warning: Extra `@` characters in a Razor file can cause compiler errors at statements later in the block. These compiler errors can be difficult to understand because the actual error occurs before the reported error. This error is common after combining multiple implicit/explicit expressions into a single code block.

# Control structures

Control structures are an extension of code blocks. All aspects of code blocks (transitioning to markup, inline C#) also apply to the following structures:

## Conditionals `@if`, `else if`, `else`, and `@switch`

`@if` controls when code runs:

```
@if (value % 2 == 0)
{
    <p>The value was even.</p>
}
```

`else` and `else if` don't require the `@` symbol:

```

@if (value % 2 == 0)
{
    <p>The value was even.</p>
}
else if (value >= 1337)
{
    <p>The value is large.</p>
}
else
{
    <p>The value is odd and small.</p>
}

```

The following markup shows how to use a switch statement:

```

@switch (value)
{
    case 1:
        <p>The value is 1!</p>
        break;
    case 1337:
        <p>Your number is 1337!</p>
        break;
    default:
        <p>Your number wasn't 1 or 1337.</p>
        break;
}

```

## Looping @for, @foreach, @while, and @do while

Templated HTML can be rendered with looping control statements. To render a list of people:

```

{@
    var people = new Person[]
    {
        new Person("Weston", 33),
        new Person("Johnathon", 41),
        ...
    };
}

```

The following looping statements are supported:

**@for**

```

@for (var i = 0; i < people.Length; i++)
{
    var person = people[i];
    <p>Name: @person.Name</p>
    <p>Age: @person.Age</p>
}

```

**@foreach**

```

@foreach (var person in people)
{
    <p>Name: @person.Name</p>
    <p>Age: @person.Age</p>
}

```

### @while

```
@{ var i = 0; }
@while (i < people.Length)
{
    var person = people[i];
    <p>Name: @person.Name</p>
    <p>Age: @person.Age</p>

    i++;
}
```

### @do while

```
@{ var i = 0; }
@do
{
    var person = people[i];
    <p>Name: @person.Name</p>
    <p>Age: @person.Age</p>

    i++;
} while (i < people.Length);
```

## Compound @using

In C#, a `using` statement is used to ensure an object is disposed. In Razor, the same mechanism is used to create HTML Helpers that contain additional content. In the following code, HTML Helpers render a form tag with the `@using` statement:

```
@using (Html.BeginForm())
{
    <div>
        email:
        <input type="email" id="Email" value="">
        <button>Register</button>
    </div>
}
```

Scope-level actions can be performed with [Tag Helpers](#).

## @try, catch, finally

Exception handling is similar to C#:

```
@try
{
    throw new InvalidOperationException("You did something invalid.");
}
catch (Exception ex)
{
    <p>The exception message: @ex.Message</p>
}
finally
{
    <p>The finally statement.</p>
}
```

## @lock

Razor has the capability to protect critical sections with lock statements:

```
@lock (SomeLock)
{
    // Do critical section work
}
```

## Comments

Razor supports C# and HTML comments:

```
@{
    /* C# comment */
    // Another C# comment
}
<!-- HTML comment -->
```

The code renders the following HTML:

```
<!-- HTML comment -->
```

Razor comments are removed by the server before the webpage is rendered. Razor uses `@* *@` to delimit comments. The following code is commented out, so the server doesn't render any markup:

```
@*
{@
    /* C# comment */
    // Another C# comment
}
<!-- HTML comment -->
*@

```

## Directives

Razor directives are represented by implicit expressions with reserved keywords following the `@` symbol. A directive typically changes the way a view is parsed or enables different functionality.

Understanding how Razor generates code for a view makes it easier to understand how directives work.

```
@{
    var quote = "Getting old ain't for wimps! - Anonymous";
}

<div>Quote of the Day: @quote</div>
```

The code generates a class similar to the following:

```
public class _Views_Something_cshtml : RazorPage<dynamic>
{
    public override async Task ExecuteAsync()
    {
        var output = "Getting old ain't for wimps! - Anonymous";

        WriteLiteral("/r/n<div>Quote of the Day: ");
        Write(output);
        WriteLiteral("</div>");
    }
}
```

Later in this article, the section [Viewing the Razor C# class generated for a view](#) explains how to view this generated class.

## @using

The `@using` directive adds the C# `using` directive to the generated view:

```
@using System.IO
#{@
    var dir = Directory.GetCurrentDirectory();
}
<p>@dir</p>
```

## @model

The `@model` directive specifies the type of the model passed to a view:

```
@model TypeNameOfModel
```

In an ASP.NET Core MVC app created with individual user accounts, the `Views/Account/Login.cshtml` view contains the following model declaration:

```
@model LoginViewModel
```

The class generated inherits from `RazorPage<dynamic>`:

```
public class _Views_Account_Login_cshtml : RazorPage<LoginViewModel>
```

Razor exposes a `Model` property for accessing the model passed to the view:

```
<div>The Login Email: @Model.Email</div>
```

The `@model` directive specifies the type of this property. The directive specifies the `T` in `RazorPage<T>` that the generated class that the view derives from. If the `@model` directive isn't specified, the `Model` property is of type `dynamic`. The value of the model is passed from the controller to the view. For more information, see [Strongly typed models and the @model keyword](#).

## @inherits

The `@inherits` directive provides full control of the class the view inherits:

```
@inherits TypeNameOfClassToInheritFrom
```

The following code is a custom Razor page type:

```
using Microsoft.AspNetCore.Mvc.Razor;

public abstract class CustomRazorPage<TModel> : RazorPage<TModel>
{
    public string CustomText { get; } = "Gardyloo! - A Scottish warning yelled from a window before dumping a slop bucket on the street below.";
}
```

The `CustomText` is displayed in a view:

```
@inherits CustomRazorPage<TModel>

<div>Custom text: @CustomText</div>
```

The code renders the following HTML:

```
<div>Custom text: Gardyloo! - A Scottish warning yelled from a window before dumping a slop bucket on the street below.</div>
```

`@model` and `@inherits` can be used in the same view. `@inherits` can be in a `_ViewImports.cshtml` file that the view imports:

```
@inherits CustomRazorPage<TModel>
```

The following code is an example of a strongly-typed view:

```
@inherits CustomRazorPage<TModel>

<div>The Login Email: @Model.Email</div>
<div>Custom text: @CustomText</div>
```

If "rick@contoso.com" is passed in the model, the view generates the following HTML markup:

```
<div>The Login Email: rick@contoso.com</div>
<div>Custom text: Gardyloo! - A Scottish warning yelled from a window before dumping a slop bucket on the street below.</div>
```

## **@inject**

The `@inject` directive enables the Razor Page to inject a service from the [service container](#) into a view. For more information, see [Dependency injection into views](#).

## **@functions**

The `@functions` directive enables a Razor Page to add a C# code block to a view:

```
@functions { // C# Code }
```

For example:

```
@functions {
    public string GetHello()
    {
        return "Hello";
    }
}

<div>From method: @GetHello()</div>
```

The code generates the following HTML markup:

```
<div>From method: Hello</div>
```

The following code is the generated Razor C# class:

```

using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc.Razor;

public class _Views_Home_Test_cshtml : RazorPage<dynamic>
{
    // Functions placed between here
    public string GetHello()
    {
        return "Hello";
    }
    // And here.
#pragma warning disable 1998
    public override async Task ExecuteAsync()
    {
        WriteLiteral("\r\n<div>From method: ");
        Write(GetHello());
        WriteLiteral("</div>\r\n");
    }
#pragma warning restore 1998

```

## @section

The `@section` directive is used in conjunction with the [layout](#) to enable views to render content in different parts of the HTML page. For more information, see [Sections](#).

## Tag Helpers

There are three directives that pertain to [Tag Helpers](#).

DIRECTIVE	FUNCTION
<code>@addTagHelper</code>	Makes Tag Helpers available to a view.
<code>@removeTagHelper</code>	Removes Tag Helpers previously added from a view.
<code>@tagHelperPrefix</code>	Specifies a tag prefix to enable Tag Helper support and to make Tag Helper usage explicit.

## Razor reserved keywords

### Razor keywords

- `page` (Requires ASP.NET Core 2.0 and later)
- `namespace`
- `functions`
- `inherits`
- `model`
- `section`
- `helper` (Not currently supported by ASP.NET Core)

Razor keywords are escaped with `@(Razor Keyword)` (for example, `@(functions)`).

### C# Razor keywords

- `case`
- `do`
- `default`
- `for`

- foreach
- if
- else
- lock
- switch
- try
- catch
- finally
- using
- while

C# Razor keywords must be double-escaped with `@@C# Razor Keyword` (for example, `@@case`). The first `@` escapes the Razor parser. The second `@` escapes the C# parser.

### Reserved keywords not used by Razor

- class

## Viewing the Razor C# class generated for a view

Add the following class to the ASP.NET Core MVC project:

```
using Microsoft.AspNetCore.Mvc.Razor.Extensions;
using Microsoft.AspNetCore.Razor.Language;

public class CustomTemplateEngine : MvcRazorTemplateEngine
{
    public CustomTemplateEngine(RazorEngine engine, RazorProject project)
        : base(engine, project)
    {
    }

    public override RazorCSharpDocument GenerateCode(RazorCodeDocument codeDocument)
    {
        var csharpDocument = base.GenerateCode(codeDocument);
        var generatedCode = csharpDocument.GeneratedCode;

        // Look at generatedCode

        return csharpDocument;
    }
}
```

Override the `RazorTemplateEngine` added by MVC with the `CustomTemplateEngine` class:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc();
    services.AddSingleton<RazorTemplateEngine, CustomTemplateEngine>();
}
```

Set a break point on the `return csharpDocument` statement of `CustomTemplateEngine`. When program execution stops at the break point, view the value of `generatedCode`.

The screenshot shows the 'Text Visualizer' window from a debugger. The 'Expression:' field is set to 'generatedCode'. The 'Value:' pane displays the generated C# code for a Razor view. The code includes directives like #line, variable assignments, and method calls such as BeginContext and WriteLiteral. It also shows pragmas like #pragma warning restore 1998.

```
public override async Task ExecuteAsync()
{
#line 1 "/Views/Home/Contact3.cshtml"

    var output = "Hello World";

#line default
#line hidden

    BeginContext(40, 15, true);
    WriteLiteral("\r\n<div>Output: ");
    EndContext();
    BeginContext(56, 6, false);
#line 5 "/Views/Home/Contact3.cshtml"
    Write(output);

#line default
#line hidden
    EndContext();
    BeginContext(62, 6, true);
    WriteLiteral("</div>");
    EndContext();
}
#pragma warning restore 1998
```

## View lookups and case sensitivity

The Razor view engine performs case-sensitive lookups for views. However, the actual lookup is determined by the underlying file system:

- File based source:
  - On operating systems with case insensitive file systems (for example, Windows), physical file provider lookups are case insensitive. For example, `return View("Test")` results in matches for `/Views/Home/Test.cshtml`, `/Views/home/test.cshtml`, and any other casing variant.
  - On case-sensitive file systems (for example, Linux, OSX, and with `EmbeddedFileProvider`), lookups are case-sensitive. For example, `return View("Test")` specifically matches `/Views/Home/Test.cshtml`.
- Precompiled views: With ASP.NET Core 2.0 and later, looking up precompiled views is case insensitive on all operating systems. The behavior is identical to physical file provider's behavior on Windows. If two precompiled views differ only in case, the result of lookup is non-deterministic.

Developers are encouraged to match the casing of file and directory names to the casing of:

```
* Area, controller, and action names.  
* Razor Pages.
```

Matching case ensures the deployments find their views regardless of the underlying file system.

# Razor file compilation in ASP.NET Core

7/10/2018 • 2 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

A Razor file is compiled at runtime, when the associated MVC view is invoked. Build-time Razor file publishing is unsupported. Razor files can optionally be compiled at publish time and deployed with the app—using the precompilation tool.

A Razor file is compiled at runtime, when the associated Razor Page or MVC view is invoked. Build-time Razor file publishing is unsupported. Razor files can optionally be compiled at publish time and deployed with the app—using the precompilation tool.

A Razor file is compiled at runtime, when the associated Razor Page or MVC view is invoked. Razor files are compiled at both build and publish time using the [Razor SDK](#).

## Precompilation considerations

The following are side effects of precompiling Razor files:

- A smaller published bundle
- A faster startup time
- You can't edit Razor files—the associated content is absent from the published bundle.

## Deploy precompiled files

Build- and publish-time compilation of Razor files is enabled by default by the Razor SDK. Editing Razor files after they're updated is supported at build time. By default, only the compiled `Views.dll` and no `.cshtml` files are deployed with your app.

### IMPORTANT

The Razor SDK is effective only when no precompilation-specific properties are set in the project file. For instance, setting the `.csproj` file's `MvcRazorCompileOnPublish` property to `true` disables the Razor SDK.

If your project targets .NET Framework, install the [Microsoft.AspNetCore.Mvc.Razor.ViewCompilation](#) NuGet package:

```
<PackageReference Include="Microsoft.AspNetCore.Mvc.Razor.ViewCompilation"  
    Version="2.0.4"  
    PrivateAssets="All" />
```

If your project targets .NET Core, no changes are necessary.

The ASP.NET Core 2.x project templates implicitly set the `MvcRazorCompileOnPublish` property to `true` by default. Consequently, this element can be safely removed from the `.csproj` file.

### IMPORTANT

Razor file precompilation is unavailable when performing a [self-contained deployment \(SCD\)](#) in ASP.NET Core 2.0.

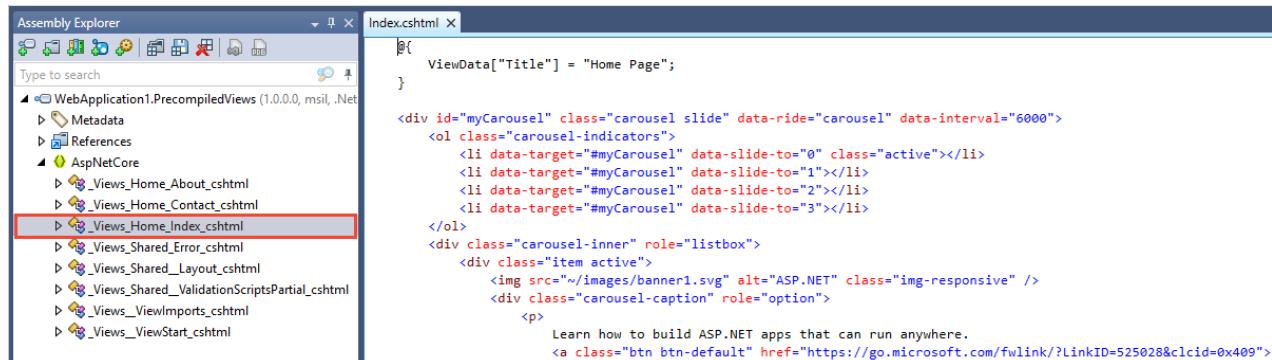
Set the `MvcRazorCompileOnPublish` property to `true`, and install the [Microsoft.AspNetCore.Mvc.Razor.ViewCompilation](#) NuGet package. The following `.csproj` sample highlights these settings:

```
<Project Sdk="Microsoft.NET.Sdk.Web">
  <PropertyGroup>
    <TargetFramework>netcoreapp1.1</TargetFramework>
    <MvcRazorCompileOnPublish>true</MvcRazorCompileOnPublish>
  </PropertyGroup>
  <ItemGroup>
    <PackageReference Include="Microsoft.AspNetCore" Version="1.1.0" />
    <PackageReference Include="Microsoft.AspNetCore.Mvc" Version="1.1.0" />
    <PackageReference Include="Microsoft.AspNetCore.StaticFiles" Version="1.1.0" />
    <PackageReference Include="Microsoft.AspNetCore.Mvc.Razor.ViewCompilation" Version="1.1.0-*" />
  </ItemGroup>
</Project>
```

Prepare the app for a [framework-dependent deployment](#) with the [.NET Core CLI publish command](#). For example, execute the following command at the project root:

```
dotnet publish -c Release
```

A `<project_name>.PrecompiledViews.dll` file, containing the compiled Razor files, is produced when precompilation succeeds. For example, the screenshot below depicts the contents of `Index.cshtml` within `WebApplication1.PrecompiledViews.dll`:



## Additional resources

- [Views in ASP.NET Core MVC](#)
- [Introduction to Razor Pages in ASP.NET Core](#)
- [Views in ASP.NET Core MVC](#)
- [Introduction to Razor Pages in ASP.NET Core](#)
- [Views in ASP.NET Core MVC](#)
- [ASP.NET Core Razor SDK](#)

# Layout in ASP.NET Core

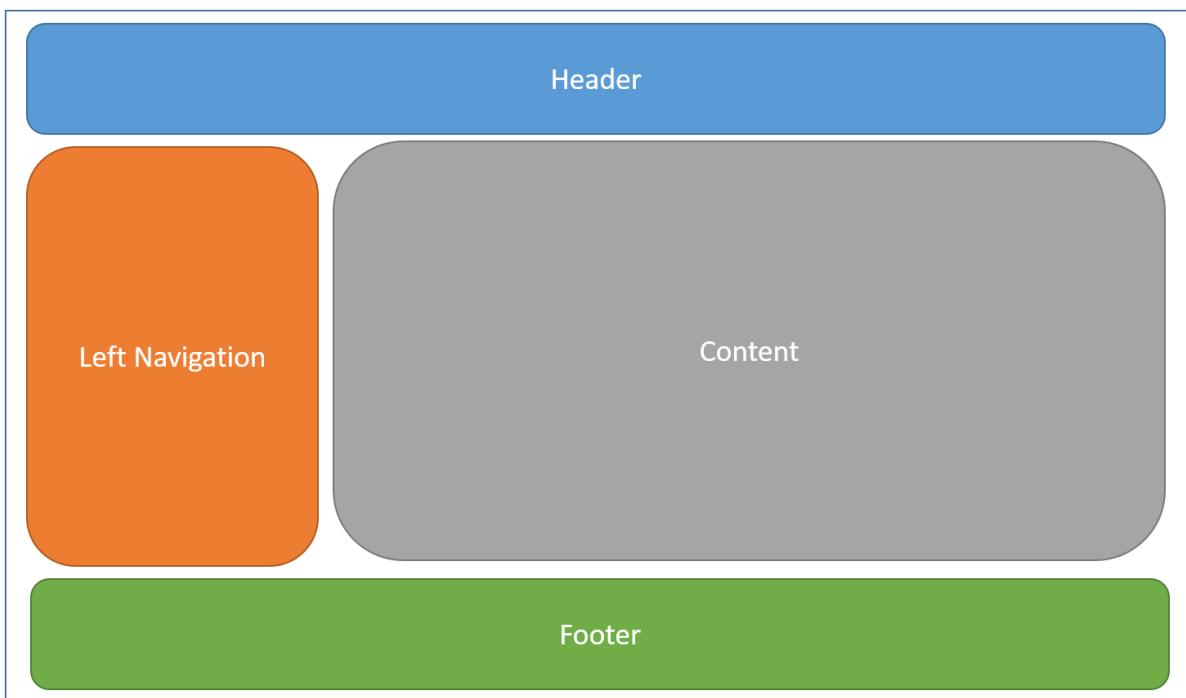
6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Steve Smith](#)

Views frequently share visual and programmatic elements. In this article, you'll learn how to use common layouts, share directives, and run common code before rendering views in your ASP.NET app.

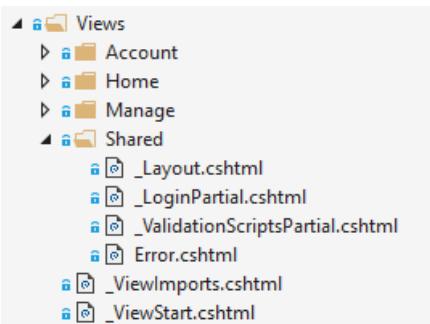
## What is a Layout

Most web apps have a common layout that provides the user with a consistent experience as they navigate from page to page. The layout typically includes common user interface elements such as the app header, navigation or menu elements, and footer.



Common HTML structures such as scripts and stylesheets are also frequently used by many pages within an app. All of these shared elements may be defined in a *layout* file, which can then be referenced by any view used within the app. Layouts reduce duplicate code in views, helping them follow the [Don't Repeat Yourself \(DRY\) principle](#).

By convention, the default layout for an ASP.NET app is named `_Layout.cshtml`. The Visual Studio ASP.NET Core MVC project template includes this layout file in the `Views/Shared` folder:



This layout defines a top level template for views in the app. Apps don't require a layout, and apps can

define more than one layout, with different views specifying different layouts.

An example `_Layout.cshtml`:

```
<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>@ViewData["Title"] - WebApplication1</title>

    <environment names="Development">
        <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />
        <link rel="stylesheet" href="~/css/site.css" />
    </environment>
    <environment names="Staging,Production">
        <link rel="stylesheet"
        href="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.6/css/bootstrap.min.css"
            asp-fallback-href="~/lib/bootstrap/dist/css/bootstrap.min.css"
            asp-fallback-test-class="sr-only" asp-fallback-test-property="position" asp-fallback-
test-value="absolute" />
        <link rel="stylesheet" href="~/css/site.min.css" asp-append-version="true" />
    </environment>
</head>
<body>
    <div class="navbar navbar-inverse navbar-fixed-top">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-
target=".navbar-collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a asp-area="" asp-controller="Home" asp-action="Index" class="navbar-
brand">WebApplication1</a>
            </div>
            <div class="navbar-collapse collapse">
                <ul class="nav navbar-nav">
                    <li><a asp-area="" asp-controller="Home" asp-action="Index">Home</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="About">About</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="Contact">Contact</a></li>
                </ul>
                @await Html.PartialAsync("_LoginPartial")
            </div>
        </div>
        <div class="container body-content">
            @RenderBody()
            <hr />
            <footer>
                <p>&copy; 2016 - WebApplication1</p>
            </footer>
        </div>

        <environment names="Development">
            <script src="~/lib/jquery/dist/jquery.js"></script>
            <script src="~/lib/bootstrap/dist/js/bootstrap.js"></script>
            <script src="~/js/site.js" asp-append-version="true"></script>
        </environment>
        <environment names="Staging,Production">
            <script src="https://ajax.aspnetcdn.com/ajax/jquery/jquery-2.2.0.min.js"
                asp-fallback-src="~/lib/jquery/dist/jquery.min.js"
                asp-fallback-test="window.jQuery">
            </script>
            <script src="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.6/bootstrap.min.js"
                asp-fallback-src="~/lib/bootstrap/dist/js/bootstrap.min.js">
            </script>
        </environment>
    </div>
</body>
</html>
```

```
        asp-fallback-test="window.jQuery && window.jQuery.fn && window.jQuery.fn.modal">
    </script>
    <script src="~/js/site.min.js" asp-append-version="true"></script>
</environment>

    @RenderSection("scripts", required: false)
</body>
</html>
```

## Specifying a Layout

Razor views have a `Layout` property. Individual views specify a layout by setting this property:

```
@{
    Layout = "_Layout";
}
```

The layout specified can use a full path (example: `/Views/Shared/_Layout.cshtml`) or a partial name (example: `_Layout`). When a partial name is provided, the Razor view engine will search for the layout file using its standard discovery process. The controller-associated folder is searched first, followed by the `Shared` folder. This discovery process is identical to the one used to discover [partial views](#).

By default, every layout must call `RenderBody`. Wherever the call to `RenderBody` is placed, the contents of the view will be rendered.

### Sections

A layout can optionally reference one or more *sections*, by calling `RenderSection`. Sections provide a way to organize where certain page elements should be placed. Each call to `RenderSection` can specify whether that section is required or optional. If a required section isn't found, an exception will be thrown. Individual views specify the content to be rendered within a section using the `@section` Razor syntax. If a view defines a section, it must be rendered (or an error will occur).

An example `@section` definition in a view:

```
@section Scripts {
    <script type="text/javascript" src="/scripts/main.js"></script>
}
```

In the code above, validation scripts are added to the `scripts` section on a view that includes a form. Other views in the same application might not require any additional scripts, and so wouldn't need to define a `scripts` section.

Sections defined in a view are available only in its immediate layout page. They cannot be referenced from partials, view components, or other parts of the view system.

### Ignoring sections

By default, the body and all sections in a content page must all be rendered by the layout page. The Razor view engine enforces this by tracking whether the body and each section have been rendered.

To instruct the view engine to ignore the body or sections, call the `IgnoreBody` and `IgnoreSection` methods.

The body and every section in a Razor page must be either rendered or ignored.

## Importing Shared Directives

Views can use Razor directives to do many things, such as importing namespaces or performing

[dependency injection](#). Directives shared by many views may be specified in a common `_ViewImports.cshtml` file. The `_ViewImports` file supports the following directives:

- `@addTagHelper`
- `@removeTagHelper`
- `@tagHelperPrefix`
- `@using`
- `@model`
- `@inherits`
- `@inject`

The file doesn't support other Razor features, such as functions and section definitions.

A sample `_ViewImports.cshtml` file:

```
@using WebApplication1
@using WebApplication1.Models
@using WebApplication1.Models.AccountViewModels
@using WebApplication1.Models.ManageViewModels
@using Microsoft.AspNetCore.Identity
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers
```

The `_ViewImports.cshtml` file for an ASP.NET Core MVC app is typically placed in the `Views` folder. A `_ViewImports.cshtml` file can be placed within any folder, in which case it will only be applied to views within that folder and its subfolders. `_ViewImports` files are processed starting at the root level, and then for each folder leading up to the location of the view itself, so settings specified at the root level may be overridden at the folder level.

For example, if a root level `_ViewImports.cshtml` file specifies `@model` and `@addTagHelper`, and another `_ViewImports.cshtml` file in the controller-associated folder of the view specifies a different `@model` and adds another `@addTagHelper`, the view will have access to both tag helpers and will use the latter `@model`.

If multiple `_ViewImports.cshtml` files are run for a view, combined behavior of the directives included in the `ViewImports.cshtml` files will be as follows:

- `@addTagHelper`, `@removeTagHelper`: all run, in order
- `@tagHelperPrefix`: the closest one to the view overrides any others
- `@model`: the closest one to the view overrides any others
- `@inherits`: the closest one to the view overrides any others
- `@using`: all are included; duplicates are ignored
- `@inject`: for each property, the closest one to the view overrides any others with the same property name

## Running Code Before Each View

If you have code you need to run before every view, this should be placed in the `_ViewStart.cshtml` file. By convention, the `_ViewStart.cshtml` file is located in the `Views` folder. The statements listed in `_ViewStart.cshtml` are run before every full view (not layouts, and not partial views). Like

`_ViewImports.cshtml`, `_ViewStart.cshtml` is hierarchical. If a `_ViewStart.cshtml` file is defined in the controller-associated view folder, it will be run after the one defined in the root of the `Views` folder (if any).

A sample `_ViewStart.cshtml` file:

```
@{  
    Layout = "_Layout";  
}
```

The file above specifies that all views will use the `_Layout.cshtml` layout.

**NOTE**

Neither `_ViewStart.cshtml` nor `_ViewImports.cshtml` are typically placed in the `/Views/Shared` folder. The app-level versions of these files should be placed directly in the `/Views` folder.

# Tag Helpers in ASP.NET Core

6/21/2018 • 11 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

## What are Tag Helpers?

Tag Helpers enable server-side code to participate in creating and rendering HTML elements in Razor files. For example, the built-in `ImageTagHelper` can append a version number to the image name. Whenever the image changes, the server generates a new unique version for the image, so clients are guaranteed to get the current image (instead of a stale cached image). There are many built-in Tag Helpers for common tasks - such as creating forms, links, loading assets and more - and even more available in public GitHub repositories and as NuGet packages. Tag Helpers are authored in C#, and they target HTML elements based on element name, attribute name, or parent tag. For example, the built-in `LabelTagHelper` can target the HTML `<label>` element when the `LabelTagHelper` attributes are applied. If you're familiar with [HTML Helpers](#), Tag Helpers reduce the explicit transitions between HTML and C# in Razor views. In many cases, HTML Helpers provide an alternative approach to a specific Tag Helper, but it's important to recognize that Tag Helpers don't replace HTML Helpers and there's not a Tag Helper for each HTML Helper. [Tag Helpers compared to HTML Helpers](#) explains the differences in more detail.

## What Tag Helpers provide

**An HTML-friendly development experience** For the most part, Razor markup using Tag Helpers looks like standard HTML. Front-end designers conversant with HTML/CSS/JavaScript can edit Razor without learning C# Razor syntax.

**A rich IntelliSense environment for creating HTML and Razor markup** This is in sharp contrast to HTML Helpers, the previous approach to server-side creation of markup in Razor views. [Tag Helpers compared to HTML Helpers](#) explains the differences in more detail. [IntelliSense support for Tag Helpers](#) explains the IntelliSense environment. Even developers experienced with Razor C# syntax are more productive using Tag Helpers than writing C# Razor markup.

**A way to make you more productive and able to produce more robust, reliable, and maintainable code using information only available on the server** For example, historically the mantra on updating images was to change the name of the image when you change the image. Images should be aggressively cached for performance reasons, and unless you change the name of an image, you risk clients getting a stale copy. Historically, after an image was edited, the name had to be changed and each reference to the image in the web app needed to be updated. Not only is this very labor intensive, it's also error prone (you could miss a reference, accidentally enter the wrong string, etc.) The built-in `ImageTagHelper` can do this for you automatically. The `ImageTagHelper` can append a version number to the image name, so whenever the image changes, the server automatically generates a new unique version for the image. Clients are guaranteed to get the current image. This robustness and labor savings comes essentially free by using the `ImageTagHelper`.

Most built-in Tag Helpers target standard HTML elements and provide server-side attributes for the element. For example, the `<input>` element used in many views in the `Views/Account` folder contains the `asp-for` attribute. This attribute extracts the name of the specified model property into the rendered HTML. Consider a Razor view with the following model:

```
public class Movie
{
    public int ID { get; set; }
    public string Title { get; set; }
    public DateTime ReleaseDate { get; set; }
    public string Genre { get; set; }
    public decimal Price { get; set; }
}
```

The following Razor markup:

```
<label asp-for="Movie.Title"></label>
```

Generates the following HTML:

```
<label for="Movie_Title">Title</label>
```

The `asp-for` attribute is made available by the `For` property in the [LabelTagHelper](#). See [Author Tag Helpers](#) for more information.

## Managing Tag Helper scope

Tag Helpers scope is controlled by a combination of `@addTagHelper`, `@removeTagHelper`, and the "!" opt-out character.

`@addTagHelper` makes Tag Helpers available

If you create a new ASP.NET Core web app named *AuthoringTagHelpers*, the following *Views/\_ViewImports.cshtml* file will be added to your project:

```
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers
@addTagHelper *, AuthoringTagHelpers
```

The `@addTagHelper` directive makes Tag Helpers available to the view. In this case, the view file is *Pages/\_ViewImports.cshtml*, which by default is inherited by all files in the *Pages* folder and sub-folders; making Tag Helpers available. The code above uses the wildcard syntax ("\*") to specify that all Tag Helpers in the specified assembly (*Microsoft.AspNetCore.Mvc.TagHelpers*) will be available to every view file in the *Views* directory or sub-directory. The first parameter after `@addTagHelper` specifies the Tag Helpers to load (we are using "\*" for all Tag Helpers), and the second parameter "*Microsoft.AspNetCore.Mvc.TagHelpers*" specifies the assembly containing the Tag Helpers. *Microsoft.AspNetCore.Mvc.TagHelpers* is the assembly for the built-in ASP.NET Core Tag Helpers.

To expose all of the Tag Helpers in this project (which creates an assembly named *AuthoringTagHelpers*), you would use the following:

```
@using AuthoringTagHelpers
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers
@addTagHelper *, AuthoringTagHelpers
```

If your project contains an `EmailTagHelper` with the default namespace (`AuthoringTagHelpers.TagHelpers.EmailTagHelper`), you can provide the fully qualified name (FQN) of the Tag Helper:

```
@using AuthoringTagHelpers  
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers  
@addTagHelper AuthoringTagHelpers.TagHelpers.EmailTagHelper, AuthoringTagHelpers
```

To add a Tag Helper to a view using an FQN, you first add the FQN (`AuthoringTagHelpers.TagHelpers.EmailTagHelper`), and then the assembly name (`AuthoringTagHelpers`). Most developers prefer to use the "\*" wildcard syntax. The wildcard syntax allows you to insert the wildcard character "\*" as the suffix in an FQN. For example, any of the following directives will bring in the `EmailTagHelper`:

```
@addTagHelper AuthoringTagHelpers.TagHelpers.E*, AuthoringTagHelpers  
@addTagHelper AuthoringTagHelpers.TagHelpers.Email*, AuthoringTagHelpers
```

As mentioned previously, adding the `@addTagHelper` directive to the `Views/_ViewImports.cshtml` file makes the Tag Helper available to all view files in the `Views` directory and sub-directories. You can use the `@addTagHelper` directive in specific view files if you want to opt-in to exposing the Tag Helper to only those views.

#### `@removeTagHelper` removes Tag Helpers

The `@removeTagHelper` has the same two parameters as `@addTagHelper`, and it removes a Tag Helper that was previously added. For example, `@removeTagHelper` applied to a specific view removes the specified Tag Helper from the view. Using `@removeTagHelper` in a `Views/Folder/_ViewImports.cshtml` file removes the specified Tag Helper from all of the views in `Folder`.

#### Controlling Tag Helper scope with the `_ViewImports.cshtml` file

You can add a `_ViewImports.cshtml` to any view folder, and the view engine applies the directives from both that file and the `Views/_ViewImports.cshtml` file. If you added an empty `Views/Home/_ViewImports.cshtml` file for the `Home` views, there would be no change because the `_ViewImports.cshtml` file is additive. Any `@addTagHelper` directives you add to the `Views/Home/_ViewImports.cshtml` file (that are not in the default `Views/_ViewImports.cshtml` file) would expose those Tag Helpers to views only in the `Home` folder.

#### Opting out of individual elements

You can disable a Tag Helper at the element level with the Tag Helper opt-out character ("!"). For example, `Email` validation is disabled in the `<span>` with the Tag Helper opt-out character:

```
<!span asp-validation-for="Email" class="text-danger"></!span>
```

You must apply the Tag Helper opt-out character to the opening and closing tag. (The Visual Studio editor automatically adds the opt-out character to the closing tag when you add one to the opening tag). After you add the opt-out character, the element and Tag Helper attributes are no longer displayed in a distinctive font.

#### Using `@tagHelperPrefix` to make Tag Helper usage explicit

The `@tagHelperPrefix` directive allows you to specify a tag prefix string to enable Tag Helper support and to make Tag Helper usage explicit. For example, you could add the following markup to the `Views/_ViewImports.cshtml` file:

```
@tagHelperPrefix th:
```

In the code image below, the Tag Helper prefix is set to `th:`, so only those elements using the prefix

`th:` support Tag Helpers (Tag Helper-enabled elements have a distinctive font). The `<label>` and `<input>` elements have the Tag Helper prefix and are Tag Helper-enabled, while the `<span>` element doesn't.

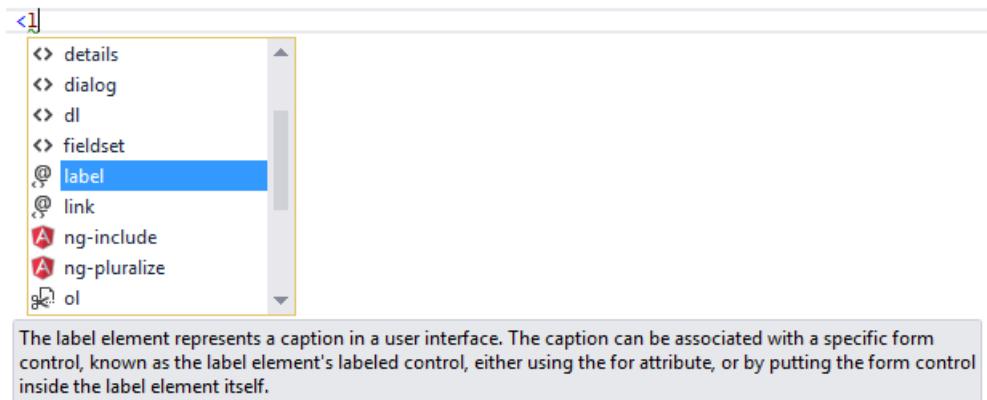
```
<div class="form-group">
<th:label asp-for="Password" class="col-md-2"></th:label>
<div class="col-md-10">
    <th:input asp-for="Password" class="form-control" />
    <span asp-validation-for="Password" class="text-danger"></span>
</div>
</div>
```

The same hierarchy rules that apply to `@addTagHelper` also apply to `@tagHelperPrefix`.

## IntelliSense support for Tag Helpers

When you create a new ASP.NET web app in Visual Studio, it adds the NuGet package "Microsoft.AspNetCore.Razor.Tools". This is the package that adds Tag Helper tooling.

Consider writing an HTML `<label>` element. As soon as you enter `<l` in the Visual Studio editor, IntelliSense displays matching elements:



Not only do you get HTML help, but the icon (the "@" symbol with "<>" under it).

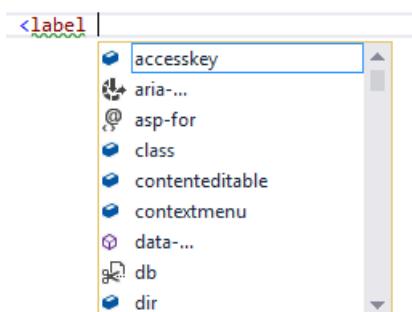


identifies the element as targeted by Tag Helpers. Pure HTML elements (such as the `fieldset`) display the "<>" icon.

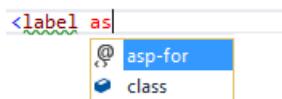
A pure HTML `<label>` tag displays the HTML tag (with the default Visual Studio color theme) in a brown font, the attributes in red, and the attribute values in blue.

```
<label class="col-md-2">Email</label>
```

After you enter `<label>`, IntelliSense lists the available HTML/CSS attributes and the Tag Helper-targeted attributes:



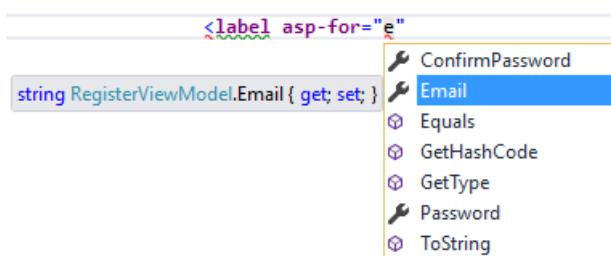
IntelliSense statement completion allows you to enter the tab key to complete the statement with the selected value:



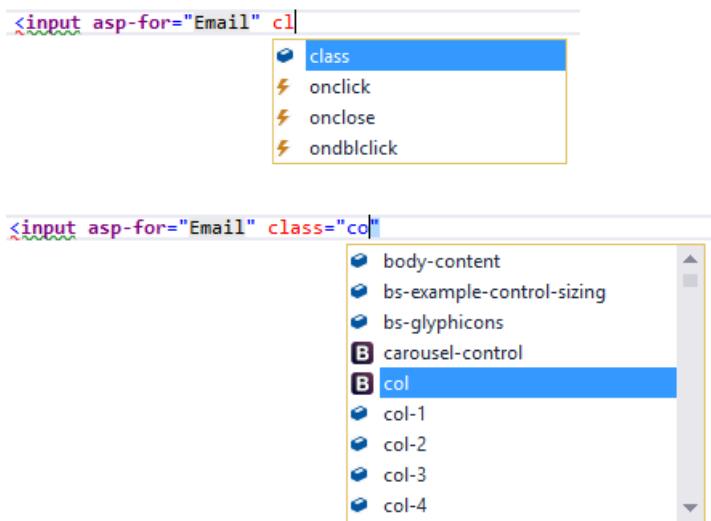
As soon as a Tag Helper attribute is entered, the tag and attribute fonts change. Using the default Visual Studio "Blue" or "Light" color theme, the font is bold purple. If you're using the "Dark" theme the font is bold teal. The images in this document were taken using the default theme.

```
<label asp-for
```

You can enter the Visual Studio *CompleteWord* shortcut (Ctrl + spacebar is the **default** inside the double quotes ("")), and you are now in C#, just like you would be in a C# class. IntelliSense displays all the methods and properties on the page model. The methods and properties are available because the property type is `ModelExpression`. In the image below, I'm editing the `Register` view, so the `RegisterViewModel` is available.



IntelliSense lists the properties and methods available to the model on the page. The rich IntelliSense environment helps you select the CSS class:



## Tag Helpers compared to HTML Helpers

Tag Helpers attach to HTML elements in Razor views, while [HTML Helpers](#) are invoked as methods interspersed with HTML in Razor views. Consider the following Razor markup, which creates an HTML label with the CSS class "caption":

```
@Html.Label("FirstName", "First Name:", new {@class="caption"})
```

The at (@) symbol tells Razor this is the start of code. The next two parameters ("FirstName" and "First Name:") are strings, so [IntelliSense](#) can't help. The last argument:

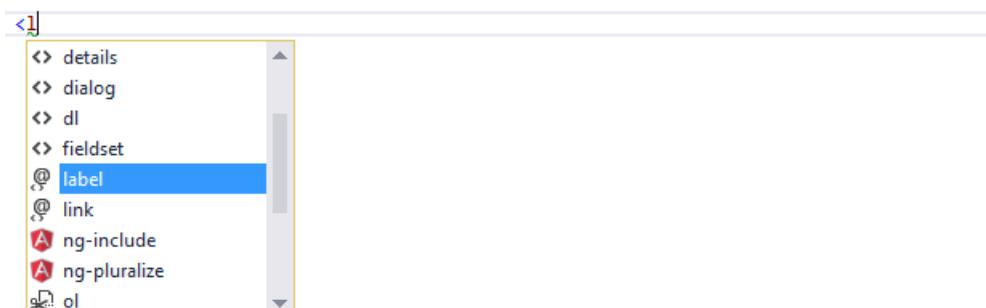
```
new {@class="caption"}
```

Is an anonymous object used to represent attributes. Because **class** is a reserved keyword in C#, you use the `@` symbol to force C# to interpret "`@class=`" as a symbol (property name). To a front-end designer (someone familiar with HTML/CSS/JavaScript and other client technologies but not familiar with C# and Razor), most of the line is foreign. The entire line must be authored with no help from IntelliSense.

Using the `LabelTagHelper`, the same markup can be written as:

```
<label class="caption" asp-for="FirstName"></label>
```

With the Tag Helper version, as soon as you enter `<l` in the Visual Studio editor, IntelliSense displays matching elements:



The `label` element represents a caption in a user interface. The caption can be associated with a specific form control, known as the `label` element's labeled control, either using the `for` attribute, or by putting the form control inside the `label` element itself.

IntelliSense helps you write the entire line. The `LabelTagHelper` also defaults to setting the content of the `asp-for` attribute value ("FirstName") to "First Name"; It converts camel-cased properties to a sentence composed of the property name with a space where each new upper-case letter occurs. In the following markup:

```
<label class="caption" asp-for="FirstName"></label>
```

generates:

```
<label class="caption" for="FirstName">First Name</label>
```

The camel-cased to sentence-cased content isn't used if you add content to the `<label>`. For example:

```
<label class="caption" asp-for="FirstName">Name First</label>
```

generates:

```
<label class="caption" for="FirstName">Name First</label>
```

The following code image shows the Form portion of the `Views/Account/Register.cshtml` Razor view generated from the legacy ASP.NET 4.5.x MVC template included with Visual Studio 2015.

```

@using (Html.BeginForm("Register", "Account", FormMethod.Post, new { @class = "form-horizo
{
    @Html.AntiForgeryToken()
    <h4>Create a new account.</h4>
    <hr />
    @Html.ValidationSummary("", new { @class = "text-danger" })
    <div class="form-group">
        @Html.LabelFor(m => m.Email, new { @class = "col-md-2 control-label" })
        <div class="col-md-10">
            @Html.TextBoxFor(m => m.Email, new { @class = "form-control" })
        </div>
    </div>
    <div class="form-group">
        @Html.LabelFor(m => m.Password, new { @class = "col-md-2 control-label" })
        <div class="col-md-10">
            @Html.PasswordFor(m => m.Password, new { @class = "form-control" })
        </div>
    </div>
    <div class="form-group">
        @Html.LabelFor(m => m.ConfirmPassword, new { @class = "col-md-2 control-label" })
        <div class="col-md-10">
            @Html.PasswordFor(m => m.ConfirmPassword, new { @class = "form-control" })
        </div>
    </div>
    <div class="form-group">
        <div class="col-md-offset-2 col-md-10">
            <input type="submit" class="btn btn-default" value="Register" />
        </div>
    </div>
}

```

The Visual Studio editor displays C# code with a grey background. For example, the `AntiForgeryToken` HTML Helper:

```

@Html.AntiForgeryToken()

```

is displayed with a grey background. Most of the markup in the Register view is C#. Compare that to the equivalent approach using Tag Helpers:

```

<form asp-controller="Account" asp-action="Register" method="post" class="form-hori
    <h4>Create a new account.</h4>
    <hr />
    <div asp-validation-summary="ValidationSummary.All" class="text-danger"></div>
    <div class="form-group">
        <label asp-for="Email" class="col-md-2 control-label"></label>
        <div class="col-md-10">
            <input asp-for="Email" class="form-control" />
            <span asp-validation-for="Email" class="text-danger"></span>
        </div>
    </div>
    <div class="form-group">
        <label asp-for="Password" class="col-md-2 control-label"></label>
        <div class="col-md-10">
            <input asp-for="Password" class="form-control" />
            <span asp-validation-for="Password" class="text-danger"></span>
        </div>
    </div>
    <div class="form-group">
        <label asp-for="ConfirmPassword" class="col-md-2 control-label"></label>
        <div class="col-md-10">
            <input asp-for="ConfirmPassword" class="form-control" />
            <span asp-validation-for="ConfirmPassword" class="text-danger"></span>
        </div>
    </div>
    <div class="form-group">
        <div class="col-md-offset-2 col-md-10">
            <button type="submit" class="btn btn-default">Register</button>
        </div>
    </div>
</form>

```

The markup is much cleaner and easier to read, edit, and maintain than the HTML Helpers approach. The C# code is reduced to the minimum that the server needs to know about. The Visual Studio editor displays markup targeted by a Tag Helper in a distinctive font.

Consider the *Email* group:

```
<div class="form-group">
    <label asp-for="Email" class="col-md-2 control-label"></label>
    <div class="col-md-10">
        <input asp-for="Email" class="form-control" />
        <span asp-validation-for="Email" class="text-danger"></span>
    </div>
</div>
```

Each of the "asp-" attributes has a value of "Email", but "Email" isn't a string. In this context, "Email" is the C# model expression property for the `RegisterViewModel`.

The Visual Studio editor helps you write **all** of the markup in the Tag Helper approach of the register form, while Visual Studio provides no help for most of the code in the HTML Helpers approach.

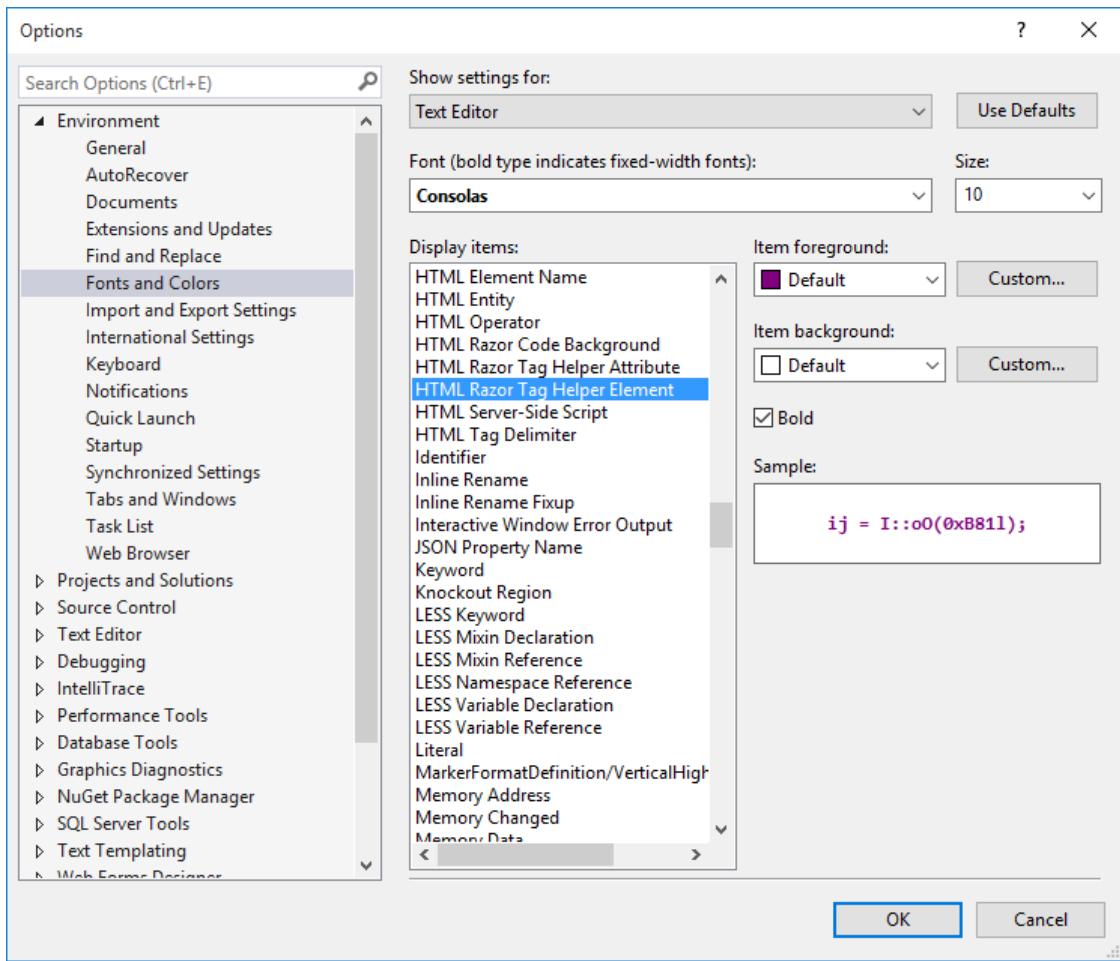
[IntelliSense support for Tag Helpers](#) goes into detail on working with Tag Helpers in the Visual Studio editor.

## Tag Helpers compared to Web Server Controls

- Tag Helpers don't own the element they're associated with; they simply participate in the rendering of the element and content. ASP.NET [Web Server controls](#) are declared and invoked on a page.
- [Web Server controls](#) have a non-trivial lifecycle that can make developing and debugging difficult.
- Web Server controls allow you to add functionality to the client Document Object Model (DOM) elements by using a client control. Tag Helpers have no DOM.
- Web Server controls include automatic browser detection. Tag Helpers have no knowledge of the browser.
- Multiple Tag Helpers can act on the same element (see [Avoiding Tag Helper conflicts](#)) while you typically can't compose Web Server controls.
- Tag Helpers can modify the tag and content of HTML elements that they're scoped to, but don't directly modify anything else on a page. Web Server controls have a less specific scope and can perform actions that affect other parts of your page; enabling unintended side effects.
- Web Server controls use type converters to convert strings into objects. With Tag Helpers, you work natively in C#, so you don't need to do type conversion.
- Web Server controls use [System.ComponentModel](#) to implement the run-time and design-time behavior of components and controls. `System.ComponentModel` includes the base classes and interfaces for implementing attributes and type converters, binding to data sources, and licensing components. Contrast that to Tag Helpers, which typically derive from `TagHelper`, and the `TagHelper` base class exposes only two methods, `Process` and `ProcessAsync`.

## Customizing the Tag Helper element font

You can customize the font and colorization from **Tools > Options > Environment > Fonts and Colors**:



## Additional resources

- [Author Tag Helpers](#)
- [Working with Forms](#)
- [TagHelperSamples on GitHub](#) contains Tag Helper samples for working with [Bootstrap](#).

# Author Tag Helpers in ASP.NET Core

6/21/2018 • 16 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

[View or download sample code](#) ([how to download](#))

## Get started with Tag Helpers

This tutorial provides an introduction to programming Tag Helpers. [Introduction to Tag Helpers](#) describes the benefits that Tag Helpers provide.

A tag helper is any class that implements the `ITagHelper` interface. However, when you author a tag helper, you generally derive from `TagHelper`, doing so gives you access to the `Process` method.

1. Create a new ASP.NET Core project called **AuthoringTagHelpers**. You won't need authentication for this project.
2. Create a folder to hold the Tag Helpers called *TagHelpers*. The *TagHelpers* folder is *not* required, but it's a reasonable convention. Now let's get started writing some simple tag helpers.

## A minimal Tag Helper

In this section, you write a tag helper that updates an email tag. For example:

```
<email>Support</email>
```

The server will use our email tag helper to convert that markup into the following:

```
<a href="mailto:Support@contoso.com">Support@contoso.com</a>
```

That is, an anchor tag that makes this an email link. You might want to do this if you are writing a blog engine and need it to send email for marketing, support, and other contacts, all to the same domain.

1. Add the following `EmailTagHelper` class to the *TagHelpers* folder.

```
using Microsoft.AspNetCore.Razor.TagHelpers;
using System.Threading.Tasks;

namespace AuthoringTagHelpers.TagHelpers
{
    public class EmailTagHelper : TagHelper
    {
        public override void Process(TagHelperContext context, TagHelperOutput output)
        {
            output.TagName = "a";      // Replaces <email> with <a> tag
        }
    }
}
```

### Notes:

- Tag helpers use a naming convention that targets elements of the root class name (minus the **TagHelper** portion of the class name). In this example, the root name of **EmailTagHelper** is *email*, so the `<email>` tag will be targeted. This naming convention should work for most tag helpers, later on I'll show how to override it.
- The `EmailTagHelper` class derives from `TagHelper`. The `TagHelper` class provides methods and properties for writing Tag Helpers.
- The overridden `Process` method controls what the tag helper does when executed. The `TagHelper` class also provides an asynchronous version (`ProcessAsync`) with the same parameters.
- The context parameter to `Process` (and `ProcessAsync`) contains information associated with the execution of the current HTML tag.
- The output parameter to `Process` (and `ProcessAsync`) contains a stateful HTML element representative of the original source used to generate an HTML tag and content.
- Our class name has a suffix of **TagHelper**, which is *not* required, but it's considered a best practice convention. You could declare the class as:

```
public class Email : TagHelper
```

2. To make the `EmailTagHelper` class available to all our Razor views, add the `@addTagHelper` directive to the `Views/_ViewImports.cshtml` file:

```
@using AuthoringTagHelpers
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers
@addTagHelper *, AuthoringTagHelpers
```

The code above uses the wildcard syntax to specify all the tag helpers in our assembly will be available. The first string after `@addTagHelper` specifies the tag helper to load (Use "\*" for all tag helpers), and the second string "AuthoringTagHelpers" specifies the assembly the tag helper is in. Also, note that the second line brings in the ASP.NET Core MVC tag helpers using the wildcard syntax (those helpers are discussed in [Introduction to Tag Helpers](#).) It's the `@addTagHelper` directive that makes the tag helper available to the Razor view. Alternatively, you can provide the fully qualified name (FQN) of a tag helper as shown below:

```
@using AuthoringTagHelpers
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers
@addTagHelper AuthoringTagHelpers.TagHelpers.EmailTagHelper, AuthoringTagHelpers
```

- To add a tag helper to a view using a FQN, you first add the FQN (`AuthoringTagHelpers.TagHelpers.EmailTagHelper`), and then the assembly name (*AuthoringTagHelpers*). Most developers will prefer to use the wildcard syntax. [Introduction to Tag Helpers](#) goes into detail on tag helper adding, removing, hierarchy, and wildcard syntax.
3. Update the markup in the `Views/Home/Contact.cshtml` file with these changes:

```

@{
    ViewData["Title"] = "Contact";
}
<h2>@ViewData["Title"].</h2>
<h3>@ViewData["Message"]</h3>

<address>
    One Microsoft Way<br />
    Redmond, WA 98052<br />
    <abbr title="Phone">P:</abbr>
    425.555.0100
</address>

<address>
    <strong>Support:</strong><email>Support</email><br />
    <strong>Marketing:</strong><email>Marketing</email>
</address>

```

- Run the app and use your favorite browser to view the HTML source so you can verify that the email tags are replaced with anchor markup (For example, `<a>Support</a>`). *Support* and *Marketing* are rendered as a links, but they don't have an `href` attribute to make them functional. We'll fix that in the next section.

## SetAttribute and SetContent

In this section, we'll update the `EmailTagHelper` so that it will create a valid anchor tag for email. We'll update it to take information from a Razor view (in the form of a `mail-to` attribute) and use that in generating the anchor.

Update the `EmailTagHelper` class with the following:

```

public class EmailTagHelper : TagHelper
{
    private const string EmailDomain = "contoso.com";

    // Can be passed via <email mail-to="..." />.
    // Pascal case gets translated into lower-kebab-case.
    public string MailTo { get; set; }

    public override void Process(TagHelperContext context, TagHelperOutput output)
    {
        output.TagName = "a";      // Replaces <email> with <a> tag

        var address = MailTo + "@" + EmailDomain;
        output.Attributes.SetAttribute("href", "mailto:" + address);
        output.Content.SetContent(address);
    }
}

```

### Notes:

- Pascal-cased class and property names for tag helpers are translated into their [lower kebab case](#). Therefore, to use the `MailTo` attribute, you'll use `<email mail-to="value"/>` equivalent.
- The last line sets the completed content for our minimally functional tag helper.
- The highlighted line shows the syntax for adding attributes:

```

public override void Process(TagHelperContext context, TagHelperOutput output)
{
    output.TagName = "a";      // Replaces <email> with <a> tag

    var address = MailTo + "@" + EmailDomain;
    output.Attributes.SetAttribute("href", "mailto:" + address);
    output.Content.SetContent(address);
}

```

That approach works for the attribute "href" as long as it doesn't currently exist in the attributes collection. You can also use the `output.Attributes.Add` method to add a tag helper attribute to the end of the collection of tag attributes.

1. Update the markup in the `Views/Home/Contact.cshtml` file with these changes:

```

@{
    ViewData["Title"] = "Contact Copy";
}

<h2>@ViewData["Title"].</h2>
<h3>@ViewData["Message"]</h3>

<address>
    One Microsoft Way Copy Version <br />
    Redmond, WA 98052-6399<br />
    <abbr title="Phone">P:</abbr>
    425.555.0100
</address>

<address>
    <strong>Support:</strong><email mail-to="Support"></email><br />
    <strong>Marketing:</strong><email mail-to="Marketing"></email>
</address>

```

2. Run the app and verify that it generates the correct links.

#### NOTE

If you were to write the email tag self-closing (`<email mail-to="Rick" />`), the final output would also be self-closing. To enable the ability to write the tag with only a start tag (`<email mail-to="Rick">`) you must decorate the class with the following:

```

[HtmlTargetElement("email", TagStructure = TagStructure.WithoutEndTag)]
public class EmailVoidTagHelper : TagHelper
{
    private const string EmailDomain = "contoso.com";
    // Code removed for brevity
}

```

With a self-closing email tag helper, the output would be `<a href="mailto:Rick@contoso.com" />`. Self-closing anchor tags are not valid HTML, so you wouldn't want to create one, but you might want to create a tag helper that's self-closing. Tag helpers set the type of the `TagMode` property after reading a tag.

## ProcessAsync

In this section, we'll write an asynchronous email helper.

1. Replace the `EmailTagHelper` class with the following code:

```

public class EmailTagHelper : TagHelper
{
    private const string EmailDomain = "contoso.com";
    public override async Task ProcessAsync(TagHelperContext context, TagHelperOutput output)
    {
        output.TagName = "a"; // Replaces <email> with <a> tag
        var content = await output.GetChildContentAsync();
        var target = content.GetContent() + "@" + EmailDomain;
        output.Attributes.SetAttribute("href", "mailto:" + target);
        output.Content.SetContent(target);
    }
}

```

**Notes:**

- This version uses the asynchronous `ProcessAsync` method. The asynchronous `GetChildContentAsync` returns a `Task` containing the `TagHelperContent`.
  - Use the `output` parameter to get contents of the HTML element.
2. Make the following change to the `Views/Home/Contact.cshtml` file so the tag helper can get the target email.

```

@{
    ViewData["Title"] = "Contact";
}
<h2>@ViewData["Title"].</h2>
<h3>@ViewData["Message"]</h3>

<address>
    One Microsoft Way<br />
    Redmond, WA 98052<br />
    <abbr title="Phone">P:</abbr>
    425.555.0100
</address>

<address>
    <strong>Support:</strong><email>Support</email><br />
    <strong>Marketing:</strong><email>Marketing</email>
</address>

```

3. Run the app and verify that it generates valid email links.

### RemoveAll, PreContent.SetHtmlContent and PostContent.SetHtmlContent

1. Add the following `BoldTagHelper` class to the `TagHelpers` folder.

```

using Microsoft.AspNetCore.Razor.TagHelpers;

namespace AuthoringTagHelpers.TagHelpers
{
    [HtmlTargetElement(Attributes = "bold")]
    public class BoldTagHelper : TagHelper
    {
        public override void Process(TagHelperContext context, TagHelperOutput output)
        {
            output.Attributes.RemoveAll("bold");
            output.PreContent.SetHtmlContent("<strong>");
            output.PostContent.SetHtmlContent("</strong>");
        }
    }
}

```

## Notes:

- The `[HtmlTargetElement]` attribute passes an attribute parameter that specifies that any HTML element that contains an HTML attribute named "bold" will match, and the `Process` override method in the class will run. In our sample, the `Process` method removes the "bold" attribute and surrounds the containing markup with `<strong></strong>`.
- Because you don't want to replace the existing tag content, you must write the opening `<strong>` tag with the `PreContent.SetHtmlContent` method and the closing `</strong>` tag with the `PostContent.SetHtmlContent` method.

2. Modify the `About.cshtml` view to contain a `bold` attribute value. The completed code is shown below.

```
@{  
    ViewData["Title"] = "About";  
}  
<h2>@ViewData["Title"].</h2>  
<h3>@ViewData["Message"]</h3>  
  
<p bold>Use this area to provide additional information.</p>  
  
<bold> Is this bold?</bold>
```

3. Run the app. You can use your favorite browser to inspect the source and verify the markup.

The `[HtmlTargetElement]` attribute above only targets HTML markup that provides an attribute name of "bold". The `<bold>` element wasn't modified by the tag helper.

4. Comment out the `[HtmlTargetElement]` attribute line and it will default to targeting `<bold>` tags, that is, HTML markup of the form `<bold>`. Remember, the default naming convention will match the class name `BoldTagHelper` to `<bold>` tags.

5. Run the app and verify that the `<bold>` tag is processed by the tag helper.

Decorating a class with multiple `[HtmlTargetElement]` attributes results in a logical-OR of the targets. For example, using the code below, a bold tag or a bold attribute will match.

```
[HtmlTargetElement("bold")]  
[HtmlTargetElement(Attributes = "bold")]  
public class BoldTagHelper : TagHelper  
{  
    public override void Process(TagHelperContext context, TagHelperOutput output)  
    {  
        output.Attributes.RemoveAll("bold");  
        output.PreContent.SetHtmlContent("<strong>");  
        output.PostContent.SetHtmlContent("</strong>");  
    }  
}
```

When multiple attributes are added to the same statement, the runtime treats them as a logical-AND. For example, in the code below, an HTML element must be named "bold" with an attribute named "bold" (`<bold bold />`) to match.

```
[HtmlTargetElement("bold", Attributes = "bold")]
```

You can also use the `[HtmlTargetElement]` to change the name of the targeted element. For example if you wanted the `BoldTagHelper` to target `<MyBold>` tags, you would use the following attribute:

```
[HtmlTargetElement("MyBold")]
```

## Pass a model to a Tag Helper

1. Add a *Models* folder.
2. Add the following `WebsiteContext` class to the *Models* folder:

```
using System;

namespace AuthoringTagHelpers.Models
{
    public class WebsiteContext
    {
        public Version Version { get; set; }
        public int CopyrightYear { get; set; }
        public bool Approved { get; set; }
        public int TagsToShow { get; set; }
    }
}
```

3. Add the following `WebsiteInformationTagHelper` class to the *TagHelpers* folder.

```
using System;
using AuthoringTagHelpers.Models;
using Microsoft.AspNetCore.Razor.TagHelpers;

namespace AuthoringTagHelpers.TagHelpers
{
    public class WebsiteInformationTagHelper : TagHelper
    {
        public WebsiteContext Info { get; set; }

        public override void Process(TagHelperContext context, TagHelperOutput output)
        {
            output.TagName = "section";
            output.Content.SetHtmlContent(
$@"<ul><li><strong>Version:</strong> {Info.Version}</li>
<li><strong>Copyright Year:</strong> {Info.CopyrightYear}</li>
<li><strong>Approved:</strong> {Info.Approved}</li>
<li><strong>Number of tags to show:</strong> {Info.TagsToShow}</li></ul>");
            output.TagMode = TagMode.StartTagAndEndTag;
        }
    }
}
```

### Notes:

- As mentioned previously, tag helpers translates Pascal-cased C# class names and properties for tag helpers into [lower kebab case](#). Therefore, to use the `WebsiteInformationTagHelper` in Razor, you'll write `<website-information />`.
- You are not explicitly identifying the target element with the `[HtmlTargetElement]` attribute, so the default of `website-information` will be targeted. If you applied the following attribute (note it's not kebab case but matches the class name):

```
[HtmlTargetElement("WebsiteInformation")]
```

The lower kebab case tag `<website-information />` wouldn't match. If you want use the `[HtmlTargetElement]` attribute, you would use kebab case as shown below:

```
[HtmlTargetElement("Website-Information")]
```

- Elements that are self-closing have no content. For this example, the Razor markup will use a self-closing tag, but the tag helper will be creating a `section` element (which isn't self-closing and you are writing content inside the `section` element). Therefore, you need to set `TagMode` to `StartTagAndEndTag` to write output. Alternatively, you can comment out the line setting `TagMode` and write markup with a closing tag. (Example markup is provided later in this tutorial.)
- The `$` (dollar sign) in the following line uses an [interpolated string](#):

```
$$<ul><li><strong>Version:</strong> {Info.Version}</li>
```

- Add the following markup to the `About.cshtml` view. The highlighted markup displays the web site information.

```
@using AuthoringTagHelpers.Models  
{@  
    ViewData["Title"] = "About";  
}  
<h2>@ViewData["Title"].</h2>  
<h3>@ViewData["Message"]</h3>  
  
<p bold>Use this area to provide additional information.</p>  
  
<bold> Is this bold?</bold>  
  
<h3> web site info </h3>  
<website-information info="new WebsiteContext {  
    Version = new Version(1, 3),  
    CopyrightYear = 1638,  
    Approved = true,  
    TagsToShow = 131 }" />
```

#### NOTE

In the Razor markup shown below:

```
<website-information info="new WebsiteContext {  
    Version = new Version(1, 3),  
    CopyrightYear = 1638,  
    Approved = true,  
    TagsToShow = 131 }" />
```

Razor knows the `info` attribute is a class, not a string, and you want to write C# code. Any non-string tag helper attribute should be written without the `@` character.

- Run the app, and navigate to the About view to see the web site information.

## NOTE

You can use the following markup with a closing tag and remove the line with `TagMode.StartTagAndEndTag` in the tag helper:

```
<website-information info="new WebsiteContext {  
    Version = new Version(1, 3),  
    CopyrightYear = 1638,  
    Approved = true,  
    TagsToShow = 131 }" >  
</website-information>
```

## Condition Tag Helper

The condition tag helper renders output when passed a true value.

1. Add the following `ConditionTagHelper` class to the `TagHelpers` folder.

```
using Microsoft.AspNetCore.Razor.TagHelpers;  
  
namespace AuthoringTagHelpers.TagHelpers  
{  
    [HtmlTargetElement(Attributes = nameof(Condition))]  
    public class ConditionTagHelper : TagHelper  
    {  
        public bool Condition { get; set; }  
  
        public override void Process(TagHelperContext context, TagHelperOutput output)  
        {  
            if (!Condition)  
            {  
                output.SuppressOutput();  
            }  
        }  
    }  
}
```

2. Replace the contents of the `Views/Home/Index.cshtml` file with the following markup:

```
@using AuthoringTagHelpers.Models  
@model WebsiteContext  
  
{@  
    ViewData["Title"] = "Home Page";  
}  
  
<div>  
    <h3>Information about our website (outdated):</h3>  
    <website-information info=@Model />  
    <div condition="@Model.Approved">  
        <p>  
            This website has <strong surround="em"> @Model.Approved </strong> been approved yet.  
            Visit www.contoso.com for more information.  
        </p>  
    </div>  
</div>
```

3. Replace the `Index` method in the `Home` controller with the following code:

```
public IActionResult Index(bool approved = false)
{
    return View(new WebsiteContext
    {
        Approved = approved,
        CopyrightYear = 2015,
        Version = new Version(1, 3, 3, 7),
        TagsToShow = 20
    });
}
```

4. Run the app and browse to the home page. The markup in the conditional `div` won't be rendered.

Append the query string `?approved=true` to the URL (for example,

`http://localhost:1235/Home/Index?approved=true`). `approved` is set to true and the conditional markup will be displayed.

#### NOTE

Use the `nameof` operator to specify the attribute to target rather than specifying a string as you did with the `bold` tag helper:

```
[HtmlTargetElement(Attributes = nameof(Condition))]
// [HtmlTargetElement(Attributes = "condition")]
public class ConditionTagHelper : TagHelper
{
    public bool Condition { get; set; }

    public override void Process(TagHelperContext context, TagHelperOutput output)
    {
        if (!Condition)
        {
            output.SuppressOutput();
        }
    }
}
```

The `nameof` operator will protect the code should it ever be refactored (we might want to change the name to `RedCondition`).

#### Avoid Tag Helper conflicts

In this section, you write a pair of auto-linking tag helpers. The first will replace markup containing a URL starting with HTTP to an HTML anchor tag containing the same URL (and thus yielding a link to the URL). The second will do the same for a URL starting with WWW.

Because these two helpers are closely related and you may refactor them in the future, we'll keep them in the same file.

1. Add the following `AutoLinkerHttpTagHelper` class to the `TagHelpers` folder.

```

[HtmlTargetElement("p")]
public class AutoLinkerHttpTagHelper : TagHelper
{
    public override async Task ProcessAsync(TagHelperContext context, TagHelperOutput output)
    {
        var childContent = await output.GetChildContentAsync();
        // Find URLs in the content and replace them with their anchor tag equivalent.
        output.Content.SetHtmlContent(Regex.Replace(
            childContent.GetContent(),
            @"\b(?:https?:\/\/)(\S+)\b",
            "<a target=\"_blank\" href=\"$0\">$0</a>")); // http link version}
    }
}

```

**NOTE**

The `AutoLinkerHttpTagHelper` class targets `p` elements and uses `Regex` to create the anchor.

2. Add the following markup to the end of the `Views/Home/Contact.cshtml` file:

```

@{
    ViewData["Title"] = "Contact";
}
<h2>@ViewData["Title"].</h2>
<h3>@ViewData["Message"]</h3>

<address>
    One Microsoft Way<br />
    Redmond, WA 98052<br />
    <abbr title="Phone">P:</abbr>
    425.555.0100
</address>

<address>
    <strong>Support:</strong><email>Support</email><br />
    <strong>Marketing:</strong><email>Marketing</email>
</address>

<p>Visit us at http://docs.asp.net or at www.microsoft.com</p>

```

3. Run the app and verify that the tag helper renders the anchor correctly.

4. Update the `AutoLinker` class to include the `AutoLinkerWwwTagHelper` which will convert www text to an anchor tag that also contains the original www text. The updated code is highlighted below:

```

[HtmlTargetElement("p")]
public class AutoLinkerHttpTagHelper : TagHelper
{
    public override async Task ProcessAsync(TagHelperContext context, TagHelperOutput output)
    {
        var childContent = await output.GetChildContentAsync();
        // Find URLs in the content and replace them with their anchor tag equivalent.
        output.Content.SetHtmlContent(Regex.Replace(
            childContent.GetContent(),
            @"\b(?:https?:\/\/)(\S+)\b",
            "<a target=\"_blank\" href=\"$0\">$0</a>"); // http link version
        )
    }
}

[HtmlTargetElement("p")]
public class AutoLinkerWwwTagHelper : TagHelper
{
    public override async Task ProcessAsync(TagHelperContext context, TagHelperOutput output)
    {
        var childContent = await output.GetChildContentAsync();
        // Find URLs in the content and replace them with their anchor tag equivalent.
        output.Content.SetHtmlContent(Regex.Replace(
            childContent.GetContent(),
            @"\b(www\.)\b(\S+)\b",
            "<a target=\"_blank\" href=\"http://$0\">$0</a>"); // www version
        )
    }
}

```

- Run the app. Notice the www text is rendered as a link but the HTTP text isn't. If you put a break point in both classes, you can see that the HTTP tag helper class runs first. The problem is that the tag helper output is cached, and when the WWW tag helper is run, it overwrites the cached output from the HTTP tag helper. Later in the tutorial we'll see how to control the order that tag helpers run in. We'll fix the code with the following:

```

public class AutoLinkerHttpTagHelper : TagHelper
{
    public override async Task ProcessAsync(TagHelperContext context, TagHelperOutput output)
    {
        var childContent = output.Content.IsModified ? output.Content.GetContent() :
            (await output.GetChildContentAsync()).GetContent();

        // Find URLs in the content and replace them with their anchor tag equivalent.
        output.Content.SetHtmlContent(Regex.Replace(
            childContent,
            @"\b(?:https?:\/\/)(\S+)\b",
            "<a target=\"_blank\" href=\"$0\">$0</a>"); // http link version
        }
    }

    [HtmlTargetElement("p")]
    public class AutoLinkerWwwTagHelper : TagHelper
    {
        public override async Task ProcessAsync(TagHelperContext context, TagHelperOutput output)
        {
            var childContent = output.Content.IsModified ? output.Content.GetContent() :
                (await output.GetChildContentAsync()).GetContent();

            // Find URLs in the content and replace them with their anchor tag equivalent.
            output.Content.SetHtmlContent(Regex.Replace(
                childContent,
                @"\b(www\.)\b",
                "<a target=\"_blank\" href=\"http://$0\">$0</a>"); // www version
            }
        }
    }
}

```

## NOTE

In the first edition of the auto-linking tag helpers, you got the content of the target with the following code:

```
var childContent = await output.GetChildContentAsync();
```

That is, you call `GetChildContentAsync` using the `TagHelperOutput` passed into the `ProcessAsync` method. As mentioned previously, because the output is cached, the last tag helper to run wins. You fixed that problem with the following code:

```
var childContent = output.Content.IsModified ? output.Content.GetContent() :
    (await output.GetChildContentAsync()).GetContent();
```

The code above checks to see if the content has been modified, and if it has, it gets the content from the output buffer.

- Run the app and verify that the two links work as expected. While it might appear our auto linker tag helper is correct and complete, it has a subtle problem. If the WWW tag helper runs first, the www links won't be correct. Update the code by adding the `Order` overload to control the order that the tag runs in. The `Order` property determines the execution order relative to other tag helpers targeting the same element. The default order value is zero and instances with lower values are executed first.

```

public class AutoLinkerHttpTagHelper : TagHelper
{
    // This filter must run before the AutoLinkerWwwTagHelper as it searches and replaces http and
    // the AutoLinkerWwwTagHelper adds http to the markup.
    public override int Order
    {
        get { return int.MinValue; }
    }
}

```

The above code will guarantee that the HTTP tag helper runs before the WWW tag helper. Change `Order` to `MaxValue` and verify that the markup generated for the WWW tag is incorrect.

## Inspect and retrieve child content

The tag helpers provide several properties to retrieve content.

- The result of `GetChildContentAsync` can be appended to `output.Content`.
- You can inspect the result of `GetChildContentAsync` with `GetContent`.
- If you modify `output.Content`, the `TagHelper` body won't be executed or rendered unless you call `GetChildContentAsync` as in our auto-linker sample:

```

public class AutoLinkerHttpTagHelper : TagHelper
{
    public override async Task ProcessAsync(TagHelperContext context, TagHelperOutput output)
    {
        var childContent = output.Content.IsModified ? output.Content.GetContent() :
            (await output.GetChildContentAsync()).GetContent();

        // Find URLs in the content and replace them with their anchor tag equivalent.
        output.Content.SetHtmlContent(Regex.Replace(
            childContent,
            @"\b(?:https?:\/\/)(\S+)\b",
            "<a target=\"_blank\" href=\"$0\">$0</a>"); // http link version}
    }
}

```

- Multiple calls to `GetChildContentAsync` returns the same value and doesn't re-execute the `TagHelper` body unless you pass in a false parameter indicating not to use the cached result.

# Tag Helpers in forms in ASP.NET Core

6/21/2018 • 17 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [Dave Paquette](#), and [Jerrie Pelser](#)

This document demonstrates working with Forms and the HTML elements commonly used on a Form. The [HTML Form](#) element provides the primary mechanism web apps use to post back data to the server. Most of this document describes [Tag Helpers](#) and how they can help you productively create robust HTML forms. We recommend you read [Introduction to Tag Helpers](#) before you read this document.

In many cases, HTML Helpers provide an alternative approach to a specific Tag Helper, but it's important to recognize that Tag Helpers don't replace HTML Helpers and there's not a Tag Helper for each HTML Helper. When an HTML Helper alternative exists, it's mentioned.

## The Form Tag Helper

The [Form](#) Tag Helper:

- Generates the HTML `<FORM>` `action` attribute value for a MVC controller action or named route
- Generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method)
- Provides the `asp-route-<Parameter Name>` attribute, where `<Parameter Name>` is added to the route values. The `routeValues` parameters to `Html.BeginForm` and `Html.BeginRouteForm` provide similar functionality.
- Has an HTML Helper alternative `Html.BeginForm` and `Html.BeginRouteForm`

Sample:

```
<form asp-controller="Demo" asp-action="Register" method="post">
    <!-- Input and Submit elements -->
</form>
```

The Form Tag Helper above generates the following HTML:

```
<form method="post" action="/Demo/Register">
    <!-- Input and Submit elements -->
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

The MVC runtime generates the `action` attribute value from the Form Tag Helper attributes `asp-controller` and `asp-action`. The Form Tag Helper also generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method). Protecting a pure HTML Form from cross-site request forgery is difficult, the Form Tag Helper provides this service for you.

### Using a named route

The `asp-route` Tag Helper attribute can also generate markup for the HTML `action` attribute. An app with a route named `register` could use the following markup for the registration page:

```
<form asp-route="register" method="post">
    <!-- Input and Submit elements -->
</form>
```

Many of the views in the `Views/Account` folder (generated when you create a new web app with *Individual User Accounts*) contain the `asp-route-returnurl` attribute:

```
<form asp-controller="Account" asp-action="Login"
    asp-route-returnurl="@ViewData["ReturnUrl"]"
    method="post" class="form-horizontal" role="form">
```

#### NOTE

With the built in templates, `returnUrl` is only populated automatically when you try to access an authorized resource but are not authenticated or authorized. When you attempt an unauthorized access, the security middleware redirects you to the login page with the `returnUrl` set.

## The Input Tag Helper

The Input Tag Helper binds an HTML `<input>` element to a model expression in your razor view.

Syntax:

```
<input asp-for="<Expression Name>" />
```

The Input Tag Helper:

- Generates the `id` and `name` HTML attributes for the expression name specified in the `asp-for` attribute. `asp-for="Property1.Property2"` is equivalent to `m => m.Property1.Property2`. The name of the expression is what is used for the `asp-for` attribute value. See the [Expression names](#) section for additional information.
- Sets the HTML `type` attribute value based on the model type and [data annotation](#) attributes applied to the model property
- Won't overwrite the HTML `type` attribute value when one is specified
- Generates [HTML5](#) validation attributes from [data annotation](#) attributes applied to model properties
- Has an HTML Helper feature overlap with `Html.TextBoxFor` and `Html.EditorFor`. See the [HTML Helper alternatives to Input Tag Helper](#) section for details.
- Provides strong typing. If the name of the property changes and you don't update the Tag Helper you'll get an error similar to the following:

```
An error occurred during the compilation of a resource required to process
this request. Please review the following specific error details and modify
your source code appropriately.
```

```
Type expected
'RegisterViewModel' does not contain a definition for 'Email' and no
extension method 'Email' accepting a first argument of type 'RegisterViewModel'
could be found (are you missing a using directive or an assembly reference?)
```

The `Input` Tag Helper sets the HTML `type` attribute based on the .NET type. The following table lists some common .NET types and generated HTML type (not every .NET type is listed).

.NET TYPE	INPUT TYPE
Bool	type="checkbox"
String	type="text"
DateTime	type="datetime"
Byte	type="number"
Int	type="number"
Single, Double	type="number"

The following table shows some common [data annotations](#) attributes that the input tag helper will map to specific input types (not every validation attribute is listed):

ATTRIBUTE	INPUT TYPE
[EmailAddress]	type="email"
[Url]	type="url"
[HiddenInput]	type="hidden"
[Phone]	type="tel"
[DataType(DataType.Password)]	type="password"
[DataType(DataType.Date)]	type="date"
[DataType(DataType.Time)]	type="time"

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}
```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterInput" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    <button type="submit">Register</button>
</form>

```

The code above generates the following HTML:

```

<form method="post" action="/Demo/RegisterInput">
    Email:
    <input type="email" data-val="true"
           data-val-email="The Email Address field is not a valid email address."
           data-val-required="The Email Address field is required."
           id="Email" name="Email" value="" /> <br>
    Password:
    <input type="password" data-val="true"
           data-val-required="The Password field is required."
           id="Password" name="Password" /><br>
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

The data annotations applied to the `Email` and `Password` properties generate metadata on the model. The Input Tag Helper consumes the model metadata and produces [HTML5](#) `data-val-*` attributes (see [Model Validation](#)). These attributes describe the validators to attach to the input fields. This provides unobtrusive HTML5 and [jQuery](#) validation. The unobtrusive attributes have the format `data-val-rule="Error Message"`, where rule is the name of the validation rule (such as `data-val-required`, `data-val-email`, `data-val-maxlength`, etc.) If an error message is provided in the attribute, it's displayed as the value for the `data-val-rule` attribute. There are also attributes of the form `data-val-ruleName-argumentName="argumentValue"` that provide additional details about the rule, for example, `data-val-maxlength-max="1024"`.

## HTML Helper alternatives to Input Tag Helper

`Html.TextBox`, `Html.TextBoxFor`, `Html.Editor` and `Html.EditorFor` have overlapping features with the Input Tag Helper. The Input Tag Helper will automatically set the `type` attribute; `Html.TextBox` and `Html.TextBoxFor` won't. `Html.Editor` and `Html.EditorFor` handle collections, complex objects and templates; the Input Tag Helper doesn't. The Input Tag Helper, `Html.EditorFor` and `Html.TextBoxFor` are strongly typed (they use lambda expressions); `Html.TextBox` and `Html.Editor` are not (they use expression names).

## HtmlAttributes

`@Html.Editor()` and `@Html.EditorFor()` use a special `ViewDataDictionary` entry named `htmlAttributes` when executing their default templates. This behavior is optionally augmented using `additional ViewData` parameters. The key "htmlAttributes" is case-insensitive. The key "htmlAttributes" is handled similarly to the `htmlAttributes` object passed to input helpers like `@Html.TextBox()`.

```

@Html.EditorFor(model => model.YourProperty,
    new { htmlAttributes = new { @class="myCssClass", style="Width:100px" } })

```

## Expression names

The `asp-for` attribute value is a `ModelExpression` and the right hand side of a lambda expression. Therefore, `asp-for="Property1"` becomes `m => m.Property1` in the generated code which is why you don't need to prefix with `Model`. You can use the "@" character to start an inline expression and move before the `m`:

```
@{
    var joe = "Joe";
}
<input asp-for="@joe" />
```

Generates the following:

```
<input type="text" id="joe" name="joe" value="Joe" />
```

With collection properties, `asp-for="CollectionProperty[23].Member"` generates the same name as `asp-for="CollectionProperty[i].Member"` when `i` has the value `23`.

When ASP.NET Core MVC calculates the value of `ModelExpression`, it inspects several sources, including `ModelState`. Consider `<input type="text" asp-for="@Name" />`. The calculated `value` attribute is the first non-null value from:

- `ModelState` entry with key "Name".
- Result of the expression `Model.Name`.

### Navigating child properties

You can also navigate to child properties using the property path of the view model. Consider a more complex model class that contains a child `Address` property.

```
public class AddressViewModel
{
    public string AddressLine1 { get; set; }
}
```

```
public class RegisterAddressViewModel
{
    public string Email { get; set; }

    [DataType(DataType.Password)]
    public string Password { get; set; }

    public AddressViewModel Address { get; set; }
}
```

In the view, we bind to `Address.AddressLine1`:

```
@model RegisterAddressViewModel

<form asp-controller="Demo" asp-action="RegisterAddress" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    Address: <input asp-for="Address.AddressLine1" /><br />
    <button type="submit">Register</button>
</form>
```

The following HTML is generated for `Address.AddressLine1`:

```
<input type="text" id="Address_AddressLine1" name="Address.AddressLine1" value="" />
```

## Expression names and Collections

Sample, a model containing an array of `Colors`:

```
public class Person
{
    public List<string> Colors { get; set; }

    public int Age { get; set; }
}
```

The action method:

```
public IActionResult Edit(int id, int colorIndex)
{
    ViewData["Index"] = colorIndex;
    return View(GetPerson(id));
}
```

The following Razor shows how you access a specific `Color` element:

```
@model Person
@{
    var index = (int)ViewData["index"];
}

<form asp-controller="ToDo" asp-action="Edit" method="post">
    @Html.EditorFor(m => m.Colors[index])
    <label asp-for="Age"></label>
    <input asp-for="Age" /><br />
    <button type="submit">Post</button>
</form>
```

The *Views/Shared/EditorTemplates/String.cshtml* template:

```
@model string

<label asp-for="@Model"></label>
<input asp-for="@Model" /> <br />
```

Sample using `List<T>`:

```
public class ToDoItem
{
    public string Name { get; set; }

    public bool IsDone { get; set; }
}
```

The following Razor shows how to iterate over a collection:

```

@model List<ToDoItem>

<form asp-controller="ToDo" asp-action="Edit" method="post">
    <table>
        <tr> <th>Name</th> <th>Is Done</th> </tr>

        @for (int i = 0; i < Model.Count; i++)
        {
            <tr>
                @Html.EditorFor(model => model[i])
            </tr>
        }

    </table>
    <button type="submit">Save</button>
</form>

```

The *Views/Shared/EditorTemplates/ToDoItem.cshtml* template:

```

@model ToDoItem

<td>
    <label asp-for="@Model.Name"></label>
    @Html.DisplayFor(model => model.Name)
</td>
<td>
    <input asp-for="@Model.IsDone" />
</td>



```

#### NOTE

Always use `for` (and *not* `foreach`) to iterate over a list. Evaluating an indexer in a LINQ expression can be expensive and should be minimized.

#### NOTE

The commented sample code above shows how you would replace the lambda expression with the `@` operator to access each `ToDoItem` in the list.

## The Textarea Tag Helper

The `Textarea Tag Helper` tag helper is similar to the Input Tag Helper.

- Generates the `id` and `name` attributes, and the data validation attributes from the model for a `<textarea>` element.

- Provides strong typing.
- HTML Helper alternative: `Html.TextAreaFor`

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class DescriptionViewModel
    {
        [MinLength(5)]
        [MaxLength(1024)]
        public string Description { get; set; }
    }
}
```

```
@model DescriptionViewModel

<form asp-controller="Demo" asp-action="RegisterTextArea" method="post">
    <textarea asp-for="Description"></textarea>
    <button type="submit">Test</button>
</form>
```

The following HTML is generated:

```
<form method="post" action="/Demo/RegisterTextArea">
    <textarea data-val="true"
              data-val-maxlength="The field Description must be a string or array type with a maximum length of
              &#x27;1024&#x27;;."
              data-val-maxlength-max="1024"
              data-val-minlength="The field Description must be a string or array type with a minimum length of
              &#x27;5&#x27;;."
              data-val-minlength-min="5"
              id="Description" name="Description">
    </textarea>
    <button type="submit">Test</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## The Label Tag Helper

- Generates the label caption and `for` attribute on a element for an expression name
- HTML Helper alternative: `Html.LabelFor`.

The `Label Tag Helper` provides the following benefits over a pure HTML label element:

- You automatically get the descriptive label value from the `Display` attribute. The intended display name might change over time, and the combination of `Display` attribute and Label Tag Helper will apply the `Display` everywhere it's used.
- Less markup in source code
- Strong typing with the model property.

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class SimpleViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }
    }
}
```

```
@model SimpleViewModel

<form asp-controller="Demo" asp-action="RegisterLabel" method="post">
    <label asp-for="Email"></label>
    <input asp-for="Email" /> <br />
</form>
```

The following HTML is generated for the `<label>` element:

```
<label for="Email">Email Address</label>
```

The Label Tag Helper generated the `for` attribute value of "Email", which is the ID associated with the `<input>` element. The Tag Helpers generate consistent `id` and `for` elements so they can be correctly associated. The caption in this sample comes from the `Display` attribute. If the model didn't contain a `Display` attribute, the caption would be the property name of the expression.

## The Validation Tag Helpers

There are two Validation Tag Helpers. The `Validation Message Tag Helper` (which displays a validation message for a single property on your model), and the `Validation Summary Tag Helper` (which displays a summary of validation errors). The `Input Tag Helper` adds HTML5 client side validation attributes to input elements based on data annotation attributes on your model classes. Validation is also performed on the server. The Validation Tag Helper displays these error messages when a validation error occurs.

### The Validation Message Tag Helper

- Adds the `HTML5` `data-valmsg-for="property"` attribute to the `span` element, which attaches the validation error messages on the input field of the specified model property. When a client side validation error occurs, `jQuery` displays the error message in the `<span>` element.
- Validation also takes place on the server. Clients may have JavaScript disabled and some validation can only be done on the server side.
- HTML Helper alternative: `Html.ValidationMessageFor`

The `Validation Message Tag Helper` is used with the `asp-validation-for` attribute on a HTML `span` element.

```
<span asp-validation-for="Email"></span>
```

The Validation Message Tag Helper will generate the following HTML:

```
<span class="field-validation-valid"  
      data-valmsg-for="Email"  
      data-valmsg-replace="true"></span>
```

You generally use the `Validation Message Tag Helper` after an `Input` Tag Helper for the same property. Doing so displays any validation error messages near the input that caused the error.

#### NOTE

You must have a view with the correct JavaScript and [jQuery](#) script references in place for client side validation. See [Model Validation](#) for more information.

When a server side validation error occurs (for example when you have custom server side validation or client-side validation is disabled), MVC places that error message as the body of the `<span>` element.

```
<span class="field-validation-error" data-valmsg-for="Email"  
      data-valmsg-replace="true">  
    The Email Address field is required.  
</span>
```

### The Validation Summary Tag Helper

- Targets `<div>` elements with the `asp-validation-summary` attribute
- HTML Helper alternative: `@Html.ValidationSummary`

The `Validation Summary Tag Helper` is used to display a summary of validation messages. The `asp-validation-summary` attribute value can be any of the following:

ASP-VALIDATION-SUMMARY	VALIDATION MESSAGES DISPLAYED
ValidationSummary.All	Property and model level
ValidationSummary.ModelOnly	Model
ValidationSummary.None	None

### Sample

In the following example, the data model is decorated with `DataAnnotation` attributes, which generates validation error messages on the `<input>` element. When a validation error occurs, the Validation Tag Helper displays the error message:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}

```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterValidation" method="post">
    <div asp-validation-summary="ModelOnly"></div>
    Email: <input asp-for="Email" /> <br />
    <span asp-validation-for="Email"></span><br />
    Password: <input asp-for="Password" /><br />
    <span asp-validation-for="Password"></span><br />
    <button type="submit">Register</button>
</form>

```

The generated HTML (when the model is valid):

```

<form action="/DemoReg/Register" method="post">
    <div class="validation-summary-valid" data-valmsg-summary="true">
        <ul><li style="display:none"></li></ul></div>
    Email: <input name="Email" id="Email" type="email" value="" data-val-required="The Email field is required." data-val-email="The Email field is not a valid email address." data-val="true"> <br />
    <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Email"></span><br />
    Password: <input name="Password" id="Password" type="password" data-val-required="The Password field is required." data-val="true"><br />
    <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Password"></span><br />
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## The Select Tag Helper

- Generates `select` and associated `option` elements for properties of your model.
- Has an HTML Helper alternative `Html.DropDownListFor` and `Html.ListBoxFor`

The `Select Tag Helper` `asp-for` specifies the model property name for the `select` element and `asp-items` specifies the `option` elements. For example:

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

Sample:

```

using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel
    {
        public string Country { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
        };
    }
}

```

The `Index` method initializes the `CountryViewModel`, sets the selected country and passes it to the `Index` view.

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

The HTTP POST `Index` method displays the selection:

```

[HttpPost]
[ValidateAntiForgeryToken]
public IActionResult Index(CountryViewModel model)
{
    if (ModelState.IsValid)
    {
        var msg = model.Country + " selected";
        return RedirectToAction("IndexSuccess", new { message = msg });
    }

    // If we got this far, something failed; redisplay form.
    return View(model);
}

```

The `Index` view:

```

@model CountryViewModel

<form asp-controller="Home" asp-action="Index" method="post">
    <select asp-for="Country" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>

```

Which generates the following HTML (with "CA" selected):

```
<form method="post" action="/">
    <select id="Country" name="Country">
        <option value="MX">Mexico</option>
        <option selected="selected" value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## NOTE

We don't recommend using `ViewBag` or `ViewData` with the Select Tag Helper. A view model is more robust at providing MVC metadata and generally less problematic.

The `asp-for` attribute value is a special case and doesn't require a `Model` prefix, the other Tag Helper attributes do (such as `asp-items`)

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

## Enum binding

It's often convenient to use `<select>` with an `enum` property and generate the `SelectListItem` elements from the `enum` values.

Sample:

```
public class CountryEnumViewModel
{
    public CountryEnum EnumCountry { get; set; }
}
```

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}
```

The `GetEnumSelectList` method generates a `SelectList` object for an enum.

```

@model CountryEnumViewModel

<form asp-controller="Home" asp-action="IndexEnum" method="post">
    <select asp-for="EnumCountry"
        asp-items="Html.GetEnumSelectList<CountryEnum>()" >
    </select>
    <br /><button type="submit">Register</button>
</form>

```

You can decorate your enumerator list with the `Display` attribute to get a richer UI:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}

```

The following HTML is generated:

```

<form method="post" action="/Home/IndexEnum">
    <select data-val="true" data-val-required="The EnumCountry field is required."
        id="EnumCountry" name="EnumCountry">
        <option value="0">United Mexican States</option>
        <option value="1">United States of America</option>
        <option value="2">Canada</option>
        <option value="3">France</option>
        <option value="4">Germany</option>
        <option selected="selected" value="5">Spain</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## Option Group

The HTML `<optgroup>` element is generated when the view model contains one or more `SelectListGroup` objects.

The `CountryViewModelGroup` groups the `SelectListItem` elements into the "North America" and "Europe" groups:

```

public class CountryViewModelGroup
{
    public CountryViewModelGroup()
    {
        var NorthAmericaGroup = new SelectListGroup { Name = "North America" };
        var EuropeGroup = new SelectListGroup { Name = "Europe" };

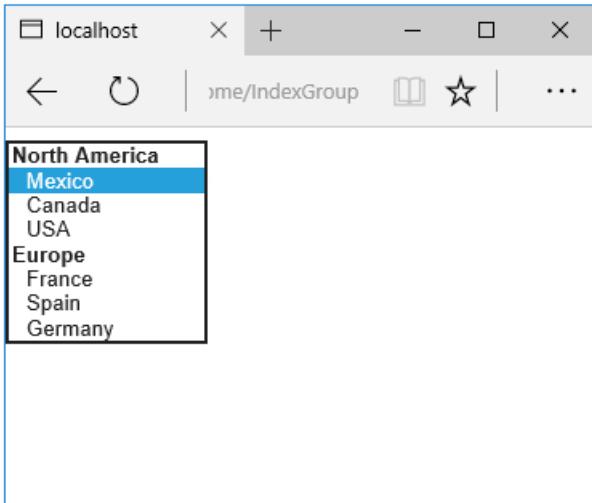
        Countries = new List<SelectListItem>
        {
            new SelectListItem
            {
                Value = "MEX",
                Text = "Mexico",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "CAN",
                Text = "Canada",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "US",
                Text = "USA",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "FR",
                Text = "France",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "ES",
                Text = "Spain",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "DE",
                Text = "Germany",
                Group = EuropeGroup
            }
        };
    }

    public string Country { get; set; }

    public List<SelectListItem> Countries { get; }
}

```

The two groups are shown below:



The generated HTML:

```
<form method="post" action="/Home/IndexGroup">
    <select id="Country" name="Country">
        <optgroup label="North America">
            <option value="MEX">Mexico</option>
            <option value="CAN">Canada</option>
            <option value="US">USA</option>
        </optgroup>
        <optgroup label="Europe">
            <option value="FR">France</option>
            <option value="ES">Spain</option>
            <option value="DE">Germany</option>
        </optgroup>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="removed for brevity" />
</form>
```

## Multiple select

The Select Tag Helper will automatically generate the `multiple = "multiple"` attribute if the property specified in the `asp-for` attribute is an `IEnumerable`. For example, given the following model:

```
using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel : IEnumerable
    {
        public IEnumerable<string> CountryCodes { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
            new SelectListItem { Value = "FR", Text = "France" },
            new SelectListItem { Value = "ES", Text = "Spain" },
            new SelectListItem { Value = "DE", Text = "Germany" }
        };
    }
}
```

With the following view:

```

@model CountryViewModelIEnumarable

<form asp-controller="Home" asp-action="IndexMultiSelect" method="post">
    <select asp-for="CountryCodes" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>

```

Generates the following HTML:

```

<form method="post" action="/Home/IndexMultiSelect">
    <select id="CountryCodes"
        multiple="multiple"
        name="CountryCodes"><option value="MX">Mexico</option>
    <option value="CA">Canada</option>
    <option value="US">USA</option>
    <option value="FR">France</option>
    <option value="ES">Spain</option>
    <option value="DE">Germany</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## No selection

If you find yourself using the "not specified" option in multiple pages, you can create a template to eliminate repeating the HTML:

```

@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    @Html.EditorForModel()
    <br /><button type="submit">Register</button>
</form>

```

The *Views/Shared/EditorTemplates/CountryViewModel.cshtml* template:

```

@model CountryViewModel

<select asp-for="Country" asp-items="Model.Countries">
    <option value="">--none--</option>
</select>

```

Adding HTML `<option>` elements isn't limited to the *No selection* case. For example, the following view and action method will generate HTML similar to the code above:

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

```
@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    <select asp-for="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
</form>
```

The correct `<option>` element will be selected ( contain the `selected="selected"` attribute) depending on the current `Country` value.

```
<form method="post" action="/Home/IndexEmpty">
    <select id="Country" name="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA" selected="selected">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## Additional resources

- [Tag Helpers](#)
- [HTML Form element](#)
- [Request Verification Token](#)
- [Model Binding](#)
- [Model Validation](#)
- [IAttributeAdapter Interface](#)
- [Code snippets for this document](#)

# ASP.NET Core built-in Tag Helpers

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Peter Kellner](#)

ASP.NET Core includes many built-in Tag Helpers to boost your productivity. This section provides an overview of the built-in Tag Helpers.

## NOTE

There are built-in Tag Helpers which aren't discussed, since they're used internally by the [Razor](#) view engine. This includes a Tag Helper for the ~ character, which expands to the root path of the website.

## Built-in ASP.NET Core Tag Helpers

[Anchor Tag Helper](#)

[Cache Tag Helper](#)

[Distributed Cache Tag Helper](#)

[Environment Tag Helper](#)

[Form Tag Helper](#)

[Image Tag Helper](#)

[Input Tag Helper](#)

[Label Tag Helper](#)

[Partial Tag Helper](#)

[Select Tag Helper](#)

[Textarea Tag Helper](#)

[Validation Message Tag Helper](#)

[Validation Summary Tag Helper](#)

## Additional resources

- [Client-side development](#)
- [Tag Helpers](#)

# Anchor Tag Helper in ASP.NET Core

6/21/2018 • 6 minutes to read • [Edit Online](#)

By [Peter Kellner](#) and [Scott Addie](#)

[View or download sample code \(how to download\)](#)

The [Anchor Tag Helper](#) enhances the standard HTML anchor (`<a ... ></a>`) tag by adding new attributes. By convention, the attribute names are prefixed with `asp-`. The rendered anchor element's `href` attribute value is determined by the values of the `asp-` attributes.

*SpeakerController* is used in samples throughout this document:

```
using Microsoft.AspNetCore.Mvc;
using System.Collections.Generic;
using System.Linq;

public class SpeakerController : Controller
{
    private List<Speaker> Speakers =
        new List<Speaker>
    {
        new Speaker {SpeakerId = 10},
        new Speaker {SpeakerId = 11},
        new Speaker {SpeakerId = 12}
    };

    [Route("Speaker/{id:int}")]
    public IActionResult Detail(int id) =>
        View(Speakers.FirstOrDefault(a => a.SpeakerId == id));

    [Route("/Speaker/Evaluations",
           Name = "speakerevals")]
    public IActionResult Evaluations() => View();

    [Route("/Speaker/EvaluationsCurrent",
           Name = "speakerevalscurrent")]
    public IActionResult Evaluations(
        int speakerId,
        bool currentYear) => View();

    public IActionResult Index() => View(Speakers);
}

public class Speaker
{
    public int SpeakerId { get; set; }
}
```

An inventory of the `asp-` attributes follows.

## asp-controller

The [asp-controller](#) attribute assigns the controller used for generating the URL. The following markup lists all speakers:

```
<a asp-controller="Speaker"  
    asp-action="Index">All Speakers</a>
```

The generated HTML:

```
<a href="/Speaker">All Speakers</a>
```

If the `asp-controller` attribute is specified and `asp-action` isn't, the default `asp-action` value is the controller action associated with the currently executing view. If `asp-action` is omitted from the preceding markup, and the Anchor Tag Helper is used in *HomeController's Index* view (`/Home`), the generated HTML is:

```
<a href="/Home">All Speakers</a>
```

## asp-action

The `asp-action` attribute value represents the controller action name included in the generated `href` attribute. The following markup sets the generated `href` attribute value to the speaker evaluations page:

```
<a asp-controller="Speaker"  
    asp-action="Evaluations">Speaker Evaluations</a>
```

The generated HTML:

```
<a href="/Speaker/Evaluations">Speaker Evaluations</a>
```

If no `asp-controller` attribute is specified, the default controller calling the view executing the current view is used.

If the `asp-action` attribute value is `Index`, then no action is appended to the URL, leading to the invocation of the default `Index` action. The action specified (or defaulted) must exist in the controller referenced in `asp-controller`.

## asp-route-{value}

The `asp-route-{value}` attribute enables a wildcard route prefix. Any value occupying the `{value}` placeholder is interpreted as a potential route parameter. If a default route isn't found, this route prefix is appended to the generated `href` attribute as a request parameter and value. Otherwise, it's substituted in the route template.

Consider the following controller action:

```
public IActionResult AnchorTagHelper(int id)  
{  
    var speaker = new Speaker  
    {  
        SpeakerId = id  
    };  
  
    return View(speaker);  
}
```

With a default route template defined in *Startup.Configure*:

```

app.UseMvc(routes =>
{
    // need route and attribute on controller: [Area("Blogs")]
    routes.MapRoute(name: "areaRoute",
                    template: "{area:exists}/{controller=Home}/{action=Index}");

    // default route for non-areas
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});

```

The MVC view uses the model, provided by the action, as follows:

```

@model Speaker
<!DOCTYPE html>
<html>
<body>
    <a asp-controller="Speaker"
       asp-action="Detail"
       asp-route-id="@Model.SpeakerId">SpeakerId: @Model.SpeakerId</a>
</body>
</html>

```

The default route's `{id?}` placeholder was matched. The generated HTML:

```
<a href="/Speaker/Detail/12">SpeakerId: 12</a>
```

Assume the route prefix isn't part of the matching routing template, as with the following MVC view:

```

@model Speaker
<!DOCTYPE html>
<html>
<body>
    <a asp-controller="Speaker"
       asp-action="Detail"
       asp-route-speakerid="@Model.SpeakerId">SpeakerId: @Model.SpeakerId</a>
</body>
</html>

```

The following HTML is generated because `speakerid` wasn't found in the matching route:

```
<a href="/Speaker/Detail?speakerid=12">SpeakerId: 12</a>
```

If either `asp-controller` or `asp-action` aren't specified, then the same default processing is followed as is in the `asp-route` attribute.

## asp-route

The `asp-route` attribute is used for creating a URL linking directly to a named route. Using [routing attributes](#), a route can be named as shown in the `SpeakerController` and used in its `Evaluations` action:

```

[Route("/Speaker/Evaluations",
      Name = "speakerevals")]
public IActionResult Evaluations() => View();

```

In the following markup, the `asp-route` attribute references the named route:

```
<a asp-route="speakerevals">Speaker Evaluations</a>
```

The Anchor Tag Helper generates a route directly to that controller action using the URL `/Speaker/Evaluations`.  
The generated HTML:

```
<a href="/Speaker/Evaluations">Speaker Evaluations</a>
```

If `asp-controller` or `asp-action` is specified in addition to `asp-route`, the route generated may not be what you expect. To avoid a route conflict, `asp-route` shouldn't be used with the `asp-controller` and `asp-action` attributes.

## asp-all-route-data

The `asp-all-route-data` attribute supports the creation of a dictionary of key-value pairs. The key is the parameter name, and the value is the parameter value.

In the following example, a dictionary is initialized and passed to a Razor view. Alternatively, the data could be passed in with your model.

```
@{  
    var parms = new Dictionary<string, string>  
    {  
        { "speakerId", "11" },  
        { "currentYear", "true" }  
    };  
}  
  
<a asp-route="speakerevalscurrent"  
    asp-all-route-data="parms">Speaker Evaluations</a>
```

The preceding code generates the following HTML:

```
<a href="/Speaker/EvaluationsCurrent?speakerId=11&currentYear=true">Speaker Evaluations</a>
```

The `asp-all-route-data` dictionary is flattened to produce a querystring meeting the requirements of the overloaded `Evaluations` action:

```
[Route("/Speaker/EvaluationsCurrent",  
      Name = "speakerevalscurrent")]  
public IActionResult Evaluations(  
    int speakerId,  
    bool currentYear) => View();
```

If any keys in the dictionary match route parameters, those values are substituted in the route as appropriate. The other non-matching values are generated as request parameters.

## asp-fragment

The `asp-fragment` attribute defines a URL fragment to append to the URL. The Anchor Tag Helper adds the hash character (#). Consider the following markup:

```
<a asp-controller="Speaker"  
    asp-action="Evaluations"  
    asp-fragment="SpeakerEvaluations">Speaker Evaluations</a>
```

The generated HTML:

```
<a href="/Speaker/Evaluations#SpeakerEvaluations">Speaker Evaluations</a>
```

Hash tags are useful when building client-side apps. They can be used for easy marking and searching in JavaScript, for example.

## asp-area

The `asp-area` attribute sets the area name used to set the appropriate route. The following example depicts how the area attribute causes a remapping of routes. Setting `asp-area` to "Blogs" prefixes the directory *Areas/Blogs* to the routes of the associated controllers and views for this anchor tag.

- <**Project name**>
  - **wwwroot**
  - **Areas**
    - **Blogs**
      - **Controllers**
        - *HomeController.cs*
      - **Views**
        - **Home**
          - *AboutBlog.cshtml*
          - *Index.cshtml*
          - *\_ViewStart.cshtml*
      - **Controllers**

Given the preceding directory hierarchy, the markup to reference the *AboutBlog.cshtml* file is:

```
<a asp-area="Blogs"  
    asp-controller="Home"  
    asp-action="AboutBlog">About Blog</a>
```

The generated HTML:

```
<a href="/Blogs/Home/AboutBlog">About Blog</a>
```

## TIP

For areas to work in an MVC app, the route template must include a reference to the area, if it exists. That template is represented by the second parameter of the `routes.MapRoute` method call in `Startup.Configure`:

```
app.UseMvc(routes =>
{
    // need route and attribute on controller: [Area("Blogs")]
    routes.MapRoute(name: "areaRoute",
                    template: "{area:exists}/{controller=Home}/{action=Index}");

    // default route for non-areas
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
```

## asp-protocol

The `asp-protocol` attribute is for specifying a protocol (such as `https`) in your URL. For example:

```
<a asp-protocol="https"
    asp-controller="Home"
    asp-action="About">About</a>
```

The generated HTML:

```
<a href="https://localhost/Home/About">About</a>
```

The host name in the example is localhost, but the Anchor Tag Helper uses the website's public domain when generating the URL.

## asp-host

The `asp-host` attribute is for specifying a host name in your URL. For example:

```
<a asp-protocol="https"
    asp-host="microsoft.com"
    asp-controller="Home"
    asp-action="About">About</a>
```

The generated HTML:

```
<a href="https://microsoft.com/Home/About">About</a>
```

## asp-page

The `asp-page` attribute is used with Razor Pages. Use it to set an anchor tag's `href` attribute value to a specific page. Prefixing the page name with a forward slash ("/") creates the URL.

The following sample points to the attendee Razor Page:

```
<a asp-page="/Attendee">All Attendees</a>
```

The generated HTML:

```
<a href="/Attendee">All Attendees</a>
```

The `asp-page` attribute is mutually exclusive with the `asp-route`, `asp-controller`, and `asp-action` attributes. However, `asp-page` can be used with `asp-route-{value}` to control routing, as the following markup demonstrates:

```
<a asp-page="/Attendee"  
    asp-route-attendeeid="10">View Attendee</a>
```

The generated HTML:

```
<a href="/Attendee?attendeeid=10">View Attendee</a>
```

## asp-page-handler

The `asp-page-handler` attribute is used with Razor Pages. It's intended for linking to specific page handlers.

Consider the following page handler:

```
public void OnGetProfile(int attendeeId)  
{  
    ViewData["AttendeeId"] = attendeeId;  
  
    // code omitted for brevity  
}
```

The page model's associated markup links to the `OnGetProfile` page handler. Note that the `On<Verb>` prefix of the page handler method name is omitted in the `asp-page-handler` attribute value. If this were an asynchronous method, the `Async` suffix would be omitted too.

```
<a asp-page="/Attendee"  
    asp-page-handler="Profile"  
    asp-route-attendeeid="12">Attendee Profile</a>
```

The generated HTML:

```
<a href="/Attendee?attendeeid=12&handler=Profile">Attendee Profile</a>
```

## Additional resources

- [Areas](#)
- [Intro to Razor Pages](#)

# Cache Tag Helper in ASP.NET Core MVC

6/21/2018 • 4 minutes to read • [Edit Online](#)

By [Peter Kellner](#)

The Cache Tag Helper provides the ability to dramatically improve the performance of your ASP.NET Core app by caching its content to the internal ASP.NET Core cache provider.

The Razor View Engine sets the default `expires-after` to twenty minutes.

The following Razor markup caches the date/time:

```
<cache>@DateTime.Now</cache>
```

The first request to the page that contains `CacheTagHelper` will display the current date/time. Additional requests will show the cached value until the cache expires (default 20 minutes) or is evicted by memory pressure.

You can set the cache duration with the following attributes:

## Cache Tag Helper Attributes

### enabled

ATTRIBUTE TYPE	VALID VALUES
boolean	"true" (default)
	"false"

Determines whether the content enclosed by the Cache Tag Helper is cached. The default is `true`. If set to `false` this Cache Tag Helper will have no caching effect on the rendered output.

Example:

```
<cache enabled="true">
    Current Time Inside Cache Tag Helper: @DateTime.Now
</cache>
```

### expires-on

ATTRIBUTE TYPE	EXAMPLE VALUE
DateTimeOffset	"@new DateTime(2025,1,29,17,02,0)"

Sets an absolute expiration date. The following example will cache the contents of the Cache Tag Helper until 5:02 PM on January 29, 2025.

Example:

```
<cache expires-on="@new DateTime(2025,1,29,17,02,0)">
    Current Time Inside Cache Tag Helper: @DateTime.Now
</cache>
```

## expires-after

ATTRIBUTE TYPE	EXAMPLE VALUE
TimeSpan	"@TimeSpan.FromSeconds(120)"

Sets the length of time from the first request time to cache the contents.

Example:

```
<cache expires-after="@TimeSpan.FromSeconds(120)">
    Current Time Inside Cache Tag Helper: @DateTime.Now
</cache>
```

## expires-sliding

ATTRIBUTE TYPE	EXAMPLE VALUE
TimeSpan	"@TimeSpan.FromSeconds(60)"

Sets the time that a cache entry should be evicted if it has not been accessed.

Example:

```
<cache expires-sliding="@TimeSpan.FromSeconds(60)">
    Current Time Inside Cache Tag Helper: @DateTime.Now
</cache>
```

## vary-by-header

ATTRIBUTE TYPE	EXAMPLE VALUES
String	"User-Agent"
	"User-Agent,content-encoding"

Accepts a single header value or a comma-separated list of header values that trigger a cache refresh when they change. The following example monitors the header value `User-Agent`. The example will cache the content for every different `User-Agent` presented to the web server.

Example:

```
<cache vary-by-header="User-Agent">
    Current Time Inside Cache Tag Helper: @DateTime.Now
</cache>
```

## vary-by-query

ATTRIBUTE TYPE	EXAMPLE VALUES
String	"Make"
	"Make,Model"

Accepts a single header value or a comma-separated list of header values that trigger a cache refresh when the header value changes. The following example looks at the values of `Make` and `Model`.

Example:

```
<cache vary-by-query="Make,Model">
    Current Time Inside Cache Tag Helper: @DateTime.Now
</cache>
```

## vary-by-route

ATTRIBUTE TYPE	EXAMPLE VALUES
String	"Make"
	"Make,Model"

Accepts a single header value or a comma-separated list of header values that trigger a cache refresh when the route data parameter value(s) change. Example:

*Startup.cs*

```
routes.MapRoute(
    name: "default",
    template: "{controller=Home}/{action=Index}/{Make?}/{Model?}");
```

*Index.cshtml*

```
<cache vary-by-route="Make,Model">
    Current Time Inside Cache Tag Helper: @DateTime.Now
</cache>
```

## vary-by-cookie

ATTRIBUTE TYPE	EXAMPLE VALUES
String	".AspNetCore.Identity.Application"
	".AspNetCore.Identity.Application,HairColor"

Accepts a single header value or a comma-separated list of header values that trigger a cache refresh when the header value(s) change. The following example looks at the cookie associated with ASP.NET Identity. When a user is authenticated the request cookie to be set which triggers a cache refresh.

Example:

```
<cache vary-by-cookie=".AspNetCore.Identity.Application">
    Current Time Inside Cache Tag Helper: @DateTime.Now
</cache>
```

## vary-by-user

ATTRIBUTE TYPE	EXAMPLE VALUES
Boolean	"true"
	"false" (default)

Specifies whether or not the cache should reset when the logged-in user (or Context Principal) changes. The current user is also known as the Request Context Principal and can be viewed in a Razor view by referencing `@User.Identity.Name`.

The following example looks at the current logged in user.

Example:

```
<cache vary-by-user="true">
    Current Time Inside Cache Tag Helper: @DateTime.Now
</cache>
```

Using this attribute maintains the contents in cache through a log-in and log-out cycle. When using `vary-by-user="true"`, a log-in and log-out action invalidates the cache for the authenticated user. The cache is invalidated because a new unique cookie value is generated on login. Cache is maintained for the anonymous state when no cookie is present or has expired. This means if no user is logged in, the cache will be maintained.

## vary-by

ATTRIBUTE TYPE	EXAMPLE VALUES
String	"@Model"

Allows for customization of what data gets cached. When the object referenced by the attribute's string value changes, the content of the Cache Tag Helper is updated. Often a string-concatenation of model values are assigned to this attribute. Effectively, that means an update to any of the concatenated values invalidates the cache.

The following example assumes the controller method rendering the view sums the integer value of the two route parameters, `myParam1` and `myParam2`, and returns that as the single model property. When this sum changes, the content of the Cache Tag Helper is rendered and cached again.

Example:

Action:

```

public IActionResult Index(string myParam1, string myParam2, string myParam3)
{
    int num1;
    int num2;
    int.TryParse(myParam1, out num1);
    int.TryParse(myParam2, out num2);
    return View(viewName, num1 + num2);
}

```

## Index.cshtml

```

<cache vary-by="@Model">
    Current Time Inside Cache Tag Helper: @DateTime.Now
</cache>

```

## priority

ATTRIBUTE TYPE	EXAMPLE VALUES
CacheltemPriority	"High"
	"Low"
	"NeverRemove"
	"Normal"

Provides cache eviction guidance to the built-in cache provider. The web server will evict `Low` cache entries first when it's under memory pressure.

Example:

```

<cache priority="High">
    Current Time Inside Cache Tag Helper: @DateTime.Now
</cache>

```

The `priority` attribute doesn't guarantee a specific level of cache retention. `CacheItemPriority` is only a suggestion. Setting this attribute to `NeverRemove` doesn't guarantee that the cache will always be retained. See [Additional Resources](#) for more information.

The Cache Tag Helper is dependent on the [memory cache service](#). The Cache Tag Helper adds the service if it has not been added.

## Additional resources

- [Cache in-memory](#)
- [Introduction to Identity](#)

# Distributed Cache Tag Helper in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Peter Kellner](#)

The Distributed Cache Tag Helper provides the ability to dramatically improve the performance of your ASP.NET Core app by caching its content to a distributed cache source.

The Distributed Cache Tag Helper inherits from the same base class as the Cache Tag Helper. All attributes associated with the Cache Tag Helper will also work on the Distributed Tag Helper.

The Distributed Cache Tag Helper follows the **Explicit Dependencies Principle** known as **Constructor Injection**. Specifically, the `IDistributedCache` interface container is passed into the Distributed Cache Tag Helper's constructor. If no specific concrete implementation of `IDistributedCache` has been created in `ConfigureServices`, usually found in `startup.cs`, then the Distributed Cache Tag Helper will use the same in-memory provider for storing cached data as the basic Cache Tag Helper.

## Distributed Cache Tag Helper Attributes

**enabled expires-on expires-after expires-sliding vary-by-header vary-by-query vary-by-route vary-by-cookie vary-by-user vary-by priority**

See Cache Tag Helper for definitions. Distributed Cache Tag Helper inherits from the same class as Cache Tag Helper so all these attributes are common from Cache Tag Helper.

### **name (required)**

ATTRIBUTE TYPE	EXAMPLE VALUE
string	"my-distributed-cache-unique-key-101"

The required `name` attribute is used as a key to that cache stored for each instance of a Distributed Cache Tag Helper. Unlike the basic Cache Tag Helper that assigns a key to each Cache Tag Helper instance based on the Razor page name and location of the Tag Helper in the razor page, the Distributed Cache Tag Helper only bases its key on the attribute `name`.

Usage Example:

```
<distributed-cache name="my-distributed-cache-unique-key-101">
    Time Inside Cache Tag Helper: @DateTime.Now
</distributed-cache>
```

## Distributed Cache Tag Helper `IDistributedCache` implementations

There are two implementations of `IDistributedCache` built in to ASP.NET Core. One is based on SQL Server and the other is based on Redis. Details of these implementations can be found at [Work with a distributed cache in ASP.NET Core](#). Both implementations involve setting an instance of `IDistributedCache` in ASP.NET Core's `Startup.cs`.

There are no tag attributes specifically associated with using any specific implementation of `IDistributedCache`.

## Additional resources

- [Cache Tag Helper in ASP.NET Core MVC](#)
- [Dependency injection in ASP.NET Core](#)
- [Work with a distributed cache in ASP.NET Core](#)
- [Cache in-memory in ASP.NET Core](#)
- [Introduction to Identity on ASP.NET Core](#)

# Environment Tag Helper in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Peter Kellner](#) and [Hisham Bin Ateya](#)

The Environment Tag Helper conditionally renders its enclosed content based on the current hosting environment. Its single attribute `names` is a comma separated list of environment names, that if any match to the current environment, will trigger the enclosed content to be rendered.

## Environment Tag Helper Attributes

### names

Accepts a single hosting environment name or a comma-separated list of hosting environment names that trigger the rendering of the enclosed content.

These value(s) are compared to the current value returned from the ASP.NET Core static property

`HostingEnvironment.EnvironmentName`. This value is one of the following: **Staging**; **Development** or **Production**.

The comparison ignores case.

An example of a valid `environment` tag helper is:

```
<environment names="Staging,Production">
  <strong>HostingEnvironment.EnvironmentName is Staging or Production</strong>
</environment>
```

## include and exclude attributes

ASP.NET Core 2.x adds the `include` & `exclude` attributes. These attributes control rendering the enclosed content based on the included or excluded hosting environment names.

### include ASP.NET Core 2.0 and later

The `include` property has a similar behavior of the `names` attribute in ASP.NET Core 1.0.

```
<environment include="Staging,Production">
  <strong>HostingEnvironment.EnvironmentName is Staging or Production</strong>
</environment>
```

### exclude ASP.NET Core 2.0 and later

In contrast, the `exclude` property lets the `EnvironmentTagHelper` render the enclosed content for all hosting environment names except the one(s) that you specified.

```
<environment exclude="Development">
  <strong>HostingEnvironment.EnvironmentName is Staging or Production</strong>
</environment>
```

## Additional resources

- [Use multiple environments in ASP.NET Core](#)
- [Dependency injection in ASP.NET Core](#)

# Tag Helpers in forms in ASP.NET Core

6/21/2018 • 17 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [Dave Paquette](#), and [Jerrie Pelser](#)

This document demonstrates working with Forms and the HTML elements commonly used on a Form. The [HTML Form](#) element provides the primary mechanism web apps use to post back data to the server. Most of this document describes [Tag Helpers](#) and how they can help you productively create robust HTML forms. We recommend you read [Introduction to Tag Helpers](#) before you read this document.

In many cases, HTML Helpers provide an alternative approach to a specific Tag Helper, but it's important to recognize that Tag Helpers don't replace HTML Helpers and there's not a Tag Helper for each HTML Helper. When an HTML Helper alternative exists, it's mentioned.

## The Form Tag Helper

The [Form](#) Tag Helper:

- Generates the HTML `<FORM>` `action` attribute value for a MVC controller action or named route
- Generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method)
- Provides the `asp-route-<Parameter Name>` attribute, where `<Parameter Name>` is added to the route values. The `routeValues` parameters to `Html.BeginForm` and `Html.BeginRouteForm` provide similar functionality.
- Has an HTML Helper alternative `Html.BeginForm` and `Html.BeginRouteForm`

Sample:

```
<form asp-controller="Demo" asp-action="Register" method="post">
    <!-- Input and Submit elements -->
</form>
```

The Form Tag Helper above generates the following HTML:

```
<form method="post" action="/Demo/Register">
    <!-- Input and Submit elements -->
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

The MVC runtime generates the `action` attribute value from the Form Tag Helper attributes `asp-controller` and `asp-action`. The Form Tag Helper also generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method). Protecting a pure HTML Form from cross-site request forgery is difficult, the Form Tag Helper provides this service for you.

### Using a named route

The `asp-route` Tag Helper attribute can also generate markup for the HTML `action` attribute. An app with a route named `register` could use the following markup for the registration page:

```
<form asp-route="register" method="post">
    <!-- Input and Submit elements -->
</form>
```

Many of the views in the `Views/Account` folder (generated when you create a new web app with *Individual User Accounts*) contain the `asp-route-returnurl` attribute:

```
<form asp-controller="Account" asp-action="Login"
    asp-route-returnurl="@ViewData["ReturnUrl"]"
    method="post" class="form-horizontal" role="form">
```

#### NOTE

With the built in templates, `returnUrl` is only populated automatically when you try to access an authorized resource but are not authenticated or authorized. When you attempt an unauthorized access, the security middleware redirects you to the login page with the `returnUrl` set.

## The Input Tag Helper

The Input Tag Helper binds an HTML `<input>` element to a model expression in your razor view.

Syntax:

```
<input asp-for="<Expression Name>" />
```

The Input Tag Helper:

- Generates the `id` and `name` HTML attributes for the expression name specified in the `asp-for` attribute. `asp-for="Property1.Property2"` is equivalent to `m => m.Property1.Property2`. The name of the expression is what is used for the `asp-for` attribute value. See the [Expression names](#) section for additional information.
- Sets the HTML `type` attribute value based on the model type and [data annotation](#) attributes applied to the model property
- Won't overwrite the HTML `type` attribute value when one is specified
- Generates [HTML5](#) validation attributes from [data annotation](#) attributes applied to model properties
- Has an HTML Helper feature overlap with `Html.TextBoxFor` and `Html.EditorFor`. See the [HTML Helper alternatives to Input Tag Helper](#) section for details.
- Provides strong typing. If the name of the property changes and you don't update the Tag Helper you'll get an error similar to the following:

```
An error occurred during the compilation of a resource required to process
this request. Please review the following specific error details and modify
your source code appropriately.
```

```
Type expected
'RegisterViewModel' does not contain a definition for 'Email' and no
extension method 'Email' accepting a first argument of type 'RegisterViewModel'
could be found (are you missing a using directive or an assembly reference?)
```

The `Input` Tag Helper sets the HTML `type` attribute based on the .NET type. The following table lists some common .NET types and generated HTML type (not every .NET type is listed).

.NET TYPE	INPUT TYPE
Bool	type="checkbox"
String	type="text"
DateTime	type="datetime"
Byte	type="number"
Int	type="number"
Single, Double	type="number"

The following table shows some common [data annotations](#) attributes that the input tag helper will map to specific input types (not every validation attribute is listed):

ATTRIBUTE	INPUT TYPE
[EmailAddress]	type="email"
[Url]	type="url"
[HiddenInput]	type="hidden"
[Phone]	type="tel"
[DataType(DataType.Password)]	type="password"
[DataType(DataType.Date)]	type="date"
[DataType(DataType.Time)]	type="time"

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}
```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterInput" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    <button type="submit">Register</button>
</form>

```

The code above generates the following HTML:

```

<form method="post" action="/Demo/RegisterInput">
    Email:
    <input type="email" data-val="true"
           data-val-email="The Email Address field is not a valid email address."
           data-val-required="The Email Address field is required."
           id="Email" name="Email" value="" /> <br>
    Password:
    <input type="password" data-val="true"
           data-val-required="The Password field is required."
           id="Password" name="Password" /><br>
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

The data annotations applied to the `Email` and `Password` properties generate metadata on the model. The Input Tag Helper consumes the model metadata and produces [HTML5](#) `data-val-*` attributes (see [Model Validation](#)). These attributes describe the validators to attach to the input fields. This provides unobtrusive HTML5 and [jQuery](#) validation. The unobtrusive attributes have the format `data-val-rule="Error Message"`, where rule is the name of the validation rule (such as `data-val-required`, `data-val-email`, `data-val-maxlength`, etc.) If an error message is provided in the attribute, it's displayed as the value for the `data-val-rule` attribute. There are also attributes of the form `data-val-ruleName-argumentName="argumentValue"` that provide additional details about the rule, for example, `data-val-maxlength-max="1024"`.

## HTML Helper alternatives to Input Tag Helper

`Html.TextBox`, `Html.TextBoxFor`, `Html.Editor` and `Html.EditorFor` have overlapping features with the Input Tag Helper. The Input Tag Helper will automatically set the `type` attribute; `Html.TextBox` and `Html.TextBoxFor` won't. `Html.Editor` and `Html.EditorFor` handle collections, complex objects and templates; the Input Tag Helper doesn't. The Input Tag Helper, `Html.EditorFor` and `Html.TextBoxFor` are strongly typed (they use lambda expressions); `Html.TextBox` and `Html.Editor` are not (they use expression names).

## HtmlAttributes

`@Html.Editor()` and `@Html.EditorFor()` use a special `ViewDataDictionary` entry named `htmlAttributes` when executing their default templates. This behavior is optionally augmented using `additional ViewData` parameters. The key "htmlAttributes" is case-insensitive. The key "htmlAttributes" is handled similarly to the `htmlAttributes` object passed to input helpers like `@Html.TextBox()`.

```

@Html.EditorFor(model => model.YourProperty,
    new { htmlAttributes = new { @class="myCssClass", style="Width:100px" } })

```

## Expression names

The `asp-for` attribute value is a `ModelExpression` and the right hand side of a lambda expression. Therefore, `asp-for="Property1"` becomes `m => m.Property1` in the generated code which is why you don't need to prefix with `Model`. You can use the "@" character to start an inline expression and move before the `m`:

```
@{
    var joe = "Joe";
}
<input asp-for="@joe" />
```

Generates the following:

```
<input type="text" id="joe" name="joe" value="Joe" />
```

With collection properties, `asp-for="CollectionProperty[23].Member"` generates the same name as `asp-for="CollectionProperty[i].Member"` when `i` has the value `23`.

When ASP.NET Core MVC calculates the value of `ModelExpression`, it inspects several sources, including `ModelState`. Consider `<input type="text" asp-for="@Name" />`. The calculated `value` attribute is the first non-null value from:

- `ModelState` entry with key "Name".
- Result of the expression `Model.Name`.

### Navigating child properties

You can also navigate to child properties using the property path of the view model. Consider a more complex model class that contains a child `Address` property.

```
public class AddressViewModel
{
    public string AddressLine1 { get; set; }
}
```

```
public class RegisterAddressViewModel
{
    public string Email { get; set; }

    [DataType(DataType.Password)]
    public string Password { get; set; }

    public AddressViewModel Address { get; set; }
}
```

In the view, we bind to `Address.AddressLine1`:

```
@model RegisterAddressViewModel

<form asp-controller="Demo" asp-action="RegisterAddress" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    Address: <input asp-for="Address.AddressLine1" /><br />
    <button type="submit">Register</button>
</form>
```

The following HTML is generated for `Address.AddressLine1`:

```
<input type="text" id="Address_AddressLine1" name="Address.AddressLine1" value="" />
```

## Expression names and Collections

Sample, a model containing an array of `Colors`:

```
public class Person
{
    public List<string> Colors { get; set; }

    public int Age { get; set; }
}
```

The action method:

```
public IActionResult Edit(int id, int colorIndex)
{
    ViewData["Index"] = colorIndex;
    return View(GetPerson(id));
}
```

The following Razor shows how you access a specific `Color` element:

```
@model Person
 @{
    var index = (int)ViewData["index"];
}

<form asp-controller="ToDo" asp-action="Edit" method="post">
    @Html.EditorFor(m => m.Colors[index])
    <label asp-for="Age"></label>
    <input asp-for="Age" /><br />
    <button type="submit">Post</button>
</form>
```

The *Views/Shared/EditorTemplates/String.cshtml* template:

```
@model string

<label asp-for="@Model"></label>
<input asp-for="@Model" /> <br />
```

Sample using `List<T>`:

```
public class ToDoItem
{
    public string Name { get; set; }

    public bool IsDone { get; set; }
}
```

The following Razor shows how to iterate over a collection:

```

@model List<ToDoItem>

<form asp-controller="ToDo" asp-action="Edit" method="post">
    <table>
        <tr> <th>Name</th> <th>Is Done</th> </tr>

        @for (int i = 0; i < Model.Count; i++)
        {
            <tr>
                @Html.EditorFor(model => model[i])
            </tr>
        }

    </table>
    <button type="submit">Save</button>
</form>

```

The *Views/Shared/EditorTemplates/ToDoItem.cshtml* template:

```

@model ToDoItem

<td>
    <label asp-for="@Model.Name"></label>
    @Html.DisplayFor(model => model.Name)
</td>
<td>
    <input asp-for="@Model.IsDone" />
</td>



```

#### NOTE

Always use `for` (and *not* `foreach`) to iterate over a list. Evaluating an indexer in a LINQ expression can be expensive and should be minimized.

#### NOTE

The commented sample code above shows how you would replace the lambda expression with the `@` operator to access each `ToDoItem` in the list.

## The Textarea Tag Helper

The `Textarea Tag Helper` tag helper is similar to the Input Tag Helper.

- Generates the `id` and `name` attributes, and the data validation attributes from the model for a `<textarea>` element.

- Provides strong typing.
- HTML Helper alternative: `Html.TextAreaFor`

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class DescriptionViewModel
    {
        [MinLength(5)]
        [MaxLength(1024)]
        public string Description { get; set; }
    }
}
```

```
@model DescriptionViewModel

<form asp-controller="Demo" asp-action="RegisterTextArea" method="post">
    <textarea asp-for="Description"></textarea>
    <button type="submit">Test</button>
</form>
```

The following HTML is generated:

```
<form method="post" action="/Demo/RegisterTextArea">
    <textarea data-val="true"
              data-val-maxlength="The field Description must be a string or array type with a maximum length of
              &#x27;1024&#x27;;."
              data-val-maxlength-max="1024"
              data-val-minlength="The field Description must be a string or array type with a minimum length of
              &#x27;5&#x27;;."
              data-val-minlength-min="5"
              id="Description" name="Description">
    </textarea>
    <button type="submit">Test</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## The Label Tag Helper

- Generates the label caption and `for` attribute on a element for an expression name
- HTML Helper alternative: `Html.LabelFor`.

The `Label Tag Helper` provides the following benefits over a pure HTML label element:

- You automatically get the descriptive label value from the `Display` attribute. The intended display name might change over time, and the combination of `Display` attribute and Label Tag Helper will apply the `Display` everywhere it's used.
- Less markup in source code
- Strong typing with the model property.

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class SimpleViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }
    }
}
```

```
@model SimpleViewModel

<form asp-controller="Demo" asp-action="RegisterLabel" method="post">
    <label asp-for="Email"></label>
    <input asp-for="Email" /> <br />
</form>
```

The following HTML is generated for the `<label>` element:

```
<label for="Email">Email Address</label>
```

The Label Tag Helper generated the `for` attribute value of "Email", which is the ID associated with the `<input>` element. The Tag Helpers generate consistent `id` and `for` elements so they can be correctly associated. The caption in this sample comes from the `Display` attribute. If the model didn't contain a `Display` attribute, the caption would be the property name of the expression.

## The Validation Tag Helpers

There are two Validation Tag Helpers. The `Validation Message Tag Helper` (which displays a validation message for a single property on your model), and the `Validation Summary Tag Helper` (which displays a summary of validation errors). The `Input Tag Helper` adds HTML5 client side validation attributes to input elements based on data annotation attributes on your model classes. Validation is also performed on the server. The Validation Tag Helper displays these error messages when a validation error occurs.

### The Validation Message Tag Helper

- Adds the `HTML5` `data-valmsg-for="property"` attribute to the `span` element, which attaches the validation error messages on the input field of the specified model property. When a client side validation error occurs, `jQuery` displays the error message in the `<span>` element.
- Validation also takes place on the server. Clients may have JavaScript disabled and some validation can only be done on the server side.
- HTML Helper alternative: `Html.ValidationMessageFor`

The `Validation Message Tag Helper` is used with the `asp-validation-for` attribute on a HTML `span` element.

```
<span asp-validation-for="Email"></span>
```

The Validation Message Tag Helper will generate the following HTML:

```
<span class="field-validation-valid"  
      data-valmsg-for="Email"  
      data-valmsg-replace="true"></span>
```

You generally use the `Validation Message Tag Helper` after an `Input` Tag Helper for the same property. Doing so displays any validation error messages near the input that caused the error.

#### NOTE

You must have a view with the correct JavaScript and [jQuery](#) script references in place for client side validation. See [Model Validation](#) for more information.

When a server side validation error occurs (for example when you have custom server side validation or client-side validation is disabled), MVC places that error message as the body of the `<span>` element.

```
<span class="field-validation-error" data-valmsg-for="Email"  
      data-valmsg-replace="true">  
    The Email Address field is required.  
</span>
```

### The Validation Summary Tag Helper

- Targets `<div>` elements with the `asp-validation-summary` attribute
- HTML Helper alternative: `@Html.ValidationSummary`

The `Validation Summary Tag Helper` is used to display a summary of validation messages. The `asp-validation-summary` attribute value can be any of the following:

ASP-VALIDATION-SUMMARY	VALIDATION MESSAGES DISPLAYED
ValidationSummary.All	Property and model level
ValidationSummary.ModelOnly	Model
ValidationSummary.None	None

### Sample

In the following example, the data model is decorated with `DataAnnotation` attributes, which generates validation error messages on the `<input>` element. When a validation error occurs, the Validation Tag Helper displays the error message:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}

```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterValidation" method="post">
    <div asp-validation-summary="ModelOnly"></div>
    Email: <input asp-for="Email" /> <br />
    <span asp-validation-for="Email"></span><br />
    Password: <input asp-for="Password" /><br />
    <span asp-validation-for="Password"></span><br />
    <button type="submit">Register</button>
</form>

```

The generated HTML (when the model is valid):

```

<form action="/DemoReg/Register" method="post">
    <div class="validation-summary-valid" data-valmsg-summary="true">
        <ul><li style="display:none"></li></ul></div>
    Email: <input name="Email" id="Email" type="email" value="" data-val-required="The Email field is required." data-val-email="The Email field is not a valid email address." data-val="true"> <br />
    <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Email"></span><br />
    Password: <input name="Password" id="Password" type="password" data-val-required="The Password field is required." data-val="true"><br />
    <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Password"></span><br />
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## The Select Tag Helper

- Generates `select` and associated `option` elements for properties of your model.
- Has an HTML Helper alternative `Html.DropDownListFor` and `Html.ListBoxFor`

The `Select Tag Helper` `asp-for` specifies the model property name for the `select` element and `asp-items` specifies the `option` elements. For example:

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

Sample:

```

using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel
    {
        public string Country { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
        };
    }
}

```

The `Index` method initializes the `CountryViewModel`, sets the selected country and passes it to the `Index` view.

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

The HTTP POST `Index` method displays the selection:

```

[HttpPost]
[ValidateAntiForgeryToken]
public IActionResult Index(CountryViewModel model)
{
    if (ModelState.IsValid)
    {
        var msg = model.Country + " selected";
        return RedirectToAction("IndexSuccess", new { message = msg });
    }

    // If we got this far, something failed; redisplay form.
    return View(model);
}

```

The `Index` view:

```

@model CountryViewModel

<form asp-controller="Home" asp-action="Index" method="post">
    <select asp-for="Country" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>

```

Which generates the following HTML (with "CA" selected):

```
<form method="post" action="/">
    <select id="Country" name="Country">
        <option value="MX">Mexico</option>
        <option selected="selected" value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## NOTE

We don't recommend using `ViewBag` or `ViewData` with the `Select` Tag Helper. A view model is more robust at providing MVC metadata and generally less problematic.

The `asp-for` attribute value is a special case and doesn't require a `Model` prefix, the other Tag Helper attributes do (such as `asp-items`)

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

## Enum binding

It's often convenient to use `<select>` with an `enum` property and generate the `SelectListItem` elements from the `enum` values.

Sample:

```
public class CountryEnumViewModel
{
    public CountryEnum EnumCountry { get; set; }
}
```

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}
```

The `GetEnumSelectList` method generates a `SelectList` object for an enum.

```

@model CountryEnumViewModel

<form asp-controller="Home" asp-action="IndexEnum" method="post">
    <select asp-for="EnumCountry"
        asp-items="Html.GetEnumSelectList<CountryEnum>()" >
    </select>
    <br /><button type="submit">Register</button>
</form>

```

You can decorate your enumerator list with the `Display` attribute to get a richer UI:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}

```

The following HTML is generated:

```

<form method="post" action="/Home/IndexEnum">
    <select data-val="true" data-val-required="The EnumCountry field is required."
        id="EnumCountry" name="EnumCountry">
        <option value="0">United Mexican States</option>
        <option value="1">United States of America</option>
        <option value="2">Canada</option>
        <option value="3">France</option>
        <option value="4">Germany</option>
        <option selected="selected" value="5">Spain</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## Option Group

The HTML `<optgroup>` element is generated when the view model contains one or more `SelectListGroup` objects.

The `CountryViewModelGroup` groups the `SelectListItem` elements into the "North America" and "Europe" groups:

```

public class CountryViewModelGroup
{
    public CountryViewModelGroup()
    {
        var NorthAmericaGroup = new SelectListGroup { Name = "North America" };
        var EuropeGroup = new SelectListGroup { Name = "Europe" };

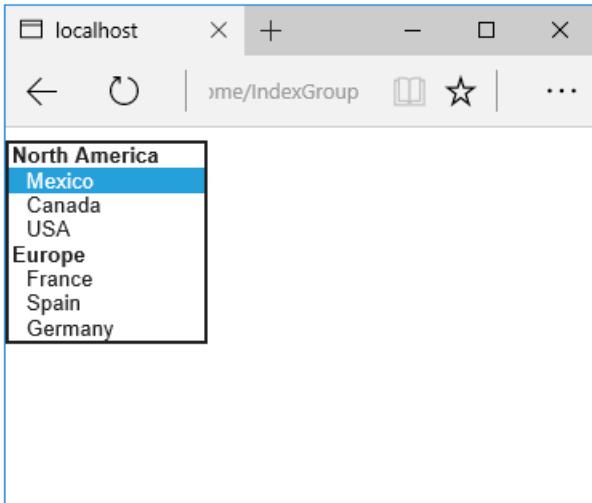
        Countries = new List<SelectListItem>
        {
            new SelectListItem
            {
                Value = "MEX",
                Text = "Mexico",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "CAN",
                Text = "Canada",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "US",
                Text = "USA",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "FR",
                Text = "France",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "ES",
                Text = "Spain",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "DE",
                Text = "Germany",
                Group = EuropeGroup
            }
        };
    }

    public string Country { get; set; }

    public List<SelectListItem> Countries { get; }
}

```

The two groups are shown below:



The generated HTML:

```
<form method="post" action="/Home/IndexGroup">
    <select id="Country" name="Country">
        <optgroup label="North America">
            <option value="MEX">Mexico</option>
            <option value="CAN">Canada</option>
            <option value="US">USA</option>
        </optgroup>
        <optgroup label="Europe">
            <option value="FR">France</option>
            <option value="ES">Spain</option>
            <option value="DE">Germany</option>
        </optgroup>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="removed for brevity" />
</form>
```

## Multiple select

The Select Tag Helper will automatically generate the `multiple = "multiple"` attribute if the property specified in the `asp-for` attribute is an `IEnumerable`. For example, given the following model:

```
using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel : IEnumerable
    {
        public IEnumerable<string> CountryCodes { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
            new SelectListItem { Value = "FR", Text = "France" },
            new SelectListItem { Value = "ES", Text = "Spain" },
            new SelectListItem { Value = "DE", Text = "Germany" }
        };
    }
}
```

With the following view:

```

@model CountryViewModelIEnumarable

<form asp-controller="Home" asp-action="IndexMultiSelect" method="post">
    <select asp-for="CountryCodes" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>

```

Generates the following HTML:

```

<form method="post" action="/Home/IndexMultiSelect">
    <select id="CountryCodes"
        multiple="multiple"
        name="CountryCodes"><option value="MX">Mexico</option>
    <option value="CA">Canada</option>
    <option value="US">USA</option>
    <option value="FR">France</option>
    <option value="ES">Spain</option>
    <option value="DE">Germany</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## No selection

If you find yourself using the "not specified" option in multiple pages, you can create a template to eliminate repeating the HTML:

```

@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    @Html.EditorForModel()
    <br /><button type="submit">Register</button>
</form>

```

The *Views/Shared/EditorTemplates/CountryViewModel.cshtml* template:

```

@model CountryViewModel

<select asp-for="Country" asp-items="Model.Countries">
    <option value="">--none--</option>
</select>

```

Adding HTML `<option>` elements isn't limited to the *No selection* case. For example, the following view and action method will generate HTML similar to the code above:

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

```
@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    <select asp-for="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
</form>
```

The correct `<option>` element will be selected ( contain the `selected="selected"` attribute) depending on the current `Country` value.

```
<form method="post" action="/Home/IndexEmpty">
    <select id="Country" name="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA" selected="selected">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## Additional resources

- [Tag Helpers](#)
- [HTML Form element](#)
- [Request Verification Token](#)
- [Model Binding](#)
- [Model Validation](#)
- [IAttributeAdapter Interface](#)
- [Code snippets for this document](#)

# Image Tag Helper in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Peter Kellner](#)

The Image Tag Helper enhances the `img` (`<img>`) tag. It requires a `src` tag as well as the `boolean` attribute `asp-append-version`.

If the image source (`src`) is a static file on the host web server, a unique cache busting string is appended as a query parameter to the image source. This ensures that if the file on the host web server changes, a unique request URL is generated that includes the updated request parameter. The cache busting string is a unique value representing the hash of the static image file.

If the image source (`src`) isn't a static file (for example a remote URL or the file doesn't exist on the server), the `<img>` tag's `src` attribute is generated with no cache busting query string parameter.

## Image Tag Helper Attributes

### **asp-append-version**

When specified along with a `src` attribute, the Image Tag Helper is invoked.

An example of a valid `img` tag helper is:

```
<img src("~/images/asplogo.png"
      asp-append-version="true" />
```

If the static file exists in the directory `..wwwroot/images/asplogo.png` the generated html is similar to the following (the hash will be different):

```

```

The value assigned to the parameter `v` is the hash value of the file on disk. If the web server is unable to obtain read access to the static file referenced, no `v` parameters is added to the `src` attribute.

### **src**

To activate the Image Tag Helper, the `src` attribute is required on the `<img>` element.

#### **NOTE**

The Image Tag Helper uses the `Cache` provider on the local web server to store the calculated `sha512` of a given file. If the file is requested again the `sha512` doesn't need to be recalculated. The Cache is invalidated by a file watcher that's attached to the file when the file's `sha512` is calculated.

## Additional resources

- [Cache in-memory in ASP.NET Core](#)

# Tag Helpers in forms in ASP.NET Core

6/21/2018 • 17 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [Dave Paquette](#), and [Jerrie Pelser](#)

This document demonstrates working with Forms and the HTML elements commonly used on a Form. The [HTML Form](#) element provides the primary mechanism web apps use to post back data to the server. Most of this document describes [Tag Helpers](#) and how they can help you productively create robust HTML forms. We recommend you read [Introduction to Tag Helpers](#) before you read this document.

In many cases, HTML Helpers provide an alternative approach to a specific Tag Helper, but it's important to recognize that Tag Helpers don't replace HTML Helpers and there's not a Tag Helper for each HTML Helper. When an HTML Helper alternative exists, it's mentioned.

## The Form Tag Helper

The [Form](#) Tag Helper:

- Generates the HTML `<FORM>` `action` attribute value for a MVC controller action or named route
- Generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method)
- Provides the `asp-route-<Parameter Name>` attribute, where `<Parameter Name>` is added to the route values. The `routeValues` parameters to `Html.BeginForm` and `Html.BeginRouteForm` provide similar functionality.
- Has an HTML Helper alternative `Html.BeginForm` and `Html.BeginRouteForm`

Sample:

```
<form asp-controller="Demo" asp-action="Register" method="post">
    <!-- Input and Submit elements -->
</form>
```

The Form Tag Helper above generates the following HTML:

```
<form method="post" action="/Demo/Register">
    <!-- Input and Submit elements -->
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

The MVC runtime generates the `action` attribute value from the Form Tag Helper attributes `asp-controller` and `asp-action`. The Form Tag Helper also generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method). Protecting a pure HTML Form from cross-site request forgery is difficult, the Form Tag Helper provides this service for you.

### Using a named route

The `asp-route` Tag Helper attribute can also generate markup for the HTML `action` attribute. An app with a route named `register` could use the following markup for the registration page:

```
<form asp-route="register" method="post">
    <!-- Input and Submit elements -->
</form>
```

Many of the views in the `Views/Account` folder (generated when you create a new web app with *Individual User Accounts*) contain the `asp-route-returnurl` attribute:

```
<form asp-controller="Account" asp-action="Login"
      asp-route-returnurl="@ViewData["ReturnUrl"]"
      method="post" class="form-horizontal" role="form">
```

#### NOTE

With the built in templates, `returnUrl` is only populated automatically when you try to access an authorized resource but are not authenticated or authorized. When you attempt an unauthorized access, the security middleware redirects you to the login page with the `returnUrl` set.

## The Input Tag Helper

The Input Tag Helper binds an HTML `<input>` element to a model expression in your razor view.

Syntax:

```
<input asp-for="<Expression Name>" />
```

The Input Tag Helper:

- Generates the `id` and `name` HTML attributes for the expression name specified in the `asp-for` attribute. `asp-for="Property1.Property2"` is equivalent to `m => m.Property1.Property2`. The name of the expression is what is used for the `asp-for` attribute value. See the [Expression names](#) section for additional information.
- Sets the HTML `type` attribute value based on the model type and [data annotation](#) attributes applied to the model property
- Won't overwrite the HTML `type` attribute value when one is specified
- Generates [HTML5](#) validation attributes from [data annotation](#) attributes applied to model properties
- Has an HTML Helper feature overlap with `Html.TextBoxFor` and `Html.EditorFor`. See the [HTML Helper alternatives to Input Tag Helper](#) section for details.
- Provides strong typing. If the name of the property changes and you don't update the Tag Helper you'll get an error similar to the following:

```
An error occurred during the compilation of a resource required to process
this request. Please review the following specific error details and modify
your source code appropriately.
```

```
Type expected
'RegisterViewModel' does not contain a definition for 'Email' and no
extension method 'Email' accepting a first argument of type 'RegisterViewModel'
could be found (are you missing a using directive or an assembly reference?)
```

The `Input` Tag Helper sets the HTML `type` attribute based on the .NET type. The following table lists some common .NET types and generated HTML type (not every .NET type is listed).

.NET TYPE	INPUT TYPE
Bool	type="checkbox"
String	type="text"
DateTime	type="datetime"
Byte	type="number"
Int	type="number"
Single, Double	type="number"

The following table shows some common [data annotations](#) attributes that the input tag helper will map to specific input types (not every validation attribute is listed):

ATTRIBUTE	INPUT TYPE
[EmailAddress]	type="email"
[Url]	type="url"
[HiddenInput]	type="hidden"
[Phone]	type="tel"
[DataType(DataType.Password)]	type="password"
[DataType(DataType.Date)]	type="date"
[DataType(DataType.Time)]	type="time"

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}
```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterInput" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    <button type="submit">Register</button>
</form>

```

The code above generates the following HTML:

```

<form method="post" action="/Demo/RegisterInput">
    Email:
    <input type="email" data-val="true"
           data-val-email="The Email Address field is not a valid email address."
           data-val-required="The Email Address field is required."
           id="Email" name="Email" value="" /> <br>
    Password:
    <input type="password" data-val="true"
           data-val-required="The Password field is required."
           id="Password" name="Password" /><br>
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

The data annotations applied to the `Email` and `Password` properties generate metadata on the model. The Input Tag Helper consumes the model metadata and produces [HTML5](#) `data-val-*` attributes (see [Model Validation](#)). These attributes describe the validators to attach to the input fields. This provides unobtrusive HTML5 and [jQuery](#) validation. The unobtrusive attributes have the format `data-val-rule="Error Message"`, where rule is the name of the validation rule (such as `data-val-required`, `data-val-email`, `data-val-maxlength`, etc.) If an error message is provided in the attribute, it's displayed as the value for the `data-val-rule` attribute. There are also attributes of the form `data-val-ruleName-argumentName="argumentValue"` that provide additional details about the rule, for example, `data-val-maxlength-max="1024"`.

## HTML Helper alternatives to Input Tag Helper

`Html.TextBox`, `Html.TextBoxFor`, `Html.Editor` and `Html.EditorFor` have overlapping features with the Input Tag Helper. The Input Tag Helper will automatically set the `type` attribute; `Html.TextBox` and `Html.TextBoxFor` won't. `Html.Editor` and `Html.EditorFor` handle collections, complex objects and templates; the Input Tag Helper doesn't. The Input Tag Helper, `Html.EditorFor` and `Html.TextBoxFor` are strongly typed (they use lambda expressions); `Html.TextBox` and `Html.Editor` are not (they use expression names).

## HtmlAttributes

`@Html.Editor()` and `@Html.EditorFor()` use a special `ViewDataDictionary` entry named `htmlAttributes` when executing their default templates. This behavior is optionally augmented using `additional ViewData` parameters. The key "htmlAttributes" is case-insensitive. The key "htmlAttributes" is handled similarly to the `htmlAttributes` object passed to input helpers like `@Html.TextBox()`.

```

@Html.EditorFor(model => model.YourProperty,
    new { htmlAttributes = new { @class="myCssClass", style="Width:100px" } })

```

## Expression names

The `asp-for` attribute value is a `ModelExpression` and the right hand side of a lambda expression. Therefore, `asp-for="Property1"` becomes `m => m.Property1` in the generated code which is why you don't need to prefix with `Model`. You can use the "@" character to start an inline expression and move before the `m`:

```
@{
    var joe = "Joe";
}
<input asp-for="@joe" />
```

Generates the following:

```
<input type="text" id="joe" name="joe" value="Joe" />
```

With collection properties, `asp-for="CollectionProperty[23].Member"` generates the same name as `asp-for="CollectionProperty[i].Member"` when `i` has the value `23`.

When ASP.NET Core MVC calculates the value of `ModelExpression`, it inspects several sources, including `ModelState`. Consider `<input type="text" asp-for="@Name" />`. The calculated `value` attribute is the first non-null value from:

- `ModelState` entry with key "Name".
- Result of the expression `Model.Name`.

### Navigating child properties

You can also navigate to child properties using the property path of the view model. Consider a more complex model class that contains a child `Address` property.

```
public class AddressViewModel
{
    public string AddressLine1 { get; set; }
}
```

```
public class RegisterAddressViewModel
{
    public string Email { get; set; }

    [DataType(DataType.Password)]
    public string Password { get; set; }

    public AddressViewModel Address { get; set; }
}
```

In the view, we bind to `Address.AddressLine1`:

```
@model RegisterAddressViewModel

<form asp-controller="Demo" asp-action="RegisterAddress" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    Address: <input asp-for="Address.AddressLine1" /><br />
    <button type="submit">Register</button>
</form>
```

The following HTML is generated for `Address.AddressLine1`:

```
<input type="text" id="Address_AddressLine1" name="Address.AddressLine1" value="" />
```

## Expression names and Collections

Sample, a model containing an array of `Colors`:

```
public class Person
{
    public List<string> Colors { get; set; }

    public int Age { get; set; }
}
```

The action method:

```
public IActionResult Edit(int id, int colorIndex)
{
    ViewData["Index"] = colorIndex;
    return View(GetPerson(id));
}
```

The following Razor shows how you access a specific `Color` element:

```
@model Person
 @{
    var index = (int)ViewData["index"];
}

<form asp-controller="ToDo" asp-action="Edit" method="post">
    @Html.EditorFor(m => m.Colors[index])
    <label asp-for="Age"></label>
    <input asp-for="Age" /><br />
    <button type="submit">Post</button>
</form>
```

The *Views/Shared/EditorTemplates/String.cshtml* template:

```
@model string

<label asp-for="@Model"></label>
<input asp-for="@Model" /> <br />
```

Sample using `List<T>`:

```
public class ToDoItem
{
    public string Name { get; set; }

    public bool IsDone { get; set; }
}
```

The following Razor shows how to iterate over a collection:

```

@model List<ToDoItem>

<form asp-controller="ToDo" asp-action="Edit" method="post">
    <table>
        <tr> <th>Name</th> <th>Is Done</th> </tr>

        @for (int i = 0; i < Model.Count; i++)
        {
            <tr>
                @Html.EditorFor(model => model[i])
            </tr>
        }

    </table>
    <button type="submit">Save</button>
</form>

```

The *Views/Shared/EditorTemplates/ToDoItem.cshtml* template:

```

@model ToDoItem

<td>
    <label asp-for="@Model.Name"></label>
    @Html.DisplayFor(model => model.Name)
</td>
<td>
    <input asp-for="@Model.IsDone" />
</td>



```

#### NOTE

Always use `for` (and *not* `foreach`) to iterate over a list. Evaluating an indexer in a LINQ expression can be expensive and should be minimized.

#### NOTE

The commented sample code above shows how you would replace the lambda expression with the `@` operator to access each `ToDoItem` in the list.

## The Textarea Tag Helper

The `Textarea Tag Helper` tag helper is similar to the Input Tag Helper.

- Generates the `id` and `name` attributes, and the data validation attributes from the model for a `<textarea>` element.

- Provides strong typing.
- HTML Helper alternative: `Html.TextAreaFor`

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class DescriptionViewModel
    {
        [MinLength(5)]
        [MaxLength(1024)]
        public string Description { get; set; }
    }
}
```

```
@model DescriptionViewModel

<form asp-controller="Demo" asp-action="RegisterTextArea" method="post">
    <textarea asp-for="Description"></textarea>
    <button type="submit">Test</button>
</form>
```

The following HTML is generated:

```
<form method="post" action="/Demo/RegisterTextArea">
    <textarea data-val="true"
              data-val-maxlength="The field Description must be a string or array type with a maximum length of
              &#x27;1024&#x27;;."
              data-val-maxlength-max="1024"
              data-val-minlength="The field Description must be a string or array type with a minimum length of
              &#x27;5&#x27;;."
              data-val-minlength-min="5"
              id="Description" name="Description">
    </textarea>
    <button type="submit">Test</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## The Label Tag Helper

- Generates the label caption and `for` attribute on a element for an expression name
- HTML Helper alternative: `Html.LabelFor`.

The `Label Tag Helper` provides the following benefits over a pure HTML label element:

- You automatically get the descriptive label value from the `Display` attribute. The intended display name might change over time, and the combination of `Display` attribute and Label Tag Helper will apply the `Display` everywhere it's used.
- Less markup in source code
- Strong typing with the model property.

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class SimpleViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }
    }
}
```

```
@model SimpleViewModel

<form asp-controller="Demo" asp-action="RegisterLabel" method="post">
    <label asp-for="Email"></label>
    <input asp-for="Email" /> <br />
</form>
```

The following HTML is generated for the `<label>` element:

```
<label for="Email">Email Address</label>
```

The Label Tag Helper generated the `for` attribute value of "Email", which is the ID associated with the `<input>` element. The Tag Helpers generate consistent `id` and `for` elements so they can be correctly associated. The caption in this sample comes from the `Display` attribute. If the model didn't contain a `Display` attribute, the caption would be the property name of the expression.

## The Validation Tag Helpers

There are two Validation Tag Helpers. The `Validation Message Tag Helper` (which displays a validation message for a single property on your model), and the `Validation Summary Tag Helper` (which displays a summary of validation errors). The `Input Tag Helper` adds HTML5 client side validation attributes to input elements based on data annotation attributes on your model classes. Validation is also performed on the server. The Validation Tag Helper displays these error messages when a validation error occurs.

### The Validation Message Tag Helper

- Adds the `HTML5` `data-valmsg-for="property"` attribute to the `span` element, which attaches the validation error messages on the input field of the specified model property. When a client side validation error occurs, `jQuery` displays the error message in the `<span>` element.
- Validation also takes place on the server. Clients may have JavaScript disabled and some validation can only be done on the server side.
- HTML Helper alternative: `Html.ValidationMessageFor`

The `Validation Message Tag Helper` is used with the `asp-validation-for` attribute on a HTML `span` element.

```
<span asp-validation-for="Email"></span>
```

The Validation Message Tag Helper will generate the following HTML:

```
<span class="field-validation-valid"  
      data-valmsg-for="Email"  
      data-valmsg-replace="true"></span>
```

You generally use the `Validation Message Tag Helper` after an `Input` Tag Helper for the same property. Doing so displays any validation error messages near the input that caused the error.

#### NOTE

You must have a view with the correct JavaScript and [jQuery](#) script references in place for client side validation. See [Model Validation](#) for more information.

When a server side validation error occurs (for example when you have custom server side validation or client-side validation is disabled), MVC places that error message as the body of the `<span>` element.

```
<span class="field-validation-error" data-valmsg-for="Email"  
      data-valmsg-replace="true">  
    The Email Address field is required.  
</span>
```

### The Validation Summary Tag Helper

- Targets `<div>` elements with the `asp-validation-summary` attribute
- HTML Helper alternative: `@Html.ValidationSummary`

The `Validation Summary Tag Helper` is used to display a summary of validation messages. The `asp-validation-summary` attribute value can be any of the following:

ASP-VALIDATION-SUMMARY	VALIDATION MESSAGES DISPLAYED
ValidationSummary.All	Property and model level
ValidationSummary.ModelOnly	Model
ValidationSummary.None	None

### Sample

In the following example, the data model is decorated with `DataAnnotation` attributes, which generates validation error messages on the `<input>` element. When a validation error occurs, the Validation Tag Helper displays the error message:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}

```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterValidation" method="post">
    <div asp-validation-summary="ModelOnly"></div>
    Email: <input asp-for="Email" /> <br />
    <span asp-validation-for="Email"></span><br />
    Password: <input asp-for="Password" /><br />
    <span asp-validation-for="Password"></span><br />
    <button type="submit">Register</button>
</form>

```

The generated HTML (when the model is valid):

```

<form action="/DemoReg/Register" method="post">
    <div class="validation-summary-valid" data-valmsg-summary="true">
        <ul><li style="display:none"></li></ul></div>
    Email: <input name="Email" id="Email" type="email" value="" data-val-required="The Email field is required." data-val-email="The Email field is not a valid email address." data-val="true"> <br />
    <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Email"></span><br />
    Password: <input name="Password" id="Password" type="password" data-val-required="The Password field is required." data-val="true"><br />
    <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Password"></span><br />
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## The Select Tag Helper

- Generates `select` and associated `option` elements for properties of your model.
- Has an HTML Helper alternative `Html.DropDownListFor` and `Html.ListBoxFor`

The `Select Tag Helper` `asp-for` specifies the model property name for the `select` element and `asp-items` specifies the `option` elements. For example:

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

Sample:

```

using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel
    {
        public string Country { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
        };
    }
}

```

The `Index` method initializes the `CountryViewModel`, sets the selected country and passes it to the `Index` view.

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

The HTTP POST `Index` method displays the selection:

```

[HttpPost]
[ValidateAntiForgeryToken]
public IActionResult Index(CountryViewModel model)
{
    if (ModelState.IsValid)
    {
        var msg = model.Country + " selected";
        return RedirectToAction("IndexSuccess", new { message = msg });
    }

    // If we got this far, something failed; redisplay form.
    return View(model);
}

```

The `Index` view:

```

@model CountryViewModel

<form asp-controller="Home" asp-action="Index" method="post">
    <select asp-for="Country" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>

```

Which generates the following HTML (with "CA" selected):

```
<form method="post" action="/">
    <select id="Country" name="Country">
        <option value="MX">Mexico</option>
        <option selected="selected" value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## NOTE

We don't recommend using `ViewBag` or `ViewData` with the `Select` Tag Helper. A view model is more robust at providing MVC metadata and generally less problematic.

The `asp-for` attribute value is a special case and doesn't require a `Model` prefix, the other Tag Helper attributes do (such as `asp-items`)

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

## Enum binding

It's often convenient to use `<select>` with an `enum` property and generate the `SelectListItem` elements from the `enum` values.

Sample:

```
public class CountryEnumViewModel
{
    public CountryEnum EnumCountry { get; set; }
}
```

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}
```

The `GetEnumSelectList` method generates a `SelectList` object for an enum.

```

@model CountryEnumViewModel

<form asp-controller="Home" asp-action="IndexEnum" method="post">
    <select asp-for="EnumCountry"
        asp-items="Html.GetEnumSelectList<CountryEnum>()" >
    </select>
    <br /><button type="submit">Register</button>
</form>

```

You can decorate your enumerator list with the `Display` attribute to get a richer UI:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}

```

The following HTML is generated:

```

<form method="post" action="/Home/IndexEnum">
    <select data-val="true" data-val-required="The EnumCountry field is required."
        id="EnumCountry" name="EnumCountry">
        <option value="0">United Mexican States</option>
        <option value="1">United States of America</option>
        <option value="2">Canada</option>
        <option value="3">France</option>
        <option value="4">Germany</option>
        <option selected="selected" value="5">Spain</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## Option Group

The HTML `<optgroup>` element is generated when the view model contains one or more `SelectListGroup` objects.

The `CountryViewModelGroup` groups the `SelectListItem` elements into the "North America" and "Europe" groups:

```

public class CountryViewModelGroup
{
    public CountryViewModelGroup()
    {
        var NorthAmericaGroup = new SelectListGroup { Name = "North America" };
        var EuropeGroup = new SelectListGroup { Name = "Europe" };

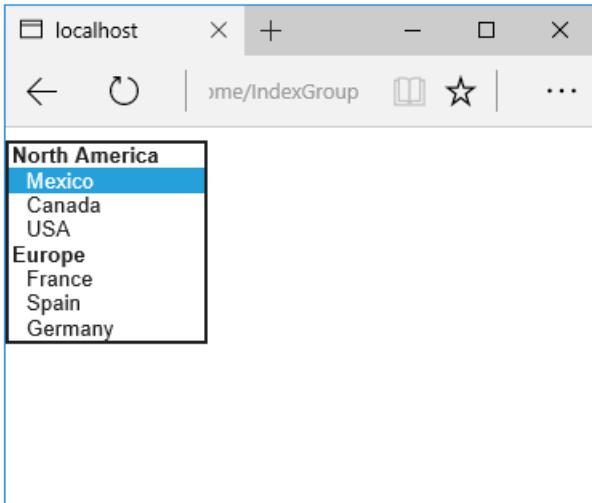
        Countries = new List<SelectListItem>
        {
            new SelectListItem
            {
                Value = "MEX",
                Text = "Mexico",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "CAN",
                Text = "Canada",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "US",
                Text = "USA",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "FR",
                Text = "France",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "ES",
                Text = "Spain",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "DE",
                Text = "Germany",
                Group = EuropeGroup
            }
        };
    }

    public string Country { get; set; }

    public List<SelectListItem> Countries { get; }
}

```

The two groups are shown below:



The generated HTML:

```
<form method="post" action="/Home/IndexGroup">
    <select id="Country" name="Country">
        <optgroup label="North America">
            <option value="MEX">Mexico</option>
            <option value="CAN">Canada</option>
            <option value="US">USA</option>
        </optgroup>
        <optgroup label="Europe">
            <option value="FR">France</option>
            <option value="ES">Spain</option>
            <option value="DE">Germany</option>
        </optgroup>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="removed for brevity" />
</form>
```

## Multiple select

The Select Tag Helper will automatically generate the `multiple = "multiple"` attribute if the property specified in the `asp-for` attribute is an `IEnumerable`. For example, given the following model:

```
using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel : IEnumerable
    {
        public IEnumerable<string> CountryCodes { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
            new SelectListItem { Value = "FR", Text = "France" },
            new SelectListItem { Value = "ES", Text = "Spain" },
            new SelectListItem { Value = "DE", Text = "Germany" }
        };
    }
}
```

With the following view:

```

@model CountryViewModelIEnumarable

<form asp-controller="Home" asp-action="IndexMultiSelect" method="post">
    <select asp-for="CountryCodes" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>

```

Generates the following HTML:

```

<form method="post" action="/Home/IndexMultiSelect">
    <select id="CountryCodes"
        multiple="multiple"
        name="CountryCodes"><option value="MX">Mexico</option>
    <option value="CA">Canada</option>
    <option value="US">USA</option>
    <option value="FR">France</option>
    <option value="ES">Spain</option>
    <option value="DE">Germany</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## No selection

If you find yourself using the "not specified" option in multiple pages, you can create a template to eliminate repeating the HTML:

```

@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    @Html.EditorForModel()
    <br /><button type="submit">Register</button>
</form>

```

The *Views/Shared/EditorTemplates/CountryViewModel.cshtml* template:

```

@model CountryViewModel

<select asp-for="Country" asp-items="Model.Countries">
    <option value="">--none--</option>
</select>

```

Adding HTML `<option>` elements isn't limited to the *No selection* case. For example, the following view and action method will generate HTML similar to the code above:

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

```
@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    <select asp-for="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
</form>
```

The correct `<option>` element will be selected ( contain the `selected="selected"` attribute) depending on the current `Country` value.

```
<form method="post" action="/Home/IndexEmpty">
    <select id="Country" name="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA" selected="selected">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## Additional resources

- [Tag Helpers](#)
- [HTML Form element](#)
- [Request Verification Token](#)
- [Model Binding](#)
- [Model Validation](#)
- [IAttributeAdapter Interface](#)
- [Code snippets for this document](#)

# Tag Helpers in forms in ASP.NET Core

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This document demonstrates working with Forms and the HTML elements commonly used on a Form. The [HTML Form](#) element provides the primary mechanism web apps use to post back data to the server. Most of this document describes [Tag Helpers](#) and how they can help you productively create robust HTML forms. We recommend you read [Introduction to Tag Helpers](#) before you read this document.

In many cases, HTML Helpers provide an alternative approach to a specific Tag Helper, but it's important to recognize that Tag Helpers don't replace HTML Helpers and there's not a Tag Helper for each HTML Helper. When an HTML Helper alternative exists, it's mentioned.

## The Form Tag Helper

The [Form](#) Tag Helper:

- Generates the HTML `<FORM>` `action` attribute value for a MVC controller action or named route
- Generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method)
- Provides the `asp-route-<Parameter Name>` attribute, where `<Parameter Name>` is added to the route values. The `routeValues` parameters to `Html.BeginForm` and `Html.BeginRouteForm` provide similar functionality.
- Has an HTML Helper alternative `Html.BeginForm` and `Html.BeginRouteForm`

Sample:

```
<form asp-controller="Demo" asp-action="Register" method="post">
    <!-- Input and Submit elements -->
</form>
```

The Form Tag Helper above generates the following HTML:

```
<form method="post" action="/Demo/Register">
    <!-- Input and Submit elements -->
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

The MVC runtime generates the `action` attribute value from the Form Tag Helper attributes `asp-controller` and `asp-action`. The Form Tag Helper also generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method). Protecting a pure HTML Form from cross-site request forgery is difficult, the Form Tag Helper provides this service for you.

### Using a named route

The `asp-route` Tag Helper attribute can also generate markup for the HTML `action` attribute. An app with a route named `register` could use the following markup for the registration page:

```
<form asp-route="register" method="post">
    <!-- Input and Submit elements -->
</form>
```

Many of the views in the `Views/Account` folder (generated when you create a new web app with *Individual User Accounts*) contain the `asp-route-returnurl` attribute:

```
<form asp-controller="Account" asp-action="Login"
      asp-route-returnurl="@ViewData["ReturnUrl"]"
      method="post" class="form-horizontal" role="form">
```

#### NOTE

With the built in templates, `returnUrl` is only populated automatically when you try to access an authorized resource but are not authenticated or authorized. When you attempt an unauthorized access, the security middleware redirects you to the login page with the `returnUrl` set.

## The Input Tag Helper

The Input Tag Helper binds an HTML `<input>` element to a model expression in your razor view.

Syntax:

```
<input asp-for="<Expression Name>" />
```

The Input Tag Helper:

- Generates the `id` and `name` HTML attributes for the expression name specified in the `asp-for` attribute. `asp-for="Property1.Property2"` is equivalent to `m => m.Property1.Property2`. The name of the expression is what is used for the `asp-for` attribute value. See the [Expression names](#) section for additional information.
- Sets the HTML `type` attribute value based on the model type and [data annotation](#) attributes applied to the model property
- Won't overwrite the HTML `type` attribute value when one is specified
- Generates [HTML5](#) validation attributes from [data annotation](#) attributes applied to model properties
- Has an HTML Helper feature overlap with `Html.TextBoxFor` and `Html.EditorFor`. See the [HTML Helper alternatives to Input Tag Helper](#) section for details.
- Provides strong typing. If the name of the property changes and you don't update the Tag Helper you'll get an error similar to the following:

```
An error occurred during the compilation of a resource required to process
this request. Please review the following specific error details and modify
your source code appropriately.
```

```
Type expected
'RegisterViewModel' does not contain a definition for 'Email' and no
extension method 'Email' accepting a first argument of type 'RegisterViewModel'
could be found (are you missing a using directive or an assembly reference?)
```

The `Input` Tag Helper sets the HTML `type` attribute based on the .NET type. The following table lists some common .NET types and generated HTML type (not every .NET type is listed).

.NET TYPE	INPUT TYPE
Bool	type="checkbox"
String	type="text"
DateTime	type="datetime"
Byte	type="number"
Int	type="number"
Single, Double	type="number"

The following table shows some common [data annotations](#) attributes that the input tag helper will map to specific input types (not every validation attribute is listed):

ATTRIBUTE	INPUT TYPE
[EmailAddress]	type="email"
[Url]	type="url"
[HiddenInput]	type="hidden"
[Phone]	type="tel"
[DataType(DataType.Password)]	type="password"
[DataType(DataType.Date)]	type="date"
[DataType(DataType.Time)]	type="time"

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}
```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterInput" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    <button type="submit">Register</button>
</form>

```

The code above generates the following HTML:

```

<form method="post" action="/Demo/RegisterInput">
    Email:
    <input type="email" data-val="true"
           data-val-email="The Email Address field is not a valid email address."
           data-val-required="The Email Address field is required."
           id="Email" name="Email" value="" /> <br>
    Password:
    <input type="password" data-val="true"
           data-val-required="The Password field is required."
           id="Password" name="Password" /><br>
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

The data annotations applied to the `Email` and `Password` properties generate metadata on the model. The Input Tag Helper consumes the model metadata and produces [HTML5](#) `data-val-*` attributes (see [Model Validation](#)). These attributes describe the validators to attach to the input fields. This provides unobtrusive HTML5 and [jQuery](#) validation. The unobtrusive attributes have the format `data-val-rule="Error Message"`, where rule is the name of the validation rule (such as `data-val-required`, `data-val-email`, `data-val-maxlength`, etc.) If an error message is provided in the attribute, it's displayed as the value for the `data-val-rule` attribute. There are also attributes of the form `data-val-ruleName-argumentName="argumentValue"` that provide additional details about the rule, for example, `data-val-maxlength-max="1024"`.

## HTML Helper alternatives to Input Tag Helper

`Html.TextBox`, `Html.TextBoxFor`, `Html.Editor` and `Html.EditorFor` have overlapping features with the Input Tag Helper. The Input Tag Helper will automatically set the `type` attribute; `Html.TextBox` and `Html.TextBoxFor` won't. `Html.Editor` and `Html.EditorFor` handle collections, complex objects and templates; the Input Tag Helper doesn't. The Input Tag Helper, `Html.EditorFor` and `Html.TextBoxFor` are strongly typed (they use lambda expressions); `Html.TextBox` and `Html.Editor` are not (they use expression names).

## HtmlAttributes

`@Html.Editor()` and `@Html.EditorFor()` use a special `ViewDataDictionary` entry named `htmlAttributes` when executing their default templates. This behavior is optionally augmented using `additional ViewData` parameters. The key "htmlAttributes" is case-insensitive. The key "htmlAttributes" is handled similarly to the `htmlAttributes` object passed to input helpers like `@Html.TextBox()`.

```

@Html.EditorFor(model => model.YourProperty,
    new { htmlAttributes = new { @class="myCssClass", style="Width:100px" } })

```

## Expression names

The `asp-for` attribute value is a `ModelExpression` and the right hand side of a lambda expression. Therefore, `asp-for="Property1"` becomes `m => m.Property1` in the generated code which is why you don't need to prefix with `Model`. You can use the "@" character to start an inline expression and move before the `m`:

```
@{
    var joe = "Joe";
}
<input asp-for="@joe" />
```

Generates the following:

```
<input type="text" id="joe" name="joe" value="Joe" />
```

With collection properties, `asp-for="CollectionProperty[23].Member"` generates the same name as `asp-for="CollectionProperty[i].Member"` when `i` has the value `23`.

When ASP.NET Core MVC calculates the value of `ModelExpression`, it inspects several sources, including `ModelState`. Consider `<input type="text" asp-for="@Name" />`. The calculated `value` attribute is the first non-null value from:

- `ModelState` entry with key "Name".
- Result of the expression `Model.Name`.

### Navigating child properties

You can also navigate to child properties using the property path of the view model. Consider a more complex model class that contains a child `Address` property.

```
public class AddressViewModel
{
    public string AddressLine1 { get; set; }
}
```

```
public class RegisterAddressViewModel
{
    public string Email { get; set; }

    [DataType(DataType.Password)]
    public string Password { get; set; }

    public AddressViewModel Address { get; set; }
}
```

In the view, we bind to `Address.AddressLine1`:

```
@model RegisterAddressViewModel

<form asp-controller="Demo" asp-action="RegisterAddress" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    Address: <input asp-for="Address.AddressLine1" /><br />
    <button type="submit">Register</button>
</form>
```

The following HTML is generated for `Address.AddressLine1`:

```
<input type="text" id="Address_AddressLine1" name="Address.AddressLine1" value="" />
```

## Expression names and Collections

Sample, a model containing an array of `Colors`:

```
public class Person
{
    public List<string> Colors { get; set; }

    public int Age { get; set; }
}
```

The action method:

```
public IActionResult Edit(int id, int colorIndex)
{
    ViewData["Index"] = colorIndex;
    return View(GetPerson(id));
}
```

The following Razor shows how you access a specific `Color` element:

```
@model Person
 @{
    var index = (int)ViewData["index"];
}

<form asp-controller="ToDo" asp-action="Edit" method="post">
    @Html.EditorFor(m => m.Colors[index])
    <label asp-for="Age"></label>
    <input asp-for="Age" /><br />
    <button type="submit">Post</button>
</form>
```

The *Views/Shared/EditorTemplates/String.cshtml* template:

```
@model string

<label asp-for="@Model"></label>
<input asp-for="@Model" /> <br />
```

Sample using `List<T>`:

```
public class ToDoItem
{
    public string Name { get; set; }

    public bool IsDone { get; set; }
}
```

The following Razor shows how to iterate over a collection:

```

@model List<ToDoItem>

<form asp-controller="ToDo" asp-action="Edit" method="post">
    <table>
        <tr> <th>Name</th> <th>Is Done</th> </tr>

        @for (int i = 0; i < Model.Count; i++)
        {
            <tr>
                @Html.EditorFor(model => model[i])
            </tr>
        }

    </table>
    <button type="submit">Save</button>
</form>

```

The *Views/Shared/EditorTemplates/ToDoItem.cshtml* template:

```

@model ToDoItem

<td>
    <label asp-for="@Model.Name"></label>
    @Html.DisplayFor(model => model.Name)
</td>
<td>
    <input asp-for="@Model.IsDone" />
</td>



```

#### NOTE

Always use `for` (and *not* `foreach`) to iterate over a list. Evaluating an indexer in a LINQ expression can be expensive and should be minimized.

#### NOTE

The commented sample code above shows how you would replace the lambda expression with the `@` operator to access each `ToDoItem` in the list.

## The Textarea Tag Helper

The `Textarea Tag Helper` tag helper is similar to the Input Tag Helper.

- Generates the `id` and `name` attributes, and the data validation attributes from the model for a `<textarea>` element.

- Provides strong typing.
- HTML Helper alternative: `Html.TextAreaFor`

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class DescriptionViewModel
    {
        [MinLength(5)]
        [MaxLength(1024)]
        public string Description { get; set; }
    }
}
```

```
@model DescriptionViewModel

<form asp-controller="Demo" asp-action="RegisterTextArea" method="post">
    <textarea asp-for="Description"></textarea>
    <button type="submit">Test</button>
</form>
```

The following HTML is generated:

```
<form method="post" action="/Demo/RegisterTextArea">
    <textarea data-val="true"
              data-val-maxlength="The field Description must be a string or array type with a maximum length of
              &#x27;1024&#x27;;."
              data-val-maxlength-max="1024"
              data-val-minlength="The field Description must be a string or array type with a minimum length of
              &#x27;5&#x27;;."
              data-val-minlength-min="5"
              id="Description" name="Description">
    </textarea>
    <button type="submit">Test</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## The Label Tag Helper

- Generates the label caption and `for` attribute on a element for an expression name
- HTML Helper alternative: `Html.LabelFor`.

The `Label Tag Helper` provides the following benefits over a pure HTML label element:

- You automatically get the descriptive label value from the `Display` attribute. The intended display name might change over time, and the combination of `Display` attribute and Label Tag Helper will apply the `Display` everywhere it's used.
- Less markup in source code
- Strong typing with the model property.

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class SimpleViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }
    }
}
```

```
@model SimpleViewModel

<form asp-controller="Demo" asp-action="RegisterLabel" method="post">
    <label asp-for="Email"></label>
    <input asp-for="Email" /> <br />
</form>
```

The following HTML is generated for the `<label>` element:

```
<label for="Email">Email Address</label>
```

The Label Tag Helper generated the `for` attribute value of "Email", which is the ID associated with the `<input>` element. The Tag Helpers generate consistent `id` and `for` elements so they can be correctly associated. The caption in this sample comes from the `Display` attribute. If the model didn't contain a `Display` attribute, the caption would be the property name of the expression.

## The Validation Tag Helpers

There are two Validation Tag Helpers. The `Validation Message Tag Helper` (which displays a validation message for a single property on your model), and the `Validation Summary Tag Helper` (which displays a summary of validation errors). The `Input Tag Helper` adds HTML5 client side validation attributes to input elements based on data annotation attributes on your model classes. Validation is also performed on the server. The Validation Tag Helper displays these error messages when a validation error occurs.

### The Validation Message Tag Helper

- Adds the `HTML5` `data-valmsg-for="property"` attribute to the `span` element, which attaches the validation error messages on the input field of the specified model property. When a client side validation error occurs, `jQuery` displays the error message in the `<span>` element.
- Validation also takes place on the server. Clients may have JavaScript disabled and some validation can only be done on the server side.
- HTML Helper alternative: `Html.ValidationMessageFor`

The `Validation Message Tag Helper` is used with the `asp-validation-for` attribute on a HTML `span` element.

```
<span asp-validation-for="Email"></span>
```

The Validation Message Tag Helper will generate the following HTML:

```
<span class="field-validation-valid"  
      data-valmsg-for="Email"  
      data-valmsg-replace="true"></span>
```

You generally use the `Validation Message Tag Helper` after an `Input` Tag Helper for the same property. Doing so displays any validation error messages near the input that caused the error.

#### NOTE

You must have a view with the correct JavaScript and [jQuery](#) script references in place for client side validation. See [Model Validation](#) for more information.

When a server side validation error occurs (for example when you have custom server side validation or client-side validation is disabled), MVC places that error message as the body of the `<span>` element.

```
<span class="field-validation-error" data-valmsg-for="Email"  
      data-valmsg-replace="true">  
    The Email Address field is required.  
</span>
```

### The Validation Summary Tag Helper

- Targets `<div>` elements with the `asp-validation-summary` attribute
- HTML Helper alternative: `@Html.ValidationSummary`

The `Validation Summary Tag Helper` is used to display a summary of validation messages. The `asp-validation-summary` attribute value can be any of the following:

ASP-VALIDATION-SUMMARY	VALIDATION MESSAGES DISPLAYED
ValidationSummary.All	Property and model level
ValidationSummary.ModelOnly	Model
ValidationSummary.None	None

### Sample

In the following example, the data model is decorated with `DataAnnotation` attributes, which generates validation error messages on the `<input>` element. When a validation error occurs, the Validation Tag Helper displays the error message:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}

```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterValidation" method="post">
    <div asp-validation-summary="ModelOnly"></div>
    Email: <input asp-for="Email" /> <br />
    <span asp-validation-for="Email"></span><br />
    Password: <input asp-for="Password" /><br />
    <span asp-validation-for="Password"></span><br />
    <button type="submit">Register</button>
</form>

```

The generated HTML (when the model is valid):

```

<form action="/DemoReg/Register" method="post">
    <div class="validation-summary-valid" data-valmsg-summary="true">
        <ul><li style="display:none"></li></ul></div>
    Email: <input name="Email" id="Email" type="email" value="" data-val-required="The Email field is required." data-val-email="The Email field is not a valid email address." data-val="true"> <br />
    <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Email"></span><br />
    Password: <input name="Password" id="Password" type="password" data-val-required="The Password field is required." data-val="true"><br />
    <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Password"></span><br />
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## The Select Tag Helper

- Generates `select` and associated `option` elements for properties of your model.
- Has an HTML Helper alternative `Html.DropDownListFor` and `Html.ListBoxFor`

The `Select Tag Helper` `asp-for` specifies the model property name for the `select` element and `asp-items` specifies the `option` elements. For example:

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

Sample:

```

using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel
    {
        public string Country { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
        };
    }
}

```

The `Index` method initializes the `CountryViewModel`, sets the selected country and passes it to the `Index` view.

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

The HTTP POST `Index` method displays the selection:

```

[HttpPost]
[ValidateAntiForgeryToken]
public IActionResult Index(CountryViewModel model)
{
    if (ModelState.IsValid)
    {
        var msg = model.Country + " selected";
        return RedirectToAction("IndexSuccess", new { message = msg });
    }

    // If we got this far, something failed; redisplay form.
    return View(model);
}

```

The `Index` view:

```

@model CountryViewModel

<form asp-controller="Home" asp-action="Index" method="post">
    <select asp-for="Country" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>

```

Which generates the following HTML (with "CA" selected):

```

<form method="post" action="/">
    <select id="Country" name="Country">
        <option value="MX">Mexico</option>
        <option selected="selected" value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## NOTE

We don't recommend using `ViewBag` or `ViewData` with the Select Tag Helper. A view model is more robust at providing MVC metadata and generally less problematic.

The `asp-for` attribute value is a special case and doesn't require a `Model` prefix, the other Tag Helper attributes do (such as `asp-items`)

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

## Enum binding

It's often convenient to use `<select>` with an `enum` property and generate the `SelectListItem` elements from the `enum` values.

Sample:

```

public class CountryEnumViewModel
{
    public CountryEnum EnumCountry { get; set; }
}

```

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}

```

The `GetEnumSelectList` method generates a `SelectList` object for an enum.

```

@model CountryEnumViewModel

<form asp-controller="Home" asp-action="IndexEnum" method="post">
    <select asp-for="EnumCountry"
        asp-items="Html.GetEnumSelectList<CountryEnum>()" >
    </select>
    <br /><button type="submit">Register</button>
</form>

```

You can decorate your enumerator list with the `Display` attribute to get a richer UI:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}

```

The following HTML is generated:

```

<form method="post" action="/Home/IndexEnum">
    <select data-val="true" data-val-required="The EnumCountry field is required."
        id="EnumCountry" name="EnumCountry">
        <option value="0">United Mexican States</option>
        <option value="1">United States of America</option>
        <option value="2">Canada</option>
        <option value="3">France</option>
        <option value="4">Germany</option>
        <option selected="selected" value="5">Spain</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## Option Group

The HTML `<optgroup>` element is generated when the view model contains one or more `SelectListGroup` objects.

The `CountryViewModelGroup` groups the `SelectListItem` elements into the "North America" and "Europe" groups:

```

public class CountryViewModelGroup
{
    public CountryViewModelGroup()
    {
        var NorthAmericaGroup = new SelectListGroup { Name = "North America" };
        var EuropeGroup = new SelectListGroup { Name = "Europe" };

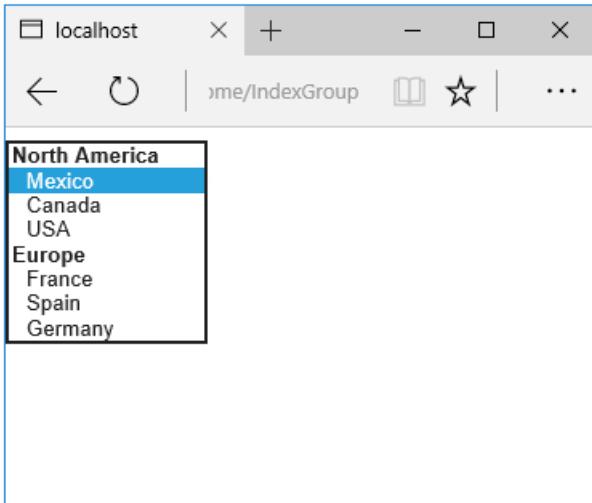
        Countries = new List<SelectListItem>
        {
            new SelectListItem
            {
                Value = "MEX",
                Text = "Mexico",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "CAN",
                Text = "Canada",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "US",
                Text = "USA",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "FR",
                Text = "France",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "ES",
                Text = "Spain",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "DE",
                Text = "Germany",
                Group = EuropeGroup
            }
        };
    }

    public string Country { get; set; }

    public List<SelectListItem> Countries { get; }
}

```

The two groups are shown below:



The generated HTML:

```
<form method="post" action="/Home/IndexGroup">
    <select id="Country" name="Country">
        <optgroup label="North America">
            <option value="MEX">Mexico</option>
            <option value="CAN">Canada</option>
            <option value="US">USA</option>
        </optgroup>
        <optgroup label="Europe">
            <option value="FR">France</option>
            <option value="ES">Spain</option>
            <option value="DE">Germany</option>
        </optgroup>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="removed for brevity" />
</form>
```

## Multiple select

The Select Tag Helper will automatically generate the `multiple = "multiple"` attribute if the property specified in the `asp-for` attribute is an `IEnumerable`. For example, given the following model:

```
using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel : IEnumerable
    {
        public IEnumerable<string> CountryCodes { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
            new SelectListItem { Value = "FR", Text = "France" },
            new SelectListItem { Value = "ES", Text = "Spain" },
            new SelectListItem { Value = "DE", Text = "Germany" }
        };
    }
}
```

With the following view:

```

@model CountryViewModelIEnumarable

<form asp-controller="Home" asp-action="IndexMultiSelect" method="post">
    <select asp-for="CountryCodes" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>

```

Generates the following HTML:

```

<form method="post" action="/Home/IndexMultiSelect">
    <select id="CountryCodes"
        multiple="multiple"
        name="CountryCodes"><option value="MX">Mexico</option>
    <option value="CA">Canada</option>
    <option value="US">USA</option>
    <option value="FR">France</option>
    <option value="ES">Spain</option>
    <option value="DE">Germany</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## No selection

If you find yourself using the "not specified" option in multiple pages, you can create a template to eliminate repeating the HTML:

```

@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    @Html.EditorForModel()
    <br /><button type="submit">Register</button>
</form>

```

The *Views/Shared/EditorTemplates/CountryViewModel.cshtml* template:

```

@model CountryViewModel

<select asp-for="Country" asp-items="Model.Countries">
    <option value="">--none--</option>
</select>

```

Adding HTML `<option>` elements isn't limited to the *No selection* case. For example, the following view and action method will generate HTML similar to the code above:

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

```
@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    <select asp-for="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
</form>
```

The correct `<option>` element will be selected ( contain the `selected="selected"` attribute) depending on the current `Country` value.

```
<form method="post" action="/Home/IndexEmpty">
    <select id="Country" name="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA" selected="selected">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## Additional resources

- [Tag Helpers](#)
- [HTML Form element](#)
- [Request Verification Token](#)
- [Model Binding](#)
- [Model Validation](#)
- [IAttributeAdapter Interface](#)
- [Code snippets for this document](#)

# Partial Tag Helper in ASP.NET Core

7/10/2018 • 3 minutes to read • [Edit Online](#)

By [Scott Addie](#)

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## Overview

The Partial Tag Helper is used for rendering a [partial view](#) in Razor Pages and MVC apps. Consider that it:

- Requires ASP.NET Core 2.1 or later.
- Is an alternative to [HTML Helper syntax](#).
- Renders the partial view asynchronously.

The HTML Helper options for rendering a partial view include:

- [@await Html.PartialAsync](#)
- [@await Html.RenderPartialAsync](#)
- [@Html.Partial](#)
- [@Html.RenderPartial](#)

The *Product* model is used in samples throughout this document:

```
namespace TagHelpersBuiltIn.Models
{
    public class Product
    {
        public int Number { get; set; }

        public string Name { get; set; }

        public string Description { get; set; }
    }
}
```

An inventory of the Partial Tag Helper attributes follows.

### name

The `name` attribute is required. It indicates the name or the path of the partial view to be rendered. When a partial view name is provided, the [view discovery](#) process is initiated. That process is bypassed when an explicit path is provided.

The following markup uses an explicit path, indicating that `_ProductPartial.cshtml` is to be loaded from the `Shared` folder. Using the `for` attribute, a model is passed to the partial view for binding.

```
<partial name="Shared/_ProductPartial.cshtml"
       for="Product" />
```

### for

The `for` attribute assigns a [ModelExpression](#) to be evaluated against the current model. A `ModelExpression` infers the `@Model.` syntax. For example, `for="Product"` can be used instead of `for="@Model.Product"`. This default inference behavior is overridden by using the `@` symbol to define an inline expression. The `for` attribute can't be used with the `model` attribute.

The following markup loads `_ProductPartial.cshtml`:

```
<partial name="_ProductPartial"
        for="Product" />
```

The partial view is bound to the associated page model's `Product` property:

```
using Microsoft.AspNetCore.Mvc.RazorPages;
using TagHelpersBuiltIn.Models;

namespace TagHelpersBuiltIn.Pages
{
    public class ProductModel : PageModel
    {
        public Product Product { get; set; }

        public void OnGet()
        {
            Product = new Product
            {
                Number = 1,
                Name = "Test product",
                Description = "This is a test product"
            };
        }
    }
}
```

## model

The `model` attribute assigns a model instance to pass to the partial view. The `model` attribute can't be used with the `for` attribute.

In the following markup, a new `Product` object is instantiated and passed to the `model` attribute for binding:

```
<partial name="_ProductPartial"
        model='new Product { Number = 1, Name = "Test product", Description = "This is a test" }' />
```

## view-data

The `view-data` attribute assigns a [ViewDataDictionary](#) to pass to the partial view. The following markup makes the entire ViewData collection accessible to the partial view:

```
@{
    ViewData["IsNumberReadOnly"] = true;
}

<partial name="_ProductViewDataPartial"
        for="Product"
        view-data="ViewData" />
```

In the preceding code, the `IsNumberReadOnly` key value is set to `true` and added to the ViewData collection.

Consequently, `ViewData["IsNumberReadOnly"]` is made accessible within the following partial view:

```
@model TagHelpersBuiltIn.Models.Product

<div class="form-group">
    <label asp-for="Number"></label>
    @if ((bool)ViewData["IsNumberReadOnly"])
    {
        <input asp-for="Number" type="number" class="form-control" readonly />
    }
    else
    {
        <input asp-for="Number" type="number" class="form-control" />
    }
</div>
<div class="form-group">
    <label asp-for="Name"></label>
    <input asp-for="Name" type="text" class="form-control" />
</div>
<div class="form-group">
    <label asp-for="Description"></label>
    <textarea asp-for="Description" rows="4" cols="50" class="form-control"></textarea>
</div>
```

In this example, the value of `ViewData["IsNumberReadOnly"]` determines whether the *Number* field is displayed as read only.

## Migrate from an HTML Helper

Consider the following asynchronous HTML Helper example. A collection of products is iterated and displayed. Per the `PartialAsync` method's first parameter, the `_ProductPartial.cshtml` partial view is loaded. An instance of the `Product` model is passed to the partial view for binding.

```
@foreach (var product in Model.Products)
{
    await Html.PartialAsync("_ProductPartial", product)
}
```

The following Partial Tag Helper achieves the same asynchronous rendering behavior as the `PartialAsync` HTML Helper. The `model` attribute is assigned a `Product` model instance for binding to the partial view.

```
@foreach (var product in Model.Products)
{
    <partial name="_ProductPartial" model="product" />
}
```

## Additional resources

- [Partial views in ASP.NET Core](#)
- [Views in ASP.NET Core MVC](#)

# Tag Helpers in forms in ASP.NET Core

6/21/2018 • 17 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [Dave Paquette](#), and [Jerrie Pelser](#)

This document demonstrates working with Forms and the HTML elements commonly used on a Form. The [HTML Form](#) element provides the primary mechanism web apps use to post back data to the server. Most of this document describes [Tag Helpers](#) and how they can help you productively create robust HTML forms. We recommend you read [Introduction to Tag Helpers](#) before you read this document.

In many cases, HTML Helpers provide an alternative approach to a specific Tag Helper, but it's important to recognize that Tag Helpers don't replace HTML Helpers and there's not a Tag Helper for each HTML Helper. When an HTML Helper alternative exists, it's mentioned.

## The Form Tag Helper

The [Form](#) Tag Helper:

- Generates the HTML `<FORM>` `action` attribute value for a MVC controller action or named route
- Generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method)
- Provides the `asp-route-<Parameter Name>` attribute, where `<Parameter Name>` is added to the route values. The `routeValues` parameters to `Html.BeginForm` and `Html.BeginRouteForm` provide similar functionality.
- Has an HTML Helper alternative `Html.BeginForm` and `Html.BeginRouteForm`

Sample:

```
<form asp-controller="Demo" asp-action="Register" method="post">
    <!-- Input and Submit elements -->
</form>
```

The Form Tag Helper above generates the following HTML:

```
<form method="post" action="/Demo/Register">
    <!-- Input and Submit elements -->
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

The MVC runtime generates the `action` attribute value from the Form Tag Helper attributes `asp-controller` and `asp-action`. The Form Tag Helper also generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method). Protecting a pure HTML Form from cross-site request forgery is difficult, the Form Tag Helper provides this service for you.

### Using a named route

The `asp-route` Tag Helper attribute can also generate markup for the HTML `action` attribute. An app with a route named `register` could use the following markup for the registration page:

```
<form asp-route="register" method="post">
    <!-- Input and Submit elements -->
</form>
```

Many of the views in the `Views/Account` folder (generated when you create a new web app with *Individual User Accounts*) contain the `asp-route-returnurl` attribute:

```
<form asp-controller="Account" asp-action="Login"
    asp-route-returnurl="@ViewData["ReturnUrl"]"
    method="post" class="form-horizontal" role="form">
```

#### NOTE

With the built in templates, `returnUrl` is only populated automatically when you try to access an authorized resource but are not authenticated or authorized. When you attempt an unauthorized access, the security middleware redirects you to the login page with the `returnUrl` set.

## The Input Tag Helper

The Input Tag Helper binds an HTML `<input>` element to a model expression in your razor view.

Syntax:

```
<input asp-for="<Expression Name>" />
```

The Input Tag Helper:

- Generates the `id` and `name` HTML attributes for the expression name specified in the `asp-for` attribute. `asp-for="Property1.Property2"` is equivalent to `m => m.Property1.Property2`. The name of the expression is what is used for the `asp-for` attribute value. See the [Expression names](#) section for additional information.
- Sets the HTML `type` attribute value based on the model type and [data annotation](#) attributes applied to the model property
- Won't overwrite the HTML `type` attribute value when one is specified
- Generates [HTML5](#) validation attributes from [data annotation](#) attributes applied to model properties
- Has an HTML Helper feature overlap with `Html.TextBoxFor` and `Html.EditorFor`. See the [HTML Helper alternatives to Input Tag Helper](#) section for details.
- Provides strong typing. If the name of the property changes and you don't update the Tag Helper you'll get an error similar to the following:

```
An error occurred during the compilation of a resource required to process
this request. Please review the following specific error details and modify
your source code appropriately.
```

```
Type expected
'RegisterViewModel' does not contain a definition for 'Email' and no
extension method 'Email' accepting a first argument of type 'RegisterViewModel'
could be found (are you missing a using directive or an assembly reference?)
```

The `Input` Tag Helper sets the HTML `type` attribute based on the .NET type. The following table lists some common .NET types and generated HTML type (not every .NET type is listed).

.NET TYPE	INPUT TYPE
Bool	type="checkbox"
String	type="text"
DateTime	type="datetime"
Byte	type="number"
Int	type="number"
Single, Double	type="number"

The following table shows some common [data annotations](#) attributes that the input tag helper will map to specific input types (not every validation attribute is listed):

ATTRIBUTE	INPUT TYPE
[EmailAddress]	type="email"
[Url]	type="url"
[HiddenInput]	type="hidden"
[Phone]	type="tel"
[DataType(DataType.Password)]	type="password"
[DataType(DataType.Date)]	type="date"
[DataType(DataType.Time)]	type="time"

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}
```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterInput" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    <button type="submit">Register</button>
</form>

```

The code above generates the following HTML:

```

<form method="post" action="/Demo/RegisterInput">
    Email:
    <input type="email" data-val="true"
           data-val-email="The Email Address field is not a valid email address."
           data-val-required="The Email Address field is required."
           id="Email" name="Email" value="" /> <br>
    Password:
    <input type="password" data-val="true"
           data-val-required="The Password field is required."
           id="Password" name="Password" /><br>
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

The data annotations applied to the `Email` and `Password` properties generate metadata on the model. The Input Tag Helper consumes the model metadata and produces [HTML5](#) `data-val-*` attributes (see [Model Validation](#)). These attributes describe the validators to attach to the input fields. This provides unobtrusive HTML5 and [jQuery](#) validation. The unobtrusive attributes have the format `data-val-rule="Error Message"`, where rule is the name of the validation rule (such as `data-val-required`, `data-val-email`, `data-val-maxlength`, etc.) If an error message is provided in the attribute, it's displayed as the value for the `data-val-rule` attribute. There are also attributes of the form `data-val-ruleName-argumentName="argumentValue"` that provide additional details about the rule, for example, `data-val-maxlength-max="1024"`.

## HTML Helper alternatives to Input Tag Helper

`Html.TextBox`, `Html.TextBoxFor`, `Html.Editor` and `Html.EditorFor` have overlapping features with the Input Tag Helper. The Input Tag Helper will automatically set the `type` attribute; `Html.TextBox` and `Html.TextBoxFor` won't. `Html.Editor` and `Html.EditorFor` handle collections, complex objects and templates; the Input Tag Helper doesn't. The Input Tag Helper, `Html.EditorFor` and `Html.TextBoxFor` are strongly typed (they use lambda expressions); `Html.TextBox` and `Html.Editor` are not (they use expression names).

## HtmlAttributes

`@Html.Editor()` and `@Html.EditorFor()` use a special `ViewDataDictionary` entry named `htmlAttributes` when executing their default templates. This behavior is optionally augmented using `additional ViewData` parameters. The key "htmlAttributes" is case-insensitive. The key "htmlAttributes" is handled similarly to the `htmlAttributes` object passed to input helpers like `@Html.TextBox()`.

```

@Html.EditorFor(model => model.YourProperty,
    new { htmlAttributes = new { @class="myCssClass", style="Width:100px" } })

```

## Expression names

The `asp-for` attribute value is a `ModelExpression` and the right hand side of a lambda expression. Therefore, `asp-for="Property1"` becomes `m => m.Property1` in the generated code which is why you don't need to prefix with `Model`. You can use the "@" character to start an inline expression and move before the `m`:

```
@{
    var joe = "Joe";
}
<input asp-for="@joe" />
```

Generates the following:

```
<input type="text" id="joe" name="joe" value="Joe" />
```

With collection properties, `asp-for="CollectionProperty[23].Member"` generates the same name as `asp-for="CollectionProperty[i].Member"` when `i` has the value `23`.

When ASP.NET Core MVC calculates the value of `ModelExpression`, it inspects several sources, including `ModelState`. Consider `<input type="text" asp-for="@Name" />`. The calculated `value` attribute is the first non-null value from:

- `ModelState` entry with key "Name".
- Result of the expression `Model.Name`.

### Navigating child properties

You can also navigate to child properties using the property path of the view model. Consider a more complex model class that contains a child `Address` property.

```
public class AddressViewModel
{
    public string AddressLine1 { get; set; }
}
```

```
public class RegisterAddressViewModel
{
    public string Email { get; set; }

    [DataType(DataType.Password)]
    public string Password { get; set; }

    public AddressViewModel Address { get; set; }
}
```

In the view, we bind to `Address.AddressLine1`:

```
@model RegisterAddressViewModel

<form asp-controller="Demo" asp-action="RegisterAddress" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    Address: <input asp-for="Address.AddressLine1" /><br />
    <button type="submit">Register</button>
</form>
```

The following HTML is generated for `Address.AddressLine1`:

```
<input type="text" id="Address_AddressLine1" name="Address.AddressLine1" value="" />
```

## Expression names and Collections

Sample, a model containing an array of `Colors`:

```
public class Person
{
    public List<string> Colors { get; set; }

    public int Age { get; set; }
}
```

The action method:

```
public IActionResult Edit(int id, int colorIndex)
{
    ViewData["Index"] = colorIndex;
    return View(GetPerson(id));
}
```

The following Razor shows how you access a specific `Color` element:

```
@model Person
 @{
    var index = (int)ViewData["index"];
}

<form asp-controller="ToDo" asp-action="Edit" method="post">
    @Html.EditorFor(m => m.Colors[index])
    <label asp-for="Age"></label>
    <input asp-for="Age" /><br />
    <button type="submit">Post</button>
</form>
```

The *Views/Shared/EditorTemplates/String.cshtml* template:

```
@model string

<label asp-for="@Model"></label>
<input asp-for="@Model" /> <br />
```

Sample using `List<T>`:

```
public class ToDoItem
{
    public string Name { get; set; }

    public bool IsDone { get; set; }
}
```

The following Razor shows how to iterate over a collection:

```

@model List<ToDoItem>

<form asp-controller="ToDo" asp-action="Edit" method="post">
    <table>
        <tr> <th>Name</th> <th>Is Done</th> </tr>

        @for (int i = 0; i < Model.Count; i++)
        {
            <tr>
                @Html.EditorFor(model => model[i])
            </tr>
        }

    </table>
    <button type="submit">Save</button>
</form>

```

The *Views/Shared/EditorTemplates/ToDoItem.cshtml* template:

```

@model ToDoItem

<td>
    <label asp-for="@Model.Name"></label>
    @Html.DisplayFor(model => model.Name)
</td>
<td>
    <input asp-for="@Model.IsDone" />
</td>



```

#### NOTE

Always use `for` (and *not* `foreach`) to iterate over a list. Evaluating an indexer in a LINQ expression can be expensive and should be minimized.

#### NOTE

The commented sample code above shows how you would replace the lambda expression with the `@` operator to access each `ToDoItem` in the list.

## The Textarea Tag Helper

The `Textarea Tag Helper` tag helper is similar to the Input Tag Helper.

- Generates the `id` and `name` attributes, and the data validation attributes from the model for a `<textarea>` element.

- Provides strong typing.
- HTML Helper alternative: `Html.TextAreaFor`

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class DescriptionViewModel
    {
        [MinLength(5)]
        [MaxLength(1024)]
        public string Description { get; set; }
    }
}
```

```
@model DescriptionViewModel

<form asp-controller="Demo" asp-action="RegisterTextArea" method="post">
    <textarea asp-for="Description"></textarea>
    <button type="submit">Test</button>
</form>
```

The following HTML is generated:

```
<form method="post" action="/Demo/RegisterTextArea">
    <textarea data-val="true"
              data-val-maxlength="The field Description must be a string or array type with a maximum length of
              &#x27;1024&#x27;;."
              data-val-maxlength-max="1024"
              data-val-minlength="The field Description must be a string or array type with a minimum length of
              &#x27;5&#x27;;."
              data-val-minlength-min="5"
              id="Description" name="Description">
    </textarea>
    <button type="submit">Test</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## The Label Tag Helper

- Generates the label caption and `for` attribute on a element for an expression name
- HTML Helper alternative: `Html.LabelFor`.

The `Label Tag Helper` provides the following benefits over a pure HTML label element:

- You automatically get the descriptive label value from the `Display` attribute. The intended display name might change over time, and the combination of `Display` attribute and Label Tag Helper will apply the `Display` everywhere it's used.
- Less markup in source code
- Strong typing with the model property.

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class SimpleViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }
    }
}
```

```
@model SimpleViewModel

<form asp-controller="Demo" asp-action="RegisterLabel" method="post">
    <label asp-for="Email"></label>
    <input asp-for="Email" /> <br />
</form>
```

The following HTML is generated for the `<label>` element:

```
<label for="Email">Email Address</label>
```

The Label Tag Helper generated the `for` attribute value of "Email", which is the ID associated with the `<input>` element. The Tag Helpers generate consistent `id` and `for` elements so they can be correctly associated. The caption in this sample comes from the `Display` attribute. If the model didn't contain a `Display` attribute, the caption would be the property name of the expression.

## The Validation Tag Helpers

There are two Validation Tag Helpers. The `Validation Message Tag Helper` (which displays a validation message for a single property on your model), and the `Validation Summary Tag Helper` (which displays a summary of validation errors). The `Input Tag Helper` adds HTML5 client side validation attributes to input elements based on data annotation attributes on your model classes. Validation is also performed on the server. The Validation Tag Helper displays these error messages when a validation error occurs.

### The Validation Message Tag Helper

- Adds the `HTML5` `data-valmsg-for="property"` attribute to the `span` element, which attaches the validation error messages on the input field of the specified model property. When a client side validation error occurs, `jQuery` displays the error message in the `<span>` element.
- Validation also takes place on the server. Clients may have JavaScript disabled and some validation can only be done on the server side.
- HTML Helper alternative: `Html.ValidationMessageFor`

The `Validation Message Tag Helper` is used with the `asp-validation-for` attribute on a HTML `span` element.

```
<span asp-validation-for="Email"></span>
```

The Validation Message Tag Helper will generate the following HTML:

```
<span class="field-validation-valid"  
      data-valmsg-for="Email"  
      data-valmsg-replace="true"></span>
```

You generally use the `Validation Message Tag Helper` after an `Input` Tag Helper for the same property. Doing so displays any validation error messages near the input that caused the error.

#### NOTE

You must have a view with the correct JavaScript and [jQuery](#) script references in place for client side validation. See [Model Validation](#) for more information.

When a server side validation error occurs (for example when you have custom server side validation or client-side validation is disabled), MVC places that error message as the body of the `<span>` element.

```
<span class="field-validation-error" data-valmsg-for="Email"  
      data-valmsg-replace="true">  
    The Email Address field is required.  
</span>
```

### The Validation Summary Tag Helper

- Targets `<div>` elements with the `asp-validation-summary` attribute
- HTML Helper alternative: `@Html.ValidationSummary`

The `Validation Summary Tag Helper` is used to display a summary of validation messages. The `asp-validation-summary` attribute value can be any of the following:

ASP-VALIDATION-SUMMARY	VALIDATION MESSAGES DISPLAYED
ValidationSummary.All	Property and model level
ValidationSummary.ModelOnly	Model
ValidationSummary.None	None

### Sample

In the following example, the data model is decorated with `DataAnnotation` attributes, which generates validation error messages on the `<input>` element. When a validation error occurs, the Validation Tag Helper displays the error message:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}

```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterValidation" method="post">
    <div asp-validation-summary="ModelOnly"></div>
    Email: <input asp-for="Email" /> <br />
    <span asp-validation-for="Email"></span><br />
    Password: <input asp-for="Password" /><br />
    <span asp-validation-for="Password"></span><br />
    <button type="submit">Register</button>
</form>

```

The generated HTML (when the model is valid):

```

<form action="/DemoReg/Register" method="post">
    <div class="validation-summary-valid" data-valmsg-summary="true">
        <ul><li style="display:none"></li></ul></div>
    Email: <input name="Email" id="Email" type="email" value="" data-val-required="The Email field is required." data-val-email="The Email field is not a valid email address." data-val="true"> <br />
    <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Email"></span><br />
    Password: <input name="Password" id="Password" type="password" data-val-required="The Password field is required." data-val="true"><br />
    <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Password"></span><br />
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## The Select Tag Helper

- Generates `select` and associated `option` elements for properties of your model.
- Has an HTML Helper alternative `Html.DropDownListFor` and `Html.ListBoxFor`

The `Select Tag Helper` `asp-for` specifies the model property name for the `select` element and `asp-items` specifies the `option` elements. For example:

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

Sample:

```

using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel
    {
        public string Country { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
        };
    }
}

```

The `Index` method initializes the `CountryViewModel`, sets the selected country and passes it to the `Index` view.

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

The HTTP POST `Index` method displays the selection:

```

[HttpPost]
[ValidateAntiForgeryToken]
public IActionResult Index(CountryViewModel model)
{
    if (ModelState.IsValid)
    {
        var msg = model.Country + " selected";
        return RedirectToAction("IndexSuccess", new { message = msg });
    }

    // If we got this far, something failed; redisplay form.
    return View(model);
}

```

The `Index` view:

```

@model CountryViewModel

<form asp-controller="Home" asp-action="Index" method="post">
    <select asp-for="Country" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>

```

Which generates the following HTML (with "CA" selected):

```
<form method="post" action="/">
    <select id="Country" name="Country">
        <option value="MX">Mexico</option>
        <option selected="selected" value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## NOTE

We don't recommend using `ViewBag` or `ViewData` with the Select Tag Helper. A view model is more robust at providing MVC metadata and generally less problematic.

The `asp-for` attribute value is a special case and doesn't require a `Model` prefix, the other Tag Helper attributes do (such as `asp-items`)

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

## Enum binding

It's often convenient to use `<select>` with an `enum` property and generate the `SelectListItem` elements from the `enum` values.

Sample:

```
public class CountryEnumViewModel
{
    public CountryEnum EnumCountry { get; set; }
}
```

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}
```

The `GetEnumSelectList` method generates a `SelectList` object for an enum.

```

@model CountryEnumViewModel

<form asp-controller="Home" asp-action="IndexEnum" method="post">
    <select asp-for="EnumCountry"
        asp-items="Html.GetEnumSelectList<CountryEnum>()" >
    </select>
    <br /><button type="submit">Register</button>
</form>

```

You can decorate your enumerator list with the `Display` attribute to get a richer UI:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}

```

The following HTML is generated:

```

<form method="post" action="/Home/IndexEnum">
    <select data-val="true" data-val-required="The EnumCountry field is required."
        id="EnumCountry" name="EnumCountry">
        <option value="0">United Mexican States</option>
        <option value="1">United States of America</option>
        <option value="2">Canada</option>
        <option value="3">France</option>
        <option value="4">Germany</option>
        <option selected="selected" value="5">Spain</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## Option Group

The HTML `<optgroup>` element is generated when the view model contains one or more `SelectListGroup` objects.

The `CountryViewModelGroup` groups the `SelectListItem` elements into the "North America" and "Europe" groups:

```

public class CountryViewModelGroup
{
    public CountryViewModelGroup()
    {
        var NorthAmericaGroup = new SelectListGroup { Name = "North America" };
        var EuropeGroup = new SelectListGroup { Name = "Europe" };

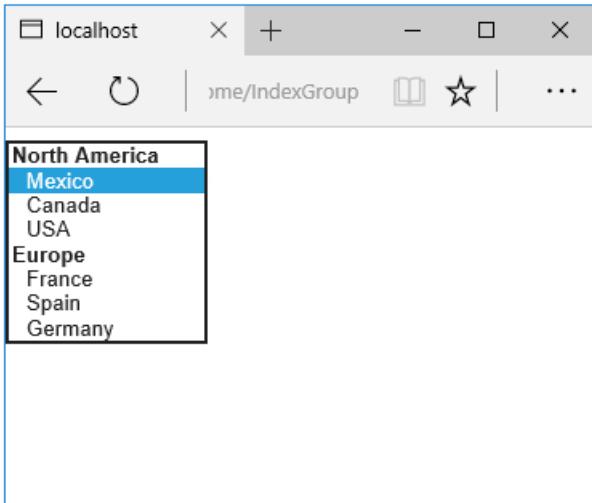
        Countries = new List<SelectListItem>
        {
            new SelectListItem
            {
                Value = "MEX",
                Text = "Mexico",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "CAN",
                Text = "Canada",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "US",
                Text = "USA",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "FR",
                Text = "France",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "ES",
                Text = "Spain",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "DE",
                Text = "Germany",
                Group = EuropeGroup
            }
        };
    }

    public string Country { get; set; }

    public List<SelectListItem> Countries { get; }
}

```

The two groups are shown below:



The generated HTML:

```
<form method="post" action="/Home/IndexGroup">
    <select id="Country" name="Country">
        <optgroup label="North America">
            <option value="MEX">Mexico</option>
            <option value="CAN">Canada</option>
            <option value="US">USA</option>
        </optgroup>
        <optgroup label="Europe">
            <option value="FR">France</option>
            <option value="ES">Spain</option>
            <option value="DE">Germany</option>
        </optgroup>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="removed for brevity" />
</form>
```

## Multiple select

The Select Tag Helper will automatically generate the `multiple = "multiple"` attribute if the property specified in the `asp-for` attribute is an `IEnumerable`. For example, given the following model:

```
using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel : IEnumerable
    {
        public IEnumerable<string> CountryCodes { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
            new SelectListItem { Value = "FR", Text = "France" },
            new SelectListItem { Value = "ES", Text = "Spain" },
            new SelectListItem { Value = "DE", Text = "Germany" }
        };
    }
}
```

With the following view:

```

@model CountryViewModelIEnumarable

<form asp-controller="Home" asp-action="IndexMultiSelect" method="post">
    <select asp-for="CountryCodes" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>

```

Generates the following HTML:

```

<form method="post" action="/Home/IndexMultiSelect">
    <select id="CountryCodes"
        multiple="multiple"
        name="CountryCodes"><option value="MX">Mexico</option>
    <option value="CA">Canada</option>
    <option value="US">USA</option>
    <option value="FR">France</option>
    <option value="ES">Spain</option>
    <option value="DE">Germany</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## No selection

If you find yourself using the "not specified" option in multiple pages, you can create a template to eliminate repeating the HTML:

```

@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    @Html.EditorForModel()
    <br /><button type="submit">Register</button>
</form>

```

The *Views/Shared/EditorTemplates/CountryViewModel.cshtml* template:

```

@model CountryViewModel

<select asp-for="Country" asp-items="Model.Countries">
    <option value="">--none--</option>
</select>

```

Adding HTML `<option>` elements isn't limited to the *No selection* case. For example, the following view and action method will generate HTML similar to the code above:

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

```
@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    <select asp-for="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
</form>
```

The correct `<option>` element will be selected ( contain the `selected="selected"` attribute) depending on the current `Country` value.

```
<form method="post" action="/Home/IndexEmpty">
    <select id="Country" name="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA" selected="selected">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## Additional resources

- [Tag Helpers](#)
- [HTML Form element](#)
- [Request Verification Token](#)
- [Model Binding](#)
- [Model Validation](#)
- [IAttributeAdapter Interface](#)
- [Code snippets for this document](#)

# Tag Helpers in forms in ASP.NET Core

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By [Rick Anderson](#), [Dave Paquette](#), and [Jerrie Pelser](#)

This document demonstrates working with Forms and the HTML elements commonly used on a Form. The [HTML Form](#) element provides the primary mechanism web apps use to post back data to the server. Most of this document describes [Tag Helpers](#) and how they can help you productively create robust HTML forms. We recommend you read [Introduction to Tag Helpers](#) before you read this document.

In many cases, HTML Helpers provide an alternative approach to a specific Tag Helper, but it's important to recognize that Tag Helpers don't replace HTML Helpers and there's not a Tag Helper for each HTML Helper. When an HTML Helper alternative exists, it's mentioned.

## The Form Tag Helper

The [Form](#) Tag Helper:

- Generates the HTML `<FORM>` `action` attribute value for a MVC controller action or named route
- Generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method)
- Provides the `asp-route-<Parameter Name>` attribute, where `<Parameter Name>` is added to the route values. The `routeValues` parameters to `Html.BeginForm` and `Html.BeginRouteForm` provide similar functionality.
- Has an HTML Helper alternative `Html.BeginForm` and `Html.BeginRouteForm`

Sample:

```
<form asp-controller="Demo" asp-action="Register" method="post">
    <!-- Input and Submit elements -->
</form>
```

The Form Tag Helper above generates the following HTML:

```
<form method="post" action="/Demo/Register">
    <!-- Input and Submit elements -->
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

The MVC runtime generates the `action` attribute value from the Form Tag Helper attributes `asp-controller` and `asp-action`. The Form Tag Helper also generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method). Protecting a pure HTML Form from cross-site request forgery is difficult, the Form Tag Helper provides this service for you.

### Using a named route

The `asp-route` Tag Helper attribute can also generate markup for the HTML `action` attribute. An app with a route named `register` could use the following markup for the registration page:

```
<form asp-route="register" method="post">
    <!-- Input and Submit elements -->
</form>
```

Many of the views in the `Views/Account` folder (generated when you create a new web app with *Individual User Accounts*) contain the `asp-route-returnurl` attribute:

```
<form asp-controller="Account" asp-action="Login"
    asp-route-returnurl="@ViewData["ReturnUrl"]"
    method="post" class="form-horizontal" role="form">
```

#### NOTE

With the built in templates, `returnUrl` is only populated automatically when you try to access an authorized resource but are not authenticated or authorized. When you attempt an unauthorized access, the security middleware redirects you to the login page with the `returnUrl` set.

## The Input Tag Helper

The Input Tag Helper binds an HTML `<input>` element to a model expression in your razor view.

Syntax:

```
<input asp-for="<Expression Name>" />
```

The Input Tag Helper:

- Generates the `id` and `name` HTML attributes for the expression name specified in the `asp-for` attribute. `asp-for="Property1.Property2"` is equivalent to `m => m.Property1.Property2`. The name of the expression is what is used for the `asp-for` attribute value. See the [Expression names](#) section for additional information.
- Sets the HTML `type` attribute value based on the model type and [data annotation](#) attributes applied to the model property
- Won't overwrite the HTML `type` attribute value when one is specified
- Generates [HTML5](#) validation attributes from [data annotation](#) attributes applied to model properties
- Has an HTML Helper feature overlap with `Html.TextBoxFor` and `Html.EditorFor`. See the [HTML Helper alternatives to Input Tag Helper](#) section for details.
- Provides strong typing. If the name of the property changes and you don't update the Tag Helper you'll get an error similar to the following:

```
An error occurred during the compilation of a resource required to process
this request. Please review the following specific error details and modify
your source code appropriately.
```

```
Type expected
'RegisterViewModel' does not contain a definition for 'Email' and no
extension method 'Email' accepting a first argument of type 'RegisterViewModel'
could be found (are you missing a using directive or an assembly reference?)
```

The `Input` Tag Helper sets the HTML `type` attribute based on the .NET type. The following table lists some common .NET types and generated HTML type (not every .NET type is listed).

.NET TYPE	INPUT TYPE
Bool	type="checkbox"
String	type="text"
DateTime	type="datetime"
Byte	type="number"
Int	type="number"
Single, Double	type="number"

The following table shows some common [data annotations](#) attributes that the input tag helper will map to specific input types (not every validation attribute is listed):

ATTRIBUTE	INPUT TYPE
[EmailAddress]	type="email"
[Url]	type="url"
[HiddenInput]	type="hidden"
[Phone]	type="tel"
[DataType(DataType.Password)]	type="password"
[DataType(DataType.Date)]	type="date"
[DataType(DataType.Time)]	type="time"

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}
```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterInput" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    <button type="submit">Register</button>
</form>

```

The code above generates the following HTML:

```

<form method="post" action="/Demo/RegisterInput">
    Email:
    <input type="email" data-val="true"
           data-val-email="The Email Address field is not a valid email address."
           data-val-required="The Email Address field is required."
           id="Email" name="Email" value="" /> <br>
    Password:
    <input type="password" data-val="true"
           data-val-required="The Password field is required."
           id="Password" name="Password" /><br>
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

The data annotations applied to the `Email` and `Password` properties generate metadata on the model. The Input Tag Helper consumes the model metadata and produces [HTML5](#) `data-val-*` attributes (see [Model Validation](#)). These attributes describe the validators to attach to the input fields. This provides unobtrusive HTML5 and [jQuery](#) validation. The unobtrusive attributes have the format `data-val-rule="Error Message"`, where rule is the name of the validation rule (such as `data-val-required`, `data-val-email`, `data-val-maxlength`, etc.) If an error message is provided in the attribute, it's displayed as the value for the `data-val-rule` attribute. There are also attributes of the form `data-val-ruleName-argumentName="argumentValue"` that provide additional details about the rule, for example, `data-val-maxlength-max="1024"`.

## HTML Helper alternatives to Input Tag Helper

`Html.TextBox`, `Html.TextBoxFor`, `Html.Editor` and `Html.EditorFor` have overlapping features with the Input Tag Helper. The Input Tag Helper will automatically set the `type` attribute; `Html.TextBox` and `Html.TextBoxFor` won't. `Html.Editor` and `Html.EditorFor` handle collections, complex objects and templates; the Input Tag Helper doesn't. The Input Tag Helper, `Html.EditorFor` and `Html.TextBoxFor` are strongly typed (they use lambda expressions); `Html.TextBox` and `Html.Editor` are not (they use expression names).

## HtmlAttributes

`@Html.Editor()` and `@Html.EditorFor()` use a special `ViewDataDictionary` entry named `htmlAttributes` when executing their default templates. This behavior is optionally augmented using `additional ViewData` parameters. The key "htmlAttributes" is case-insensitive. The key "htmlAttributes" is handled similarly to the `htmlAttributes` object passed to input helpers like `@Html.TextBox()`.

```

@Html.EditorFor(model => model.YourProperty,
    new { htmlAttributes = new { @class="myCssClass", style="Width:100px" } })

```

## Expression names

The `asp-for` attribute value is a `ModelExpression` and the right hand side of a lambda expression. Therefore, `asp-for="Property1"` becomes `m => m.Property1` in the generated code which is why you don't need to prefix with `Model`. You can use the "@" character to start an inline expression and move before the `m`:

```
@{
    var joe = "Joe";
}
<input asp-for="@joe" />
```

Generates the following:

```
<input type="text" id="joe" name="joe" value="Joe" />
```

With collection properties, `asp-for="CollectionProperty[23].Member"` generates the same name as `asp-for="CollectionProperty[i].Member"` when `i` has the value `23`.

When ASP.NET Core MVC calculates the value of `ModelExpression`, it inspects several sources, including `ModelState`. Consider `<input type="text" asp-for="@Name" />`. The calculated `value` attribute is the first non-null value from:

- `ModelState` entry with key "Name".
- Result of the expression `Model.Name`.

### Navigating child properties

You can also navigate to child properties using the property path of the view model. Consider a more complex model class that contains a child `Address` property.

```
public class AddressViewModel
{
    public string AddressLine1 { get; set; }
}
```

```
public class RegisterAddressViewModel
{
    public string Email { get; set; }

    [DataType(DataType.Password)]
    public string Password { get; set; }

    public AddressViewModel Address { get; set; }
}
```

In the view, we bind to `Address.AddressLine1`:

```
@model RegisterAddressViewModel

<form asp-controller="Demo" asp-action="RegisterAddress" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    Address: <input asp-for="Address.AddressLine1" /><br />
    <button type="submit">Register</button>
</form>
```

The following HTML is generated for `Address.AddressLine1`:

```
<input type="text" id="Address_AddressLine1" name="Address.AddressLine1" value="" />
```

## Expression names and Collections

Sample, a model containing an array of `Colors`:

```
public class Person
{
    public List<string> Colors { get; set; }

    public int Age { get; set; }
}
```

The action method:

```
public IActionResult Edit(int id, int colorIndex)
{
    ViewData["Index"] = colorIndex;
    return View(GetPerson(id));
}
```

The following Razor shows how you access a specific `Color` element:

```
@model Person
 @{
    var index = (int)ViewData["index"];
}

<form asp-controller="ToDo" asp-action="Edit" method="post">
    @Html.EditorFor(m => m.Colors[index])
    <label asp-for="Age"></label>
    <input asp-for="Age" /><br />
    <button type="submit">Post</button>
</form>
```

The *Views/Shared/EditorTemplates/String.cshtml* template:

```
@model string

<label asp-for="@Model"></label>
<input asp-for="@Model" /> <br />
```

Sample using `List<T>`:

```
public class ToDoItem
{
    public string Name { get; set; }

    public bool IsDone { get; set; }
}
```

The following Razor shows how to iterate over a collection:

```

@model List<ToDoItem>

<form asp-controller="ToDo" asp-action="Edit" method="post">
    <table>
        <tr> <th>Name</th> <th>Is Done</th> </tr>

        @for (int i = 0; i < Model.Count; i++)
        {
            <tr>
                @Html.EditorFor(model => model[i])
            </tr>
        }

    </table>
    <button type="submit">Save</button>
</form>

```

The *Views/Shared/EditorTemplates/ToDoItem.cshtml* template:

```

@model ToDoItem

<td>
    <label asp-for="@Model.Name"></label>
    @Html.DisplayFor(model => model.Name)
</td>
<td>
    <input asp-for="@Model.IsDone" />
</td>



```

#### NOTE

Always use `for` (and *not* `foreach`) to iterate over a list. Evaluating an indexer in a LINQ expression can be expensive and should be minimized.

#### NOTE

The commented sample code above shows how you would replace the lambda expression with the `@` operator to access each `ToDoItem` in the list.

## The Textarea Tag Helper

The `Textarea Tag Helper` tag helper is similar to the Input Tag Helper.

- Generates the `id` and `name` attributes, and the data validation attributes from the model for a `<textarea>` element.

- Provides strong typing.
- HTML Helper alternative: `Html.TextAreaFor`

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class DescriptionViewModel
    {
        [MinLength(5)]
        [MaxLength(1024)]
        public string Description { get; set; }
    }
}
```

```
@model DescriptionViewModel

<form asp-controller="Demo" asp-action="RegisterTextArea" method="post">
    <textarea asp-for="Description"></textarea>
    <button type="submit">Test</button>
</form>
```

The following HTML is generated:

```
<form method="post" action="/Demo/RegisterTextArea">
    <textarea data-val="true"
              data-val-maxlength="The field Description must be a string or array type with a maximum length of
              &#x27;1024&#x27;;."
              data-val-maxlength-max="1024"
              data-val-minlength="The field Description must be a string or array type with a minimum length of
              &#x27;5&#x27;;."
              data-val-minlength-min="5"
              id="Description" name="Description">
    </textarea>
    <button type="submit">Test</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## The Label Tag Helper

- Generates the label caption and `for` attribute on a element for an expression name
- HTML Helper alternative: `Html.LabelFor`.

The `Label Tag Helper` provides the following benefits over a pure HTML label element:

- You automatically get the descriptive label value from the `Display` attribute. The intended display name might change over time, and the combination of `Display` attribute and Label Tag Helper will apply the `Display` everywhere it's used.
- Less markup in source code
- Strong typing with the model property.

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class SimpleViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }
    }
}
```

```
@model SimpleViewModel

<form asp-controller="Demo" asp-action="RegisterLabel" method="post">
    <label asp-for="Email"></label>
    <input asp-for="Email" /> <br />
</form>
```

The following HTML is generated for the `<label>` element:

```
<label for="Email">Email Address</label>
```

The Label Tag Helper generated the `for` attribute value of "Email", which is the ID associated with the `<input>` element. The Tag Helpers generate consistent `id` and `for` elements so they can be correctly associated. The caption in this sample comes from the `Display` attribute. If the model didn't contain a `Display` attribute, the caption would be the property name of the expression.

## The Validation Tag Helpers

There are two Validation Tag Helpers. The `Validation Message Tag Helper` (which displays a validation message for a single property on your model), and the `Validation Summary Tag Helper` (which displays a summary of validation errors). The `Input Tag Helper` adds HTML5 client side validation attributes to input elements based on data annotation attributes on your model classes. Validation is also performed on the server. The Validation Tag Helper displays these error messages when a validation error occurs.

### The Validation Message Tag Helper

- Adds the `HTML5` `data-valmsg-for="property"` attribute to the `span` element, which attaches the validation error messages on the input field of the specified model property. When a client side validation error occurs, `jQuery` displays the error message in the `<span>` element.
- Validation also takes place on the server. Clients may have JavaScript disabled and some validation can only be done on the server side.
- HTML Helper alternative: `Html.ValidationMessageFor`

The `Validation Message Tag Helper` is used with the `asp-validation-for` attribute on a HTML `span` element.

```
<span asp-validation-for="Email"></span>
```

The Validation Message Tag Helper will generate the following HTML:

```
<span class="field-validation-valid"  
      data-valmsg-for="Email"  
      data-valmsg-replace="true"></span>
```

You generally use the `Validation Message Tag Helper` after an `Input` Tag Helper for the same property. Doing so displays any validation error messages near the input that caused the error.

#### NOTE

You must have a view with the correct JavaScript and [jQuery](#) script references in place for client side validation. See [Model Validation](#) for more information.

When a server side validation error occurs (for example when you have custom server side validation or client-side validation is disabled), MVC places that error message as the body of the `<span>` element.

```
<span class="field-validation-error" data-valmsg-for="Email"  
      data-valmsg-replace="true">  
    The Email Address field is required.  
</span>
```

### The Validation Summary Tag Helper

- Targets `<div>` elements with the `asp-validation-summary` attribute
- HTML Helper alternative: `@Html.ValidationSummary`

The `Validation Summary Tag Helper` is used to display a summary of validation messages. The `asp-validation-summary` attribute value can be any of the following:

ASP-VALIDATION-SUMMARY	VALIDATION MESSAGES DISPLAYED
ValidationSummary.All	Property and model level
ValidationSummary.ModelOnly	Model
ValidationSummary.None	None

### Sample

In the following example, the data model is decorated with `DataAnnotation` attributes, which generates validation error messages on the `<input>` element. When a validation error occurs, the Validation Tag Helper displays the error message:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}

```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterValidation" method="post">
    <div asp-validation-summary="ModelOnly"></div>
    Email: <input asp-for="Email" /> <br />
    <span asp-validation-for="Email"></span><br />
    Password: <input asp-for="Password" /><br />
    <span asp-validation-for="Password"></span><br />
    <button type="submit">Register</button>
</form>

```

The generated HTML (when the model is valid):

```

<form action="/DemoReg/Register" method="post">
    <div class="validation-summary-valid" data-valmsg-summary="true">
        <ul><li style="display:none"></li></ul></div>
    Email: <input name="Email" id="Email" type="email" value="" data-val-required="The Email field is required." data-val-email="The Email field is not a valid email address." data-val="true"> <br />
    <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Email"></span><br />
    Password: <input name="Password" id="Password" type="password" data-val-required="The Password field is required." data-val="true"><br />
    <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Password"></span><br />
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## The Select Tag Helper

- Generates `select` and associated `option` elements for properties of your model.
- Has an HTML Helper alternative `Html.DropDownListFor` and `Html.ListBoxFor`

The `Select Tag Helper` `asp-for` specifies the model property name for the `select` element and `asp-items` specifies the `option` elements. For example:

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

Sample:

```

using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel
    {
        public string Country { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
        };
    }
}

```

The `Index` method initializes the `CountryViewModel`, sets the selected country and passes it to the `Index` view.

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

The HTTP POST `Index` method displays the selection:

```

[HttpPost]
[ValidateAntiForgeryToken]
public IActionResult Index(CountryViewModel model)
{
    if (ModelState.IsValid)
    {
        var msg = model.Country + " selected";
        return RedirectToAction("IndexSuccess", new { message = msg });
    }

    // If we got this far, something failed; redisplay form.
    return View(model);
}

```

The `Index` view:

```

@model CountryViewModel

<form asp-controller="Home" asp-action="Index" method="post">
    <select asp-for="Country" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>

```

Which generates the following HTML (with "CA" selected):

```
<form method="post" action="/">
    <select id="Country" name="Country">
        <option value="MX">Mexico</option>
        <option selected="selected" value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## NOTE

We don't recommend using `ViewBag` or `ViewData` with the Select Tag Helper. A view model is more robust at providing MVC metadata and generally less problematic.

The `asp-for` attribute value is a special case and doesn't require a `Model` prefix, the other Tag Helper attributes do (such as `asp-items`)

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

## Enum binding

It's often convenient to use `<select>` with an `enum` property and generate the `SelectListItem` elements from the `enum` values.

Sample:

```
public class CountryEnumViewModel
{
    public CountryEnum EnumCountry { get; set; }
}
```

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}
```

The `GetEnumSelectList` method generates a `SelectList` object for an enum.

```

@model CountryEnumViewModel

<form asp-controller="Home" asp-action="IndexEnum" method="post">
    <select asp-for="EnumCountry"
        asp-items="Html.GetEnumSelectList<CountryEnum>()" >
    </select>
    <br /><button type="submit">Register</button>
</form>

```

You can decorate your enumerator list with the `Display` attribute to get a richer UI:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}

```

The following HTML is generated:

```

<form method="post" action="/Home/IndexEnum">
    <select data-val="true" data-val-required="The EnumCountry field is required."
        id="EnumCountry" name="EnumCountry">
        <option value="0">United Mexican States</option>
        <option value="1">United States of America</option>
        <option value="2">Canada</option>
        <option value="3">France</option>
        <option value="4">Germany</option>
        <option selected="selected" value="5">Spain</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## Option Group

The HTML `<optgroup>` element is generated when the view model contains one or more `SelectListGroup` objects.

The `CountryViewModelGroup` groups the `SelectListItem` elements into the "North America" and "Europe" groups:

```

public class CountryViewModelGroup
{
    public CountryViewModelGroup()
    {
        var NorthAmericaGroup = new SelectListGroup { Name = "North America" };
        var EuropeGroup = new SelectListGroup { Name = "Europe" };

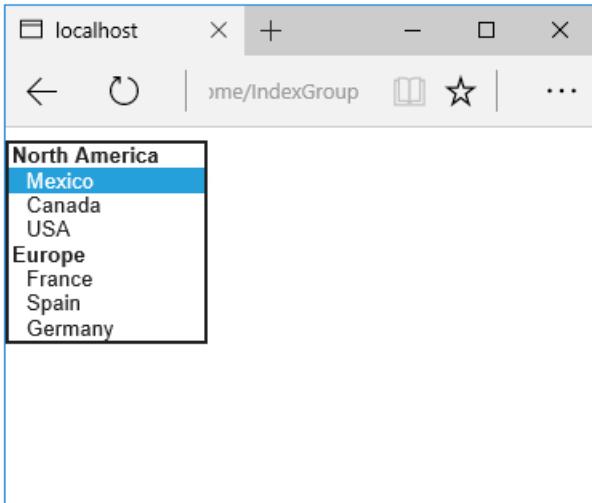
        Countries = new List<SelectListItem>
        {
            new SelectListItem
            {
                Value = "MEX",
                Text = "Mexico",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "CAN",
                Text = "Canada",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "US",
                Text = "USA",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "FR",
                Text = "France",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "ES",
                Text = "Spain",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "DE",
                Text = "Germany",
                Group = EuropeGroup
            }
        };
    }

    public string Country { get; set; }

    public List<SelectListItem> Countries { get; }
}

```

The two groups are shown below:



The generated HTML:

```
<form method="post" action="/Home/IndexGroup">
    <select id="Country" name="Country">
        <optgroup label="North America">
            <option value="MEX">Mexico</option>
            <option value="CAN">Canada</option>
            <option value="US">USA</option>
        </optgroup>
        <optgroup label="Europe">
            <option value="FR">France</option>
            <option value="ES">Spain</option>
            <option value="DE">Germany</option>
        </optgroup>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="removed for brevity" />
</form>
```

## Multiple select

The Select Tag Helper will automatically generate the `multiple = "multiple"` attribute if the property specified in the `asp-for` attribute is an `IEnumerable`. For example, given the following model:

```
using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel : IEnumerable
    {
        public IEnumerable<string> CountryCodes { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
            new SelectListItem { Value = "FR", Text = "France" },
            new SelectListItem { Value = "ES", Text = "Spain" },
            new SelectListItem { Value = "DE", Text = "Germany" }
        };
    }
}
```

With the following view:

```

@model CountryViewModelIEnumarable

<form asp-controller="Home" asp-action="IndexMultiSelect" method="post">
    <select asp-for="CountryCodes" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>

```

Generates the following HTML:

```

<form method="post" action="/Home/IndexMultiSelect">
    <select id="CountryCodes"
        multiple="multiple"
        name="CountryCodes"><option value="MX">Mexico</option>
    <option value="CA">Canada</option>
    <option value="US">USA</option>
    <option value="FR">France</option>
    <option value="ES">Spain</option>
    <option value="DE">Germany</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## No selection

If you find yourself using the "not specified" option in multiple pages, you can create a template to eliminate repeating the HTML:

```

@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    @Html.EditorForModel()
    <br /><button type="submit">Register</button>
</form>

```

The *Views/Shared/EditorTemplates/CountryViewModel.cshtml* template:

```

@model CountryViewModel

<select asp-for="Country" asp-items="Model.Countries">
    <option value="">--none--</option>
</select>

```

Adding HTML `<option>` elements isn't limited to the *No selection* case. For example, the following view and action method will generate HTML similar to the code above:

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

```
@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    <select asp-for="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
</form>
```

The correct `<option>` element will be selected ( contain the `selected="selected"` attribute) depending on the current `Country` value.

```
<form method="post" action="/Home/IndexEmpty">
    <select id="Country" name="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA" selected="selected">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## Additional resources

- [Tag Helpers](#)
- [HTML Form element](#)
- [Request Verification Token](#)
- [Model Binding](#)
- [Model Validation](#)
- [IAttributeAdapter Interface](#)
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# Tag Helpers in forms in ASP.NET Core

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This document demonstrates working with Forms and the HTML elements commonly used on a Form. The [HTML Form](#) element provides the primary mechanism web apps use to post back data to the server. Most of this document describes [Tag Helpers](#) and how they can help you productively create robust HTML forms. We recommend you read [Introduction to Tag Helpers](#) before you read this document.

In many cases, HTML Helpers provide an alternative approach to a specific Tag Helper, but it's important to recognize that Tag Helpers don't replace HTML Helpers and there's not a Tag Helper for each HTML Helper. When an HTML Helper alternative exists, it's mentioned.

## The Form Tag Helper

The [Form](#) Tag Helper:

- Generates the HTML `<FORM>` `action` attribute value for a MVC controller action or named route
- Generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method)
- Provides the `asp-route-<Parameter Name>` attribute, where `<Parameter Name>` is added to the route values. The `routeValues` parameters to `Html.BeginForm` and `Html.BeginRouteForm` provide similar functionality.
- Has an HTML Helper alternative `Html.BeginForm` and `Html.BeginRouteForm`

Sample:

```
<form asp-controller="Demo" asp-action="Register" method="post">
    <!-- Input and Submit elements -->
</form>
```

The Form Tag Helper above generates the following HTML:

```
<form method="post" action="/Demo/Register">
    <!-- Input and Submit elements -->
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

The MVC runtime generates the `action` attribute value from the Form Tag Helper attributes `asp-controller` and `asp-action`. The Form Tag Helper also generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method). Protecting a pure HTML Form from cross-site request forgery is difficult, the Form Tag Helper provides this service for you.

### Using a named route

The `asp-route` Tag Helper attribute can also generate markup for the HTML `action` attribute. An app with a route named `register` could use the following markup for the registration page:

```
<form asp-route="register" method="post">
    <!-- Input and Submit elements -->
</form>
```

Many of the views in the `Views/Account` folder (generated when you create a new web app with *Individual User Accounts*) contain the `asp-route-returnurl` attribute:

```
<form asp-controller="Account" asp-action="Login"
    asp-route-returnurl="@ViewData["ReturnUrl"]"
    method="post" class="form-horizontal" role="form">
```

#### NOTE

With the built in templates, `returnUrl` is only populated automatically when you try to access an authorized resource but are not authenticated or authorized. When you attempt an unauthorized access, the security middleware redirects you to the login page with the `returnUrl` set.

## The Input Tag Helper

The Input Tag Helper binds an HTML `<input>` element to a model expression in your razor view.

Syntax:

```
<input asp-for="<Expression Name>" />
```

The Input Tag Helper:

- Generates the `id` and `name` HTML attributes for the expression name specified in the `asp-for` attribute. `asp-for="Property1.Property2"` is equivalent to `m => m.Property1.Property2`. The name of the expression is what is used for the `asp-for` attribute value. See the [Expression names](#) section for additional information.
- Sets the HTML `type` attribute value based on the model type and [data annotation](#) attributes applied to the model property
- Won't overwrite the HTML `type` attribute value when one is specified
- Generates [HTML5](#) validation attributes from [data annotation](#) attributes applied to model properties
- Has an HTML Helper feature overlap with `Html.TextBoxFor` and `Html.EditorFor`. See the [HTML Helper alternatives to Input Tag Helper](#) section for details.
- Provides strong typing. If the name of the property changes and you don't update the Tag Helper you'll get an error similar to the following:

```
An error occurred during the compilation of a resource required to process
this request. Please review the following specific error details and modify
your source code appropriately.
```

```
Type expected
'RegisterViewModel' does not contain a definition for 'Email' and no
extension method 'Email' accepting a first argument of type 'RegisterViewModel'
could be found (are you missing a using directive or an assembly reference?)
```

The `Input` Tag Helper sets the HTML `type` attribute based on the .NET type. The following table lists some common .NET types and generated HTML type (not every .NET type is listed).

.NET TYPE	INPUT TYPE
Bool	type="checkbox"
String	type="text"
DateTime	type="datetime"
Byte	type="number"
Int	type="number"
Single, Double	type="number"

The following table shows some common [data annotations](#) attributes that the input tag helper will map to specific input types (not every validation attribute is listed):

ATTRIBUTE	INPUT TYPE
[EmailAddress]	type="email"
[Url]	type="url"
[HiddenInput]	type="hidden"
[Phone]	type="tel"
[DataType(DataType.Password)]	type="password"
[DataType(DataType.Date)]	type="date"
[DataType(DataType.Time)]	type="time"

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}
```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterInput" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    <button type="submit">Register</button>
</form>

```

The code above generates the following HTML:

```

<form method="post" action="/Demo/RegisterInput">
    Email:
    <input type="email" data-val="true"
           data-val-email="The Email Address field is not a valid email address."
           data-val-required="The Email Address field is required."
           id="Email" name="Email" value="" /> <br>
    Password:
    <input type="password" data-val="true"
           data-val-required="The Password field is required."
           id="Password" name="Password" /><br>
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

The data annotations applied to the `Email` and `Password` properties generate metadata on the model. The Input Tag Helper consumes the model metadata and produces [HTML5](#) `data-val-*` attributes (see [Model Validation](#)). These attributes describe the validators to attach to the input fields. This provides unobtrusive HTML5 and [jQuery](#) validation. The unobtrusive attributes have the format `data-val-rule="Error Message"`, where rule is the name of the validation rule (such as `data-val-required`, `data-val-email`, `data-val-maxlength`, etc.) If an error message is provided in the attribute, it's displayed as the value for the `data-val-rule` attribute. There are also attributes of the form `data-val-ruleName-argumentName="argumentValue"` that provide additional details about the rule, for example, `data-val-maxlength-max="1024"`.

## HTML Helper alternatives to Input Tag Helper

`Html.TextBox`, `Html.TextBoxFor`, `Html.Editor` and `Html.EditorFor` have overlapping features with the Input Tag Helper. The Input Tag Helper will automatically set the `type` attribute; `Html.TextBox` and `Html.TextBoxFor` won't. `Html.Editor` and `Html.EditorFor` handle collections, complex objects and templates; the Input Tag Helper doesn't. The Input Tag Helper, `Html.EditorFor` and `Html.TextBoxFor` are strongly typed (they use lambda expressions); `Html.TextBox` and `Html.Editor` are not (they use expression names).

## HtmlAttributes

`@Html.Editor()` and `@Html.EditorFor()` use a special `ViewDataDictionary` entry named `htmlAttributes` when executing their default templates. This behavior is optionally augmented using `additional ViewData` parameters. The key "htmlAttributes" is case-insensitive. The key "htmlAttributes" is handled similarly to the `htmlAttributes` object passed to input helpers like `@Html.TextBox()`.

```

@Html.EditorFor(model => model.YourProperty,
    new { htmlAttributes = new { @class="myCssClass", style="Width:100px" } })

```

## Expression names

The `asp-for` attribute value is a `ModelExpression` and the right hand side of a lambda expression. Therefore, `asp-for="Property1"` becomes `m => m.Property1` in the generated code which is why you don't need to prefix with `Model`. You can use the "@" character to start an inline expression and move before the `m`:

```
@{
    var joe = "Joe";
}
<input asp-for="@joe" />
```

Generates the following:

```
<input type="text" id="joe" name="joe" value="Joe" />
```

With collection properties, `asp-for="CollectionProperty[23].Member"` generates the same name as `asp-for="CollectionProperty[i].Member"` when `i` has the value `23`.

When ASP.NET Core MVC calculates the value of `ModelExpression`, it inspects several sources, including `ModelState`. Consider `<input type="text" asp-for="@Name" />`. The calculated `value` attribute is the first non-null value from:

- `ModelState` entry with key "Name".
- Result of the expression `Model.Name`.

### Navigating child properties

You can also navigate to child properties using the property path of the view model. Consider a more complex model class that contains a child `Address` property.

```
public class AddressViewModel
{
    public string AddressLine1 { get; set; }
}
```

```
public class RegisterAddressViewModel
{
    public string Email { get; set; }

    [DataType(DataType.Password)]
    public string Password { get; set; }

    public AddressViewModel Address { get; set; }
}
```

In the view, we bind to `Address.AddressLine1`:

```
@model RegisterAddressViewModel

<form asp-controller="Demo" asp-action="RegisterAddress" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    Address: <input asp-for="Address.AddressLine1" /><br />
    <button type="submit">Register</button>
</form>
```

The following HTML is generated for `Address.AddressLine1`:

```
<input type="text" id="Address_AddressLine1" name="Address.AddressLine1" value="" />
```

## Expression names and Collections

Sample, a model containing an array of `Colors`:

```
public class Person
{
    public List<string> Colors { get; set; }

    public int Age { get; set; }
}
```

The action method:

```
public IActionResult Edit(int id, int colorIndex)
{
    ViewData["Index"] = colorIndex;
    return View(GetPerson(id));
}
```

The following Razor shows how you access a specific `Color` element:

```
@model Person
 @{
    var index = (int)ViewData["index"];
}

<form asp-controller="ToDo" asp-action="Edit" method="post">
    @Html.EditorFor(m => m.Colors[index])
    <label asp-for="Age"></label>
    <input asp-for="Age" /><br />
    <button type="submit">Post</button>
</form>
```

The *Views/Shared/EditorTemplates/String.cshtml* template:

```
@model string

<label asp-for="@Model"></label>
<input asp-for="@Model" /> <br />
```

Sample using `List<T>`:

```
public class ToDoItem
{
    public string Name { get; set; }

    public bool IsDone { get; set; }
}
```

The following Razor shows how to iterate over a collection:

```

@model List<ToDoItem>

<form asp-controller="ToDo" asp-action="Edit" method="post">
    <table>
        <tr> <th>Name</th> <th>Is Done</th> </tr>

        @for (int i = 0; i < Model.Count; i++)
        {
            <tr>
                @Html.EditorFor(model => model[i])
            </tr>
        }

    </table>
    <button type="submit">Save</button>
</form>

```

The *Views/Shared/EditorTemplates/ToDoItem.cshtml* template:

```

@model ToDoItem

<td>
    <label asp-for="@Model.Name"></label>
    @Html.DisplayFor(model => model.Name)
</td>
<td>
    <input asp-for="@Model.IsDone" />
</td>



```

#### NOTE

Always use `for` (and *not* `foreach`) to iterate over a list. Evaluating an indexer in a LINQ expression can be expensive and should be minimized.

#### NOTE

The commented sample code above shows how you would replace the lambda expression with the `@` operator to access each `ToDoItem` in the list.

## The Textarea Tag Helper

The `Textarea Tag Helper` tag helper is similar to the Input Tag Helper.

- Generates the `id` and `name` attributes, and the data validation attributes from the model for a `<textarea>` element.

- Provides strong typing.
- HTML Helper alternative: `Html.TextAreaFor`

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class DescriptionViewModel
    {
        [MinLength(5)]
        [MaxLength(1024)]
        public string Description { get; set; }
    }
}
```

```
@model DescriptionViewModel

<form asp-controller="Demo" asp-action="RegisterTextArea" method="post">
    <textarea asp-for="Description"></textarea>
    <button type="submit">Test</button>
</form>
```

The following HTML is generated:

```
<form method="post" action="/Demo/RegisterTextArea">
    <textarea data-val="true"
              data-val-maxlength="The field Description must be a string or array type with a maximum length of
              &#x27;1024&#x27;;."
              data-val-maxlength-max="1024"
              data-val-minlength="The field Description must be a string or array type with a minimum length of
              &#x27;5&#x27;;."
              data-val-minlength-min="5"
              id="Description" name="Description">
    </textarea>
    <button type="submit">Test</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## The Label Tag Helper

- Generates the label caption and `for` attribute on a element for an expression name
- HTML Helper alternative: `Html.LabelFor`.

The `Label Tag Helper` provides the following benefits over a pure HTML label element:

- You automatically get the descriptive label value from the `Display` attribute. The intended display name might change over time, and the combination of `Display` attribute and Label Tag Helper will apply the `Display` everywhere it's used.
- Less markup in source code
- Strong typing with the model property.

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class SimpleViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }
    }
}
```

```
@model SimpleViewModel

<form asp-controller="Demo" asp-action="RegisterLabel" method="post">
    <label asp-for="Email"></label>
    <input asp-for="Email" /> <br />
</form>
```

The following HTML is generated for the `<label>` element:

```
<label for="Email">Email Address</label>
```

The Label Tag Helper generated the `for` attribute value of "Email", which is the ID associated with the `<input>` element. The Tag Helpers generate consistent `id` and `for` elements so they can be correctly associated. The caption in this sample comes from the `Display` attribute. If the model didn't contain a `Display` attribute, the caption would be the property name of the expression.

## The Validation Tag Helpers

There are two Validation Tag Helpers. The `Validation Message Tag Helper` (which displays a validation message for a single property on your model), and the `Validation Summary Tag Helper` (which displays a summary of validation errors). The `Input Tag Helper` adds HTML5 client side validation attributes to input elements based on data annotation attributes on your model classes. Validation is also performed on the server. The Validation Tag Helper displays these error messages when a validation error occurs.

### The Validation Message Tag Helper

- Adds the `HTML5` `data-valmsg-for="property"` attribute to the `span` element, which attaches the validation error messages on the input field of the specified model property. When a client side validation error occurs, `jQuery` displays the error message in the `<span>` element.
- Validation also takes place on the server. Clients may have JavaScript disabled and some validation can only be done on the server side.
- HTML Helper alternative: `Html.ValidationMessageFor`

The `Validation Message Tag Helper` is used with the `asp-validation-for` attribute on a HTML `span` element.

```
<span asp-validation-for="Email"></span>
```

The Validation Message Tag Helper will generate the following HTML:

```
<span class="field-validation-valid"  
      data-valmsg-for="Email"  
      data-valmsg-replace="true"></span>
```

You generally use the `Validation Message Tag Helper` after an `Input` Tag Helper for the same property. Doing so displays any validation error messages near the input that caused the error.

#### NOTE

You must have a view with the correct JavaScript and [jQuery](#) script references in place for client side validation. See [Model Validation](#) for more information.

When a server side validation error occurs (for example when you have custom server side validation or client-side validation is disabled), MVC places that error message as the body of the `<span>` element.

```
<span class="field-validation-error" data-valmsg-for="Email"  
      data-valmsg-replace="true">  
    The Email Address field is required.  
</span>
```

### The Validation Summary Tag Helper

- Targets `<div>` elements with the `asp-validation-summary` attribute
- HTML Helper alternative: `@Html.ValidationSummary`

The `Validation Summary Tag Helper` is used to display a summary of validation messages. The `asp-validation-summary` attribute value can be any of the following:

ASP-VALIDATION-SUMMARY	VALIDATION MESSAGES DISPLAYED
ValidationSummary.All	Property and model level
ValidationSummary.ModelOnly	Model
ValidationSummary.None	None

### Sample

In the following example, the data model is decorated with `DataAnnotation` attributes, which generates validation error messages on the `<input>` element. When a validation error occurs, the Validation Tag Helper displays the error message:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}

```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterValidation" method="post">
    <div asp-validation-summary="ModelOnly"></div>
    Email: <input asp-for="Email" /> <br />
    <span asp-validation-for="Email"></span><br />
    Password: <input asp-for="Password" /><br />
    <span asp-validation-for="Password"></span><br />
    <button type="submit">Register</button>
</form>

```

The generated HTML (when the model is valid):

```

<form action="/DemoReg/Register" method="post">
    <div class="validation-summary-valid" data-valmsg-summary="true">
        <ul><li style="display:none"></li></ul></div>
    Email: <input name="Email" id="Email" type="email" value="" data-val-required="The Email field is required." data-val-email="The Email field is not a valid email address." data-val="true"> <br />
    <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Email"></span><br />
    Password: <input name="Password" id="Password" type="password" data-val-required="The Password field is required." data-val="true"><br />
    <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Password"></span><br />
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## The Select Tag Helper

- Generates `select` and associated `option` elements for properties of your model.
- Has an HTML Helper alternative `Html.DropDownListFor` and `Html.ListBoxFor`

The `Select Tag Helper` `asp-for` specifies the model property name for the `select` element and `asp-items` specifies the `option` elements. For example:

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

Sample:

```

using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel
    {
        public string Country { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
        };
    }
}

```

The `Index` method initializes the `CountryViewModel`, sets the selected country and passes it to the `Index` view.

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

The HTTP POST `Index` method displays the selection:

```

[HttpPost]
[ValidateAntiForgeryToken]
public IActionResult Index(CountryViewModel model)
{
    if (ModelState.IsValid)
    {
        var msg = model.Country + " selected";
        return RedirectToAction("IndexSuccess", new { message = msg });
    }

    // If we got this far, something failed; redisplay form.
    return View(model);
}

```

The `Index` view:

```

@model CountryViewModel

<form asp-controller="Home" asp-action="Index" method="post">
    <select asp-for="Country" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>

```

Which generates the following HTML (with "CA" selected):

```
<form method="post" action="/">
    <select id="Country" name="Country">
        <option value="MX">Mexico</option>
        <option selected="selected" value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## NOTE

We don't recommend using `ViewBag` or `ViewData` with the `Select` Tag Helper. A view model is more robust at providing MVC metadata and generally less problematic.

The `asp-for` attribute value is a special case and doesn't require a `Model` prefix, the other Tag Helper attributes do (such as `asp-items`)

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

## Enum binding

It's often convenient to use `<select>` with an `enum` property and generate the `SelectListItem` elements from the `enum` values.

Sample:

```
public class CountryEnumViewModel
{
    public CountryEnum EnumCountry { get; set; }
}
```

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}
```

The `GetEnumSelectList` method generates a `SelectList` object for an enum.

```

@model CountryEnumViewModel

<form asp-controller="Home" asp-action="IndexEnum" method="post">
    <select asp-for="EnumCountry"
        asp-items="Html.GetEnumSelectList<CountryEnum>()" >
    </select>
    <br /><button type="submit">Register</button>
</form>

```

You can decorate your enumerator list with the `Display` attribute to get a richer UI:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}

```

The following HTML is generated:

```

<form method="post" action="/Home/IndexEnum">
    <select data-val="true" data-val-required="The EnumCountry field is required."
        id="EnumCountry" name="EnumCountry">
        <option value="0">United Mexican States</option>
        <option value="1">United States of America</option>
        <option value="2">Canada</option>
        <option value="3">France</option>
        <option value="4">Germany</option>
        <option selected="selected" value="5">Spain</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## Option Group

The HTML `<optgroup>` element is generated when the view model contains one or more `SelectListGroup` objects.

The `CountryViewModelGroup` groups the `SelectListItem` elements into the "North America" and "Europe" groups:

```

public class CountryViewModelGroup
{
    public CountryViewModelGroup()
    {
        var NorthAmericaGroup = new SelectListGroup { Name = "North America" };
        var EuropeGroup = new SelectListGroup { Name = "Europe" };

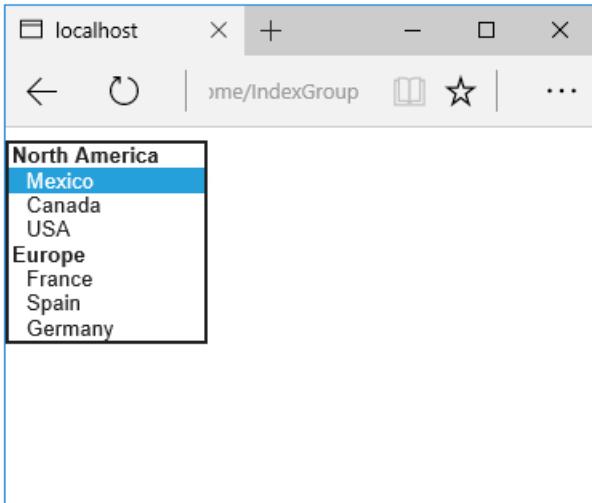
        Countries = new List<SelectListItem>
        {
            new SelectListItem
            {
                Value = "MEX",
                Text = "Mexico",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "CAN",
                Text = "Canada",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "US",
                Text = "USA",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "FR",
                Text = "France",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "ES",
                Text = "Spain",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "DE",
                Text = "Germany",
                Group = EuropeGroup
            }
        };
    }

    public string Country { get; set; }

    public List<SelectListItem> Countries { get; }
}

```

The two groups are shown below:



The generated HTML:

```
<form method="post" action="/Home/IndexGroup">
    <select id="Country" name="Country">
        <optgroup label="North America">
            <option value="MEX">Mexico</option>
            <option value="CAN">Canada</option>
            <option value="US">USA</option>
        </optgroup>
        <optgroup label="Europe">
            <option value="FR">France</option>
            <option value="ES">Spain</option>
            <option value="DE">Germany</option>
        </optgroup>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="removed for brevity" />
</form>
```

## Multiple select

The Select Tag Helper will automatically generate the `multiple = "multiple"` attribute if the property specified in the `asp-for` attribute is an `IEnumerable`. For example, given the following model:

```
using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel : IEnumerable
    {
        public IEnumerable<string> CountryCodes { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
            new SelectListItem { Value = "FR", Text = "France" },
            new SelectListItem { Value = "ES", Text = "Spain" },
            new SelectListItem { Value = "DE", Text = "Germany" }
        };
    }
}
```

With the following view:

```

@model CountryViewModelIEnumarable

<form asp-controller="Home" asp-action="IndexMultiSelect" method="post">
    <select asp-for="CountryCodes" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>

```

Generates the following HTML:

```

<form method="post" action="/Home/IndexMultiSelect">
    <select id="CountryCodes"
        multiple="multiple"
        name="CountryCodes"><option value="MX">Mexico</option>
    <option value="CA">Canada</option>
    <option value="US">USA</option>
    <option value="FR">France</option>
    <option value="ES">Spain</option>
    <option value="DE">Germany</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## No selection

If you find yourself using the "not specified" option in multiple pages, you can create a template to eliminate repeating the HTML:

```

@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    @Html.EditorForModel()
    <br /><button type="submit">Register</button>
</form>

```

The *Views/Shared/EditorTemplates/CountryViewModel.cshtml* template:

```

@model CountryViewModel

<select asp-for="Country" asp-items="Model.Countries">
    <option value="">--none--</option>
</select>

```

Adding HTML `<option>` elements isn't limited to the *No selection* case. For example, the following view and action method will generate HTML similar to the code above:

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

```
@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    <select asp-for="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
</form>
```

The correct `<option>` element will be selected ( contain the `selected="selected"` attribute) depending on the current `Country` value.

```
<form method="post" action="/Home/IndexEmpty">
    <select id="Country" name="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA" selected="selected">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## Additional resources

- [Tag Helpers](#)
- [HTML Form element](#)
- [Request Verification Token](#)
- [Model Binding](#)
- [Model Validation](#)
- [IAttributeAdapter Interface](#)
- [Code snippets for this document](#)

# Tag Helpers in forms in ASP.NET Core

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This document demonstrates working with Forms and the HTML elements commonly used on a Form. The HTML `Form` element provides the primary mechanism web apps use to post back data to the server. Most of this document describes [Tag Helpers](#) and how they can help you productively create robust HTML forms. We recommend you read [Introduction to Tag Helpers](#) before you read this document.

In many cases, HTML Helpers provide an alternative approach to a specific Tag Helper, but it's important to recognize that Tag Helpers don't replace HTML Helpers and there's not a Tag Helper for each HTML Helper. When an HTML Helper alternative exists, it's mentioned.

## The Form Tag Helper

The `Form` Tag Helper:

- Generates the HTML `<FORM>` `action` attribute value for a MVC controller action or named route
- Generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method)
- Provides the `asp-route-<Parameter Name>` attribute, where `<Parameter Name>` is added to the route values. The `routeValues` parameters to `Html.BeginForm` and `Html.BeginRouteForm` provide similar functionality.
- Has an HTML Helper alternative `Html.BeginForm` and `Html.BeginRouteForm`

Sample:

```
<form asp-controller="Demo" asp-action="Register" method="post">
    <!-- Input and Submit elements --&gt;
&lt;/form&gt;</pre>
```

The Form Tag Helper above generates the following HTML:

```
<form method="post" action="/Demo/Register">
    <!-- Input and Submit elements --&gt;
    &lt;input name="__RequestVerificationToken" type="hidden" value="&lt;removed for brevity&gt;" /&gt;
&lt;/form&gt;</pre>
```

The MVC runtime generates the `action` attribute value from the Form Tag Helper attributes `asp-controller` and `asp-action`. The Form Tag Helper also generates a hidden [Request Verification Token](#) to prevent cross-site request forgery (when used with the `[ValidateAntiForgeryToken]` attribute in the HTTP Post action method). Protecting a pure HTML Form from cross-site request forgery is difficult, the Form Tag Helper provides this service for you.

### Using a named route

The `asp-route` Tag Helper attribute can also generate markup for the HTML `action` attribute. An app with a `route` named `register` could use the following markup for the registration page:

```
<form asp-route="register" method="post">
    <!-- Input and Submit elements -->
</form>
```

Many of the views in the `Views/Account` folder (generated when you create a new web app with *Individual User Accounts*) contain the `asp-route-returnurl` attribute:

```
<form asp-controller="Account" asp-action="Login"
      asp-route-returnurl="@ViewData["ReturnUrl"]"
      method="post" class="form-horizontal" role="form">
```

#### NOTE

With the built in templates, `returnUrl` is only populated automatically when you try to access an authorized resource but are not authenticated or authorized. When you attempt an unauthorized access, the security middleware redirects you to the login page with the `returnUrl` set.

## The Input Tag Helper

The Input Tag Helper binds an HTML `<input>` element to a model expression in your razor view.

Syntax:

```
<input asp-for="<Expression Name>" />
```

The Input Tag Helper:

- Generates the `id` and `name` HTML attributes for the expression name specified in the `asp-for` attribute. `asp-for="Property1.Property2"` is equivalent to `m => m.Property1.Property2`. The name of the expression is what is used for the `asp-for` attribute value. See the [Expression names](#) section for additional information.
- Sets the HTML `type` attribute value based on the model type and [data annotation](#) attributes applied to the model property
- Won't overwrite the HTML `type` attribute value when one is specified
- Generates [HTML5](#) validation attributes from [data annotation](#) attributes applied to model properties
- Has an HTML Helper feature overlap with `Html.TextBoxFor` and `Html.EditorFor`. See the [HTML Helper alternatives to Input Tag Helper](#) section for details.
- Provides strong typing. If the name of the property changes and you don't update the Tag Helper you'll get an error similar to the following:

An error occurred during the compilation of a resource required to process this request. Please review the following specific error details and modify your source code appropriately.

Type expected

'RegisterViewModel' does not contain a definition for 'Email' and no extension method 'Email' accepting a first argument of type 'RegisterViewModel' could be found (are you missing a using directive or an assembly reference?)

The `Input` Tag Helper sets the HTML `type` attribute based on the .NET type. The following table lists some common .NET types and generated HTML type (not every .NET type is listed).

.NET TYPE	INPUT TYPE
Bool	type="checkbox"
String	type="text"
DateTime	type="datetime"
Byte	type="number"
Int	type="number"
Single, Double	type="number"

The following table shows some common [data annotations](#) attributes that the input tag helper will map to specific input types (not every validation attribute is listed):

ATTRIBUTE	INPUT TYPE
[EmailAddress]	type="email"
[Url]	type="url"
[HiddenInput]	type="hidden"
[Phone]	type="tel"
[DataType(DataType.Password)]	type="password"
[DataType(DataType.Date)]	type="date"
[DataType(DataType.Time)]	type="time"

Sample:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}

```

```

@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterInput" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    <button type="submit">Register</button>
</form>

```

The code above generates the following HTML:

```

<form method="post" action="/Demo/RegisterInput">
    Email:
    <input type="email" data-val="true"
           data-val-email="The Email Address field is not a valid email address."
           data-val-required="The Email Address field is required."
           id="Email" name="Email" value="" /> <br>
    Password:
    <input type="password" data-val="true"
           data-val-required="The Password field is required."
           id="Password" name="Password" /><br>
    <button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

The data annotations applied to the `Email` and `Password` properties generate metadata on the model. The Input Tag Helper consumes the model metadata and produces [HTML5](#) `data-val-*` attributes (see [Model Validation](#)). These attributes describe the validators to attach to the input fields. This provides unobtrusive HTML5 and [jQuery](#) validation. The unobtrusive attributes have the format `data-val-rule="Error Message"`, where rule is the name of the validation rule (such as `data-val-required`, `data-val-email`, `data-val-maxlength`, etc.) If an error message is provided in the attribute, it's displayed as the value for the `data-val-rule` attribute. There are also attributes of the form `data-val-ruleName-argumentName="argumentValue"` that provide additional details about the rule, for example, `data-val-maxlength-max="1024"`.

## HTML Helper alternatives to Input Tag Helper

`Html.TextBox`, `Html.TextBoxFor`, `Html.Editor` and `Html.EditorFor` have overlapping features with the Input Tag Helper. The Input Tag Helper will automatically set the `type` attribute; `Html.TextBox` and `Html.TextBoxFor` won't. `Html.Editor` and `Html.EditorFor` handle collections, complex objects and templates; the Input Tag Helper doesn't. The Input Tag Helper, `Html.EditorFor` and `Html.TextBoxFor` are strongly typed (they use lambda expressions);

`Html.TextBox` and `Html.Editor` are not (they use expression names).

## HtmlAttributes

`@Html.Editor()` and `@Html.EditorFor()` use a special `ViewDataDictionary` entry named `htmlAttributes` when executing their default templates. This behavior is optionally augmented using `additionalViewData` parameters. The key "htmlAttributes" is case-insensitive. The key "htmlAttributes" is handled similarly to the `htmlAttributes` object passed to input helpers like `@Html.TextBox()`.

```
@Html.EditorFor(model => model.YourProperty,  
new { htmlAttributes = new { @class="myCssClass", style="Width:100px" } })
```

## Expression names

The `asp-for` attribute value is a `ModelExpression` and the right hand side of a lambda expression. Therefore, `asp-for="Property1"` becomes `m => m.Property1` in the generated code which is why you don't need to prefix with `Model`. You can use the "@" character to start an inline expression and move before the `m`:

```
@{  
    var joe = "Joe";  
}  
<input asp-for="@joe" />
```

Generates the following:

```
<input type="text" id="joe" name="joe" value="Joe" />
```

With collection properties, `asp-for="CollectionProperty[23].Member"` generates the same name as `asp-for="CollectionProperty[i].Member"` when `i` has the value `23`.

When ASP.NET Core MVC calculates the value of `ModelExpression`, it inspects several sources, including `ModelState`. Consider `<input type="text" asp-for="@Name" />`. The calculated `value` attribute is the first non-null value from:

- `ModelState` entry with key "Name".
- Result of the expression `Model.Name`.

## Navigating child properties

You can also navigate to child properties using the property path of the view model. Consider a more complex model class that contains a child `Address` property.

```
public class AddressViewModel  
{  
    public string AddressLine1 { get; set; }  
}
```

```

public class RegisterAddressViewModel
{
    public string Email { get; set; }

    [DataType(DataType.Password)]
    public string Password { get; set; }

    public AddressViewModel Address { get; set; }
}

```

In the view, we bind to `Address.AddressLine1`:

```

@model RegisterAddressViewModel

<form asp-controller="Demo" asp-action="RegisterAddress" method="post">
    Email: <input asp-for="Email" /> <br />
    Password: <input asp-for="Password" /><br />
    Address: <input asp-for="Address.AddressLine1" /><br />
    <button type="submit">Register</button>
</form>

```

The following HTML is generated for `Address.AddressLine1`:

```
<input type="text" id="Address_AddressLine1" name="Address.AddressLine1" value="" />
```

## Expression names and Collections

Sample, a model containing an array of `Colors`:

```

public class Person
{
    public List<string> Colors { get; set; }

    public int Age { get; set; }
}

```

The action method:

```

public IActionResult Edit(int id, int colorIndex)
{
    ViewData["Index"] = colorIndex;
    return View(GetPerson(id));
}

```

The following Razor shows how you access a specific `Color` element:

```

@model Person
 @{
    var index = (int)ViewData["index"];
}

<form asp-controller="ToDo" asp-action="Edit" method="post">
    @Html.EditorFor(m => m.Colors[index])
    <label asp-for="Age"></label>
    <input asp-for="Age" /><br />
    <button type="submit">Post</button>
</form>

```

The *Views/Shared/EditorTemplates/String.cshtml* template:

```
@model string

<label asp-for="@Model"></label>
<input asp-for="@Model" /> <br />
```

Sample using `List<T>`:

```
public class ToDoItem
{
    public string Name { get; set; }

    public bool IsDone { get; set; }
}
```

The following Razor shows how to iterate over a collection:

```
@model List<ToDoItem>

<form asp-controller="ToDo" asp-action="Edit" method="post">
    <table>
        <tr> <th>Name</th> <th>Is Done</th> </tr>

        @for (int i = 0; i < Model.Count; i++)
        {
            <tr>
                @Html.EditorFor(model => model[i])
            </tr>
        }

    </table>
    <button type="submit">Save</button>
</form>
```

The *Views/Shared/EditorTemplates/ToDoItem.cshtml* template:

```
@model ToDoItem

<td>
    <label asp-for="@Model.Name"></label>
    @Html.DisplayFor(model => model.Name)
</td>
<td>
    <input asp-for="@Model.IsDone" />
</td>

/*
    This template replaces the following Razor which evaluates the indexer three times.
<td>
    <label asp-for="@Model[i].Name"></label>
    @Html.DisplayFor(model => model[i].Name)
</td>
<td>
    <input asp-for="@Model[i].IsDone" />
</td>
*/

```

**NOTE**

Always use `for` (and *not* `foreach`) to iterate over a list. Evaluating an indexer in a LINQ expression can be expensive and should be minimized.

**NOTE**

The commented sample code above shows how you would replace the lambda expression with the `@` operator to access each `ToDoItem` in the list.

## The Textarea Tag Helper

The `Textarea Tag Helper` tag helper is similar to the Input Tag Helper.

- Generates the `id` and `name` attributes, and the data validation attributes from the model for a `<textarea>` element.
- Provides strong typing.
- HTML Helper alternative: `Html.TextAreaFor`

Sample:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class DescriptionViewModel
    {
        [MinLength(5)]
        [MaxLength(1024)]
        public string Description { get; set; }
    }
}
```

```
@model DescriptionViewModel

<form asp-controller="Demo" asp-action="RegisterTextArea" method="post">
    <textarea asp-for="Description"></textarea>
    <button type="submit">Test</button>
</form>
```

The following HTML is generated:

```

<form method="post" action="/Demo/RegisterTextArea">
    <textarea data-val="true"
        data-val-maxlength="The field Description must be a string or array type with a maximum
        length of 1024."
        data-val-maxlength-max="1024"
        data-val-minlength="The field Description must be a string or array type with a minimum
        length of 5."
        data-val-minlength-min="5"
        id="Description" name="Description">
    </textarea>
    <button type="submit">Test</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>

```

## The Label Tag Helper

- Generates the label caption and `for` attribute on a element for an expression name
- HTML Helper alternative: `Html.LabelFor`.

The `Label Tag Helper` provides the following benefits over a pure HTML label element:

- You automatically get the descriptive label value from the `Display` attribute. The intended display name might change over time, and the combination of `Display` attribute and Label Tag Helper will apply the `Display` everywhere it's used.
- Less markup in source code
- Strong typing with the model property.

Sample:

```

using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class SimpleViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }
    }
}

```

```

@model SimpleViewModel

<form asp-controller="Demo" asp-action="RegisterLabel" method="post">
    <label asp-for="Email"></label>
    <input asp-for="Email" /> <br />
</form>

```

The following HTML is generated for the `<label>` element:

```

<label for="Email">Email Address</label>

```

The Label Tag Helper generated the `for` attribute value of "Email", which is the ID associated

with the `<input>` element. The Tag Helpers generate consistent `id` and `for` elements so they can be correctly associated. The caption in this sample comes from the `Display` attribute. If the model didn't contain a `Display` attribute, the caption would be the property name of the expression.

## The Validation Tag Helpers

There are two Validation Tag Helpers. The `Validation Message Tag Helper` (which displays a validation message for a single property on your model), and the `Validation Summary Tag Helper` (which displays a summary of validation errors). The `Input Tag Helper` adds HTML5 client side validation attributes to input elements based on data annotation attributes on your model classes. Validation is also performed on the server. The Validation Tag Helper displays these error messages when a validation error occurs.

### The Validation Message Tag Helper

- Adds the `HTML5` `data-valmsg-for="property"` attribute to the `span` element, which attaches the validation error messages on the input field of the specified model property. When a client side validation error occurs, `jQuery` displays the error message in the `<span>` element.
- Validation also takes place on the server. Clients may have JavaScript disabled and some validation can only be done on the server side.
- HTML Helper alternative: `Html.ValidationMessageFor`

The `Validation Message Tag Helper` is used with the `asp-validation-for` attribute on a HTML `span` element.

```
<span asp-validation-for="Email"></span>
```

The Validation Message Tag Helper will generate the following HTML:

```
<span class="field-validation-valid"
      data-valmsg-for="Email"
      data-valmsg-replace="true"></span>
```

You generally use the `Validation Message Tag Helper` after an `Input` Tag Helper for the same property. Doing so displays any validation error messages near the input that caused the error.

#### NOTE

You must have a view with the correct JavaScript and `jQuery` script references in place for client side validation. See [Model Validation](#) for more information.

When a server side validation error occurs (for example when you have custom server side validation or client-side validation is disabled), MVC places that error message as the body of the `<span>` element.

```
<span class="field-validation-error" data-valmsg-for="Email"
      data-valmsg-replace="true">
    The Email Address field is required.
</span>
```

## The Validation Summary Tag Helper

- Targets `<div>` elements with the `asp-validation-summary` attribute
- HTML Helper alternative: `@Html.ValidationSummary`

The `Validation Summary Tag Helper` is used to display a summary of validation messages. The `asp-validation-summary` attribute value can be any of the following:

ASP-VALIDATION-SUMMARY	VALIDATION MESSAGES DISPLAYED
ValidationSummary.All	Property and model level
ValidationSummary.ModelOnly	Model
ValidationSummary.None	None

### Sample

In the following example, the data model is decorated with `DataAnnotation` attributes, which generates validation error messages on the `<input>` element. When a validation error occurs, the Validation Tag Helper displays the error message:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public class RegisterViewModel
    {
        [Required]
        [EmailAddress]
        [Display(Name = "Email Address")]
        public string Email { get; set; }

        [Required]
        [DataType(DataType.Password)]
        public string Password { get; set; }
    }
}
```

```
@model RegisterViewModel

<form asp-controller="Demo" asp-action="RegisterValidation" method="post">
    <div asp-validation-summary="ModelOnly"></div>
    Email: <input asp-for="Email" /> <br />
    <span asp-validation-for="Email"></span><br />
    Password: <input asp-for="Password" /><br />
    <span asp-validation-for="Password"></span><br />
    <button type="submit">Register</button>
</form>
```

The generated HTML (when the model is valid):

```

<form action="/DemoReg/Register" method="post">
    <div class="validation-summary-valid" data-valmsg-summary="true">
        <ul><li style="display:none"></li></ul></div>
        Email: <input name="Email" id="Email" type="email" value="" data-val-required="The Email field is required." data-val-email="The Email field is not a valid email address." data-val="true"> <br>
        <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Email"></span><br>
        Password: <input name="Password" id="Password" type="password" data-val-required="The Password field is required." data-val="true"><br>
        <span class="field-validation-valid" data-valmsg-replace="true" data-valmsg-for="Password"></span><br>
        <button type="submit">Register</button>
        <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
    </form>

```

## The Select Tag Helper

- Generates `select` and associated `option` elements for properties of your model.
- Has an HTML Helper alternative `Html.DropDownListFor` and `Html.ListBoxFor`

The `Select Tag Helper` `asp-for` specifies the model property name for the `select` element and `asp-items` specifies the `option` elements. For example:

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

Sample:

```

using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel
    {
        public string Country { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" }
        };
    }
}

```

The `Index` method initializes the `CountryViewModel`, sets the selected country and passes it to the `Index` view.

```

public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}

```

The HTTP POST `Index` method displays the selection:

```
[HttpPost]
[ValidateAntiForgeryToken]
public IActionResult Index(CountryViewModel model)
{
    if (ModelState.IsValid)
    {
        var msg = model.Country + " selected";
        return RedirectToAction("IndexSuccess", new { message = msg });
    }

    // If we got this far, something failed; redisplay form.
    return View(model);
}
```

The `Index` view:

```
@model CountryViewModel

<form asp-controller="Home" asp-action="Index" method="post">
    <select asp-for="Country" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>
```

Which generates the following HTML (with "CA" selected):

```
<form method="post" action="/">
    <select id="Country" name="Country">
        <option value="MX">Mexico</option>
        <option selected="selected" value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="removed for brevity" />
</form>
```

#### NOTE

We don't recommend using `ViewBag` or `ViewData` with the `Select` Tag Helper. A view model is more robust at providing MVC metadata and generally less problematic.

The `asp-for` attribute value is a special case and doesn't require a `Model` prefix, the other Tag Helper attributes do (such as `asp-items`)

```
<select asp-for="Country" asp-items="Model.Countries"></select>
```

#### Enum binding

It's often convenient to use `<select>` with an `enum` property and generate the `SelectListItem` elements from the `enum` values.

Sample:

```
public class CountryEnumViewModel
{
    public CountryEnum EnumCountry { get; set; }
}
```

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}
```

The `GetEnumSelectList` method generates a `SelectList` object for an enum.

```
@model CountryEnumViewModel

<form asp-controller="Home" asp-action="IndexEnum" method="post">
    <select asp-for="EnumCountry"
           asp-items="Html.GetEnumSelectList<CountryEnum>()">
    </select>
    <br /><button type="submit">Register</button>
</form>
```

You can decorate your enumerator list with the `Display` attribute to get a richer UI:

```
using System.ComponentModel.DataAnnotations;

namespace FormsTagHelper.ViewModels
{
    public enum CountryEnum
    {
        [Display(Name = "United Mexican States")]
        Mexico,
        [Display(Name = "United States of America")]
        USA,
        Canada,
        France,
        Germany,
        Spain
    }
}
```

The following HTML is generated:

```
<form method="post" action="/Home/IndexEnum">
    <select data-val="true" data-val-required="The EnumCountry field is required."
            id="EnumCountry" name="EnumCountry">
        <option value="0">United Mexican States</option>
        <option value="1">United States of America</option>
        <option value="2">Canada</option>
        <option value="3">France</option>
        <option value="4">Germany</option>
        <option selected="selected" value="5">Spain</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## Option Group

The HTML `<optgroup>` element is generated when the view model contains one or more `SelectListGroup` objects.

The `CountryViewModelGroup` groups the `SelectListItem` elements into the "North America" and "Europe" groups:

```

public class CountryViewModelGroup
{
    public CountryViewModelGroup()
    {
        var NorthAmericaGroup = new SelectListGroup { Name = "North America" };
        var EuropeGroup = new SelectListGroup { Name = "Europe" };

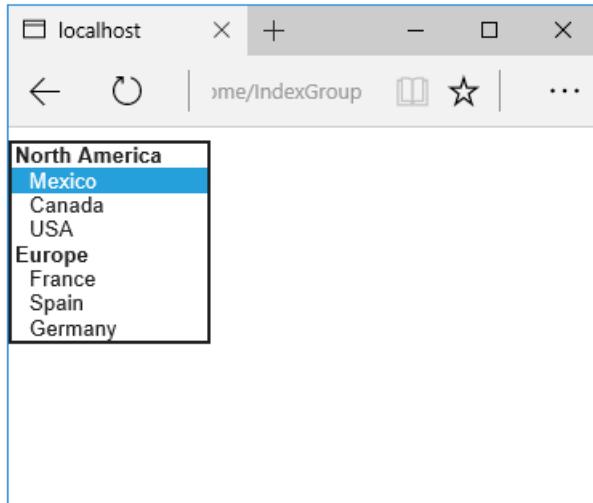
        Countries = new List<SelectListItem>
        {
            new SelectListItem
            {
                Value = "MEX",
                Text = "Mexico",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "CAN",
                Text = "Canada",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "US",
                Text = "USA",
                Group = NorthAmericaGroup
            },
            new SelectListItem
            {
                Value = "FR",
                Text = "France",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "ES",
                Text = "Spain",
                Group = EuropeGroup
            },
            new SelectListItem
            {
                Value = "DE",
                Text = "Germany",
                Group = EuropeGroup
            }
        };
    }

    public string Country { get; set; }

    public List<SelectListItem> Countries { get; }
}

```

The two groups are shown below:



The generated HTML:

```
<form method="post" action="/Home/IndexGroup">
    <select id="Country" name="Country">
        <optgroup label="North America">
            <option value="MEX">Mexico</option>
            <option value="CAN">Canada</option>
            <option value="US">USA</option>
        </optgroup>
        <optgroup label="Europe">
            <option value="FR">France</option>
            <option value="ES">Spain</option>
            <option value="DE">Germany</option>
        </optgroup>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

### Multiple select

The Select Tag Helper will automatically generate the `multiple = "multiple"` attribute if the property specified in the `asp-for` attribute is an `IEnumerable`. For example, given the following model:

```
using Microsoft.AspNetCore.Mvc.Rendering;
using System.Collections.Generic;

namespace FormsTagHelper.ViewModels
{
    public class CountryViewModel : IEnumerable
    {
        public IEnumerable<string> CountryCodes { get; set; }

        public List<SelectListItem> Countries { get; } = new List<SelectListItem>
        {
            new SelectListItem { Value = "MX", Text = "Mexico" },
            new SelectListItem { Value = "CA", Text = "Canada" },
            new SelectListItem { Value = "US", Text = "USA" },
            new SelectListItem { Value = "FR", Text = "France" },
            new SelectListItem { Value = "ES", Text = "Spain" },
            new SelectListItem { Value = "DE", Text = "Germany" }
        };
    }
}
```

With the following view:

```
@model CountryViewModelI Enumerable

<form asp-controller="Home" asp-action="IndexMultiSelect" method="post">
    <select asp-for="CountryCodes" asp-items="Model.Countries"></select>
    <br /><button type="submit">Register</button>
</form>
```

Generates the following HTML:

```
<form method="post" action="/Home/IndexMultiSelect">
    <select id="CountryCodes"
        multiple="multiple"
        name="CountryCodes"><option value="MX">Mexico</option>
    <option value="CA">Canada</option>
    <option value="US">USA</option>
    <option value="FR">France</option>
    <option value="ES">Spain</option>
    <option value="DE">Germany</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

### No selection

If you find yourself using the "not specified" option in multiple pages, you can create a template to eliminate repeating the HTML:

```
@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    @Html.EditorForModel()
    <br /><button type="submit">Register</button>
</form>
```

The *Views/Shared/EditorTemplates/CountryViewModel.cshtml* template:

```
@model CountryViewModel

<select asp-for="Country" asp-items="Model.Countries">
    <option value="">--none--</option>
</select>
```

Adding HTML `<option>` elements isn't limited to the *No selection* case. For example, the following view and action method will generate HTML similar to the code above:

```
public IActionResult IndexOption(int id)
{
    var model = new CountryViewModel();
    model.Country = "CA";
    return View(model);
}
```

```
@model CountryViewModel

<form asp-controller="Home" asp-action="IndexEmpty" method="post">
    <select asp-for="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
</form>
```

The correct `<option>` element will be selected ( contain the `selected="selected"` attribute) depending on the current `Country` value.

```
<form method="post" action="/Home/IndexEmpty">
    <select id="Country" name="Country">
        <option value="">&lt;none&gt;</option>
        <option value="MX">Mexico</option>
        <option value="CA" selected="selected">Canada</option>
        <option value="US">USA</option>
    </select>
    <br /><button type="submit">Register</button>
    <input name="__RequestVerificationToken" type="hidden" value="<removed for brevity>" />
</form>
```

## Additional resources

- [Tag Helpers](#)
- [HTML Form element](#)
- [Request Verification Token](#)
- [Model Binding](#)
- [Model Validation](#)
- [IAttributeAdapter Interface](#)
- [Code snippets for this document](#)

# Partial views in ASP.NET Core

7/10/2018 • 6 minutes to read • [Edit Online](#)

By [Steve Smith](#), [Maher JENDOUBI](#), [Rick Anderson](#), and [Scott Sauber](#)

ASP.NET Core MVC supports partial views, which are useful for sharing reusable parts of web pages across different views.

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## What are partial views

A partial view is a view that's rendered within another view. The HTML output generated by executing the partial view is rendered into the calling (or parent) view. Like views, partial views use the `.cshtml` file extension.

For example, the ASP.NET Core 2.1 **Web Application** project template includes a `_CookieConsentPartial.cshtml` partial view. The partial view is loaded from within `_Layout.cshtml`:

```
<partial name="_CookieConsentPartial" />
```

## When to use partial views

Partial views are an effective way of breaking up large views into smaller components. They can reduce duplication of view content and allow view elements to be reused. Common layout elements should be specified in `_Layout.cshtml`. Non-layout reusable content can be encapsulated into partial views.

In a complex page composed of several logical pieces, it's helpful to work with each piece as its own partial view. Each piece of the page can be viewed in isolation from the rest of the page. The view for the page itself becomes simpler, since it only contains the overall page structure and calls to render the partial views.

### TIP

Follow the [Don't Repeat Yourself Principle](#) in your views.

## Declare partial views

Partial views are created like a regular view—by creating a `.cshtml` file within the `Views` folder. There's no semantic difference between a partial view and a regular view; however, they're rendered differently. You can have a view that's returned directly from a controller's [ViewResult](#), and the same view can be used as a partial view. The main difference between how a view and a partial view are rendered is that partial views don't run `_ViewStart.cshtml`. Regular views do run `_ViewStart.cshtml`. Learn more about `_ViewStart.cshtml` in [Layout](#).

As a convention, partial view file names often begin with `_`. This naming convention isn't a requirement, but it helps to visually differentiate partial views from regular views.

## Reference a partial view

Within a view page, there are several ways to render a partial view. The best practice is to use asynchronous rendering.

## Partial Tag Helper

The Partial Tag Helper requires ASP.NET Core 2.1 or later. It renders asynchronously and uses an HTML-like syntax:

```
<partial name="_AuthorPartial" />
```

For more information, see [Partial Tag Helper in ASP.NET Core](#).

## Asynchronous HTML Helper

When using an HTML Helper, the best practice is to use `PartialAsync`. It returns an `IHtmlContent` type wrapped in a `Task`. The method is referenced by prefixing the call with `@`:

```
@await Html.PartialAsync("_AuthorPartial")
```

Alternatively, you can render a partial view with `RenderPartialAsync`. This method doesn't return a result. It streams the rendered output directly to the response. Because the method doesn't return a result, it must be called within a Razor code block:

```
@{
    await Html.RenderPartialAsync("_AuthorPartial");
}
```

Since it streams the result directly, `RenderPartialAsync` may perform better in some scenarios. However, it's recommended that you use `PartialAsync`.

## Synchronous HTML Helper

`Partial` and `RenderPartial` are the synchronous equivalents of `PartialAsync` and `RenderPartialAsync`, respectively. Use of the synchronous equivalents isn't recommended because there are scenarios in which they deadlock. Future releases won't contain the synchronous methods.

### IMPORTANT

If your views need to execute code, use a [view component](#) instead of a partial view.

In ASP.NET Core 2.1 or later, calling `Partial` or `RenderPartial` results in an analyzer warning. For example, usage of `Partial` yields the following warning message:

```
Use of IHtmlHelper.Partial may result in application deadlocks. Consider using <partial> Tag Helper or  
IHtmlHelper.PartialAsync .
```

Replace calls to `@Html.Partial` with `@await Html.PartialAsync` or the Partial Tag Helper. For more information on Partial Tag Helper migration, see [Migrate from an HTML Helper](#).

## Partial view discovery

When referencing a partial view, you can refer to its location in several ways. For example:

```
// Uses a view in current folder with this name.
// If none is found, searches the Shared folder.
<partial name="_ViewName" />

// A view with this name must be in the same folder
<partial name="_ViewName.cshtml" />

// Locate the view based on the app root.
// Paths that start with "/" or "~/ refer to the app root.
<partial name("~/Views/Folder/_ViewName.cshtml" />
<partial name="/Views/Folder/_ViewName.cshtml" />

// Locate the view using a relative path
<partial name="../Account/_LoginPartial.cshtml" />
```

The preceding example uses the Partial Tag Helper, which requires ASP.NET Core 2.1 or later. The following example uses asynchronous HTML Helpers to accomplish the same task.

```
// Uses a view in current folder with this name.
// If none is found, searches the Shared folder.
@await Html.PartialAsync("_ViewName")

// A view with this name must be in the same folder
@await Html.PartialAsync("_ViewName.cshtml")

// Locate the view based on the app root.
// Paths that start with "/" or "~/ refer to the app root.
@await Html.PartialAsync("~/Views/Folder/_ViewName.cshtml")
@await Html.PartialAsync("/Views/Folder/_ViewName.cshtml")

// Locate the view using a relative path
@await Html.PartialAsync("../Account/_LoginPartial.cshtml")
```

You can have different partial views with the same file name in different view folders. When referencing the views by name (without a file extension), views in each folder use the partial view in the same folder with them. You can also specify a default partial view to use, placing it in the *Shared* folder. The shared partial view is used by any views that don't have their own version of the partial view. You can have a default partial view (in *Shared*), which is overridden by a partial view with the same name in the same folder as the parent view.

Partial views can be *chained*—a partial view can call another partial view (as long as you don't create a loop). Within each view or partial view, relative paths are always relative to that view, not to the root or parent view.

#### NOTE

A Razor `section` defined in a partial view is invisible to parents views. The `section` is only visible to the partial view in which it's defined.

## Access data from partial views

When a partial view is instantiated, it gets a copy of the parent view's `ViewData` dictionary. Updates made to the data within the partial view aren't persisted to the parent view. `ViewData` changes in a partial view are lost when the partial view returns.

You can pass an instance of [ViewDataDictionary](#) to the partial view:

```
@await Html.PartialAsync("_PartialName", custom ViewData)
```

You can pass a model into a partial view. The model can be the page's view model or a custom object. You can pass a model to `PartialAsync` or `RenderPartialAsync`:

```
@await Html.PartialAsync("_PartialName", viewModel)
```

You can pass an instance of `ViewDataDictionary` and a view model to a partial view:

```
@await Html.PartialAsync("_ArticleSection", section,
    new ViewDataDictionary(this.ViewData)
    {
        { "index", index }
    })
```

The following markup shows the `Views/Articles/Read.cshtml` view, which contains two partial views. The second partial view passes in a model and `ViewData` to the partial view. Use the highlighted `ViewDataDictionary` constructor overload to pass a new `ViewData` dictionary while retaining the existing `ViewData` dictionary.

```
@model PartialViewsSample.ViewModels.Article

<h2>@Model.Title</h2>
/*Pass the author's name to Views\Shared\_AuthorPartial.cshtml*/
@await Html.PartialAsync("_AuthorPartial", Model.AuthorName)
@Model.PublicationDate

/*Loop over the Sections and pass in a section and additional ViewData
   to the strongly typed Views\Articles\_ArticleSection.cshtml partial view.*/
@foreach (var section in Model.Sections)
{
    @await Html.PartialAsync("_ArticleSection", section,
        new ViewDataDictionary(this.ViewData)
        {
            { "index", index }
        })

    index++;
}
```

*Views/Shared/\_AuthorPartial:*

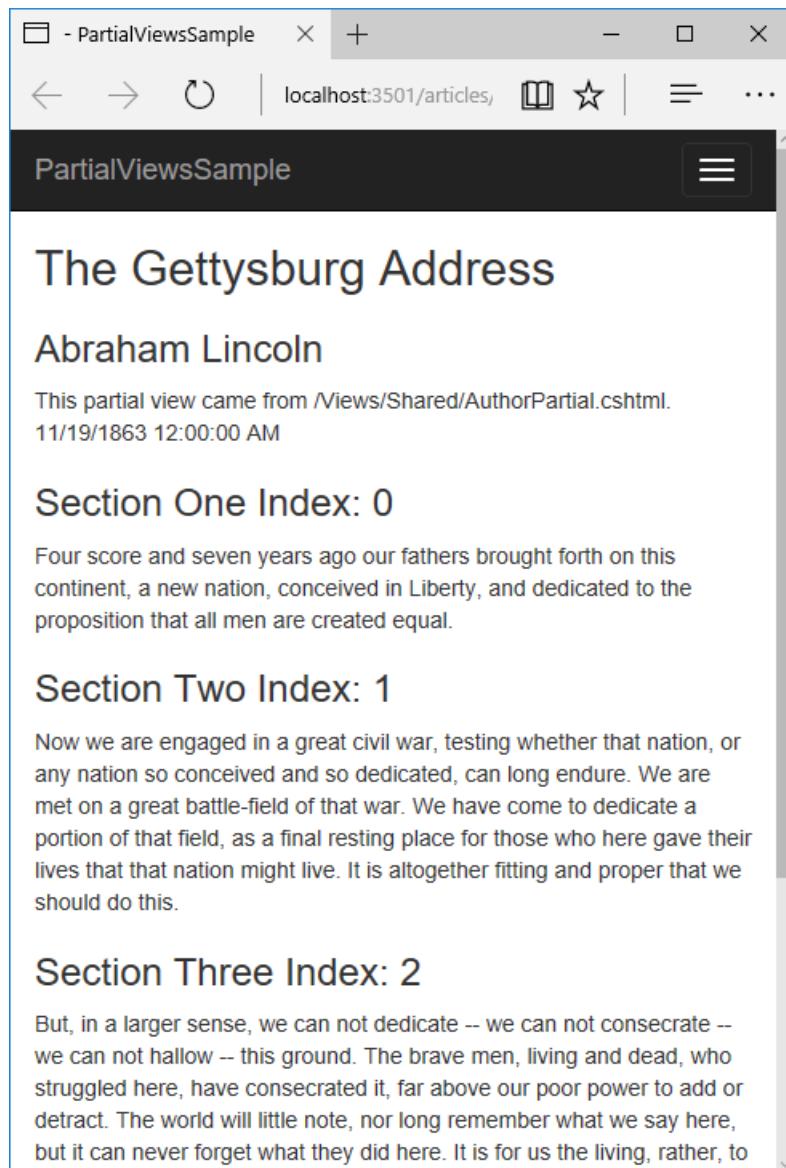
```
@model string
<div>
    <h3>@Model</h3>
    This partial view came from /Views/Shared/_AuthorPartial.cshtml.<br />
</div>
```

The `_ArticleSection` partial:

```
@using PartialViewsSample.ViewModels
@model ArticleSection

<h3>@Model.Title Index: @ViewData["index"]</h3>
<div>
    @Model.Content
</div>
```

At runtime, the partials are rendered into the parent view, which itself is rendered within the shared `_Layout.cshtml`.



The screenshot shows a browser window titled "PartialViewsSample" with the URL "localhost:3501/articles". The page displays the Gettysburg Address by Abraham Lincoln. The title "The Gettysburg Address" and author "Abraham Lincoln" are at the top. Below them is a partial view from "AuthorPartial.cshtml" showing the author's name and a timestamp. The main content is divided into three sections: "Section One Index: 0", "Section Two Index: 1", and "Section Three Index: 2", each containing a portion of the speech.

The browser interface includes standard navigation buttons (back, forward, search), a tab bar, and a header bar with the page title.

This partial view came from /Views/Shared/AuthorPartial.cshtml.  
11/19/1863 12:00:00 AM

**Section One Index: 0**

Four score and seven years ago our fathers brought forth on this continent, a new nation, conceived in Liberty, and dedicated to the proposition that all men are created equal.

**Section Two Index: 1**

Now we are engaged in a great civil war, testing whether that nation, or any nation so conceived and so dedicated, can long endure. We are met on a great battle-field of that war. We have come to dedicate a portion of that field, as a final resting place for those who here gave their lives that that nation might live. It is altogether fitting and proper that we should do this.

**Section Three Index: 2**

But, in a larger sense, we can not dedicate -- we can not consecrate -- we can not hallow -- this ground. The brave men, living and dead, who struggled here, have consecrated it, far above our poor power to add or detract. The world will little note, nor long remember what we say here, but it can never forget what they did here. It is for us the living, rather, to

## Additional resources

- [Razor syntax reference for ASP.NET Core](#)
- [Tag Helpers in ASP.NET Core](#)
- [Partial Tag Helper in ASP.NET Core](#)
- [View components in ASP.NET Core](#)
- [Razor syntax reference for ASP.NET Core](#)
- [View components in ASP.NET Core](#)

# Dependency injection into views in ASP.NET Core

6/21/2018 • 4 minutes to read • [Edit Online](#)

By [Steve Smith](#)

ASP.NET Core supports [dependency injection](#) into views. This can be useful for view-specific services, such as localization or data required only for populating view elements. You should try to maintain [separation of concerns](#) between your controllers and views. Most of the data your views display should be passed in from the controller.

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## A Simple Example

You can inject a service into a view using the `@inject` directive. You can think of `@inject` as adding a property to your view, and populating the property using DI.

The syntax for `@inject : @inject <type> <name>`

An example of `@inject` in action:

```
@using System.Threading.Tasks
@using ViewInjectSample.Model
@using ViewInjectSample.Model.Services
@model IEnumerable<ToDoItem>
@inject StatisticsService StatsService
<!DOCTYPE html>
<html>
<head>
    <title>To Do Items</title>
</head>
<body>
    <div>
        <h1>To Do Items</h1>
        <ul>
            <li>Total Items: @StatsService.GetCount()</li>
            <li>Completed: @StatsService.GetCompletedCount()</li>
            <li>Avg. Priority: @StatsService.GetAveragePriority()</li>
        </ul>
        <table>
            <thead>
                <tr>
                    <th>Name</th>
                    <th>Priority</th>
                    <th>Is Done?</th>
                </tr>
            </thead>
            <tbody>
                @foreach (var item in Model)
                {
                    <tr>
                        <td>@item.Name</td>
                        <td>@item.Priority</td>
                        <td>@item.IsDone</td>
                    </tr>
                }
            </tbody>
        </table>
    </div>
</body>
</html>
```

This view displays a list of `ToDoItem` instances, along with a summary showing overall statistics. The summary is

populated from the injected `StatisticsService`. This service is registered for dependency injection in `ConfigureServices` in `Startup.cs`:

```
// For more information on how to configure your application, visit http://go.microsoft.com/fwlink/?LinkID=398940
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc();

    services.AddTransient<IToDoItemRepository, ToDoItemRepository>();
    services.AddTransient<StatisticsService>();
    services.AddTransient<ProfileOptionsService>();
```

The `StatisticsService` performs some calculations on the set of `ToDoItem` instances, which it accesses via a repository:

```
using System.Linq;
using ViewInjectSample.Interfaces;

namespace ViewInjectSample.Model.Services
{
    public class StatisticsService
    {
        private readonly IToDoItemRepository _toDoItemRepository;

        public StatisticsService(IToDoItemRepository toDoItemRepository)
        {
            _toDoItemRepository = toDoItemRepository;
        }

        public int GetCount()
        {
            return _toDoItemRepository.List().Count();
        }

        public int GetCompletedCount()
        {
            return _toDoItemRepository.List().Count(x => x.IsDone);
        }

        public double GetAveragePriority()
        {
            if (_toDoItemRepository.List().Count() == 0)
            {
                return 0.0;
            }

            return _toDoItemRepository.List().Average(x => x.Priority);
        }
    }
}
```

The sample repository uses an in-memory collection. The implementation shown above (which operates on all of the data in memory) isn't recommended for large, remotely accessed data sets.

The sample displays data from the model bound to the view and the service injected into the view:

## To Do Items

- Total Items: 50
- Completed: 17
- Avg. Priority: 3

Name	Priority	Is Done?
Task 1	1	True
Task 2	2	False
Task 3	3	False
Task 4	4	True
Task 5	5	False

## Populating Lookup Data

View injection can be useful to populate options in UI elements, such as dropdown lists. Consider a user profile form that includes options for specifying gender, state, and other preferences. Rendering such a form using a standard MVC approach would require the controller to request data access services for each of these sets of options, and then populate a model or `ViewBag` with each set of options to be bound.

An alternative approach injects services directly into the view to obtain the options. This minimizes the amount of code required by the controller, moving this view element construction logic into the view itself. The controller action to display a profile editing form only needs to pass the form the profile instance:

```
using Microsoft.AspNetCore.Mvc;
using ViewInjectSample.Model;

namespace ViewInjectSample.Controllers
{
    public class ProfileController : Controller
    {
        [Route("Profile")]
        public IActionResult Index()
        {
            // TODO: look up profile based on logged-in user
            var profile = new Profile()
            {
                Name = "Steve",
                FavColor = "Blue",
                Gender = "Male",
                State = new State("Ohio", "OH")
            };
            return View(profile);
        }
    }
}
```

The HTML form used to update these preferences includes dropdown lists for three of the properties:

## Update Profile

Name:

Gender:

State:

Fav. Color:

These lists are populated by a service that has been injected into the view:

```
@using System.Threading.Tasks
@using ViewInjectSample.Model.Services
@model ViewInjectSample.Model.Profile
@inject ProfileOptionsService Options
<!DOCTYPE html>
<html>
<head>
    <title>Update Profile</title>
</head>
<body>
<div>
    <h1>Update Profile</h1>
    Name: @Html.TextBoxFor(m => m.Name)
    <br/>
    Gender: @Html.DropDownList("Gender",
        Options.ListGenders().Select(g =>
            new SelectListItem() { Text = g, Value = g }))
    <br/>

    State: @Html.DropDownListFor(m => m.State.Code,
        Options.ListStates().Select(s =>
            new SelectListItem() { Text = s.Name, Value = s.Code}))
    <br />

    Fav. Color: @Html.DropDownList("FavColor",
        Options.ListColors().Select(c =>
            new SelectListItem() { Text = c, Value = c }))
</div>
</body>
</html>
```

The `ProfileOptionsService` is a UI-level service designed to provide just the data needed for this form:

```

using System.Collections.Generic;

namespace ViewInjectSample.Model.Services
{
    public class ProfileOptionsService
    {
        public List<string> ListGenders()
        {
            // keeping this simple
            return new List<string>() {"Female", "Male"};
        }

        public List<State> ListStates()
        {
            // a few states from USA
            return new List<State>()
            {
                new State("Alabama", "AL"),
                new State("Alaska", "AK"),
                new State("Ohio", "OH")
            };
        }

        public List<string> ListColors()
        {
            return new List<string>() { "Blue", "Green", "Red", "Yellow" };
        }
    }
}

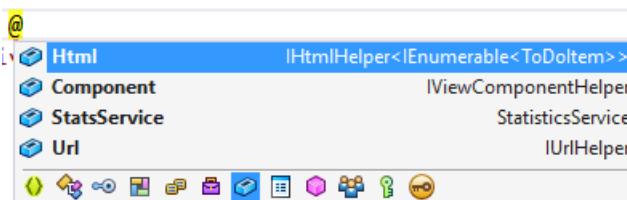
```

#### IMPORTANT

Don't forget to register types you request through dependency injection in `Startup.ConfigureServices`. An unregistered type throws an exception at runtime because the service provider is internally queried via `GetRequiredService`.

## Overriding Services

In addition to injecting new services, this technique can also be used to override previously injected services on a page. The figure below shows all of the fields available on the page used in the first example:



As you can see, the default fields include `Html`, `Component`, and `Url` (as well as the `StatsService` that we injected). If for instance you wanted to replace the default HTML Helpers with your own, you could easily do so using `@inject`:

```
@using System.Threading.Tasks
@using ViewInjectSample.Helpers
@inject MyHtmlHelper Html
<!DOCTYPE html>
<html>
<head>
    <title>My Helper</title>
</head>
<body>
    <div>
        Test: @Html.Value
    </div>
</body>
</html>
```

If you want to extend existing services, you can simply use this technique while inheriting from or wrapping the existing implementation with your own.

## See Also

- Simon Timms Blog: [Getting Lookup Data Into Your View](#)

# View components in ASP.NET Core

6/21/2018 • 9 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

[View or download sample code \(how to download\)](#)

## View components

View components are similar to partial views, but they're much more powerful. View components don't use model binding, and only depend on the data provided when calling into it. This article was written using ASP.NET Core MVC, but view components also work with Razor Pages.

A view component:

- Renders a chunk rather than a whole response.
- Includes the same separation-of-concerns and testability benefits found between a controller and view.
- Can have parameters and business logic.
- Is typically invoked from a layout page.

View components are intended anywhere you have reusable rendering logic that's too complex for a partial view, such as:

- Dynamic navigation menus
- Tag cloud (where it queries the database)
- Login panel
- Shopping cart
- Recently published articles
- Sidebar content on a typical blog
- A login panel that would be rendered on every page and show either the links to log out or log in, depending on the log in state of the user

A view component consists of two parts: the class (typically derived from [ViewComponent](#)) and the result it returns (typically a view). Like controllers, a view component can be a POCO, but most developers will want to take advantage of the methods and properties available by deriving from [viewComponent](#).

## Creating a view component

This section contains the high-level requirements to create a view component. Later in the article, we'll examine each step in detail and create a view component.

### The view component class

A view component class can be created by any of the following:

- Deriving from *ViewComponent*
- Decorating a class with the `[ViewComponent]` attribute, or deriving from a class with the `[ViewComponent]` attribute
- Creating a class where the name ends with the suffix *ViewComponent*

Like controllers, view components must be public, non-nested, and non-abstract classes. The view component name is the class name with the "ViewComponent" suffix removed. It can also be explicitly specified using the

`ViewComponentAttribute.Name` property.

A view component class:

- Fully supports constructor [dependency injection](#)
- Doesn't take part in the controller lifecycle, which means you can't use [filters](#) in a view component

## View component methods

A view component defines its logic in an `InvokeAsync` method that returns an `IViewComponentResult`. Parameters come directly from invocation of the view component, not from model binding. A view component never directly handles a request. Typically, a view component initializes a model and passes it to a view by calling the `View` method. In summary, view component methods:

- Define an `InvokeAsync` method that returns an `IViewComponentResult`
- Typically initializes a model and passes it to a view by calling the `ViewComponent` `View` method
- Parameters come from the calling method, not HTTP, there's no model binding
- Are not reachable directly as an HTTP endpoint, they're invoked from your code (usually in a view). A view component never handles a request
- Are overloaded on the signature rather than any details from the current HTTP request

## View search path

The runtime searches for the view in the following paths:

- Views/<controller\_name>/Components/<view\_component\_name>/<view\_name>
- Views/Shared/Components/<view\_component\_name>/<view\_name>

The default view name for a view component is *Default*, which means your view file will typically be named *Default.cshtml*. You can specify a different view name when creating the view component result or when calling the `View` method.

We recommend you name the view file *Default.cshtml* and use the *Views/Shared/Components/<view\_component\_name>/<view\_name>* path. The `PriorityList` view component used in this sample uses *Views/Shared/Components/PriorityList/Default.cshtml* for the view component view.

## Invoking a view component

To use the view component, call the following inside a view:

```
@Component.InvokeAsync("Name of view component", <anonymous type containing parameters>)
```

The parameters will be passed to the `InvokeAsync` method. The `PriorityList` view component developed in the article is invoked from the *Views/Todo/Index.cshtml* view file. In the following, the `InvokeAsync` method is called with two parameters:

```
@await Component.InvokeAsync("PriorityList", new { maxPriority = 4, isDone = true })
```

## Invoking a view component as a Tag Helper

For ASP.NET Core 1.1 and higher, you can invoke a view component as a [Tag Helper](#):

```
<vc:priority-list max-priority="2" is-done="false">
</vc:priority-list>
```

Pascal-cased class and method parameters for Tag Helpers are translated into their [lower kebab case](#). The Tag Helper to invoke a view component uses the `<vc></vc>` element. The view component is specified as follows:

```
<vc:[view-component-name]
  parameter1="parameter1 value"
  parameter2="parameter2 value">
</vc:[view-component-name]>
```

Note: In order to use a View Component as a Tag Helper, you must register the assembly containing the View Component using the `@addTagHelper` directive. For example, if your View Component is in an assembly called "MyWebApp", add the following directive to the `_ViewImports.cshtml` file:

```
@addTagHelper *, MyWebApp
```

You can register a View Component as a Tag Helper to any file that references the View Component. See [Managing Tag Helper Scope](#) for more information on how to register Tag Helpers.

The `InvokeAsync` method used in this tutorial:

```
@await Component.InvokeAsync("PriorityList", new { maxPriority = 4, isDone = true })
```

In Tag Helper markup:

```
<vc:priority-list max-priority="2" is-done="false">
</vc:priority-list>
```

In the sample above, the `PriorityList` view component becomes `priority-list`. The parameters to the view component are passed as attributes in lower kebab case.

### Invoking a view component directly from a controller

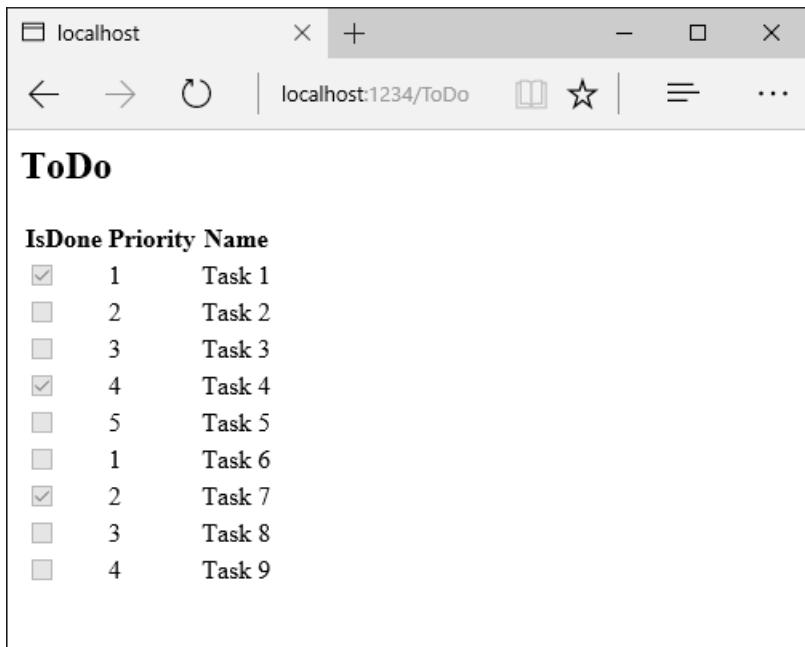
View components are typically invoked from a view, but you can invoke them directly from a controller method. While view components don't define endpoints like controllers, you can easily implement a controller action that returns the content of a `ViewComponentResult`.

In this example, the view component is called directly from the controller:

```
public IActionResult IndexVC()
{
    return ViewComponent("PriorityList", new { maxPriority = 3, isDone = false });
}
```

## Walkthrough: Creating a simple view component

[Download](#), build and test the starter code. It's a simple project with a `Todo` controller that displays a list of *Todo* items.



## Add a ViewComponent class

Create a `ViewComponents` folder and add the following `PriorityListViewComponent` class:

```
using Microsoft.AspNetCore.Mvc;
using Microsoft.EntityFrameworkCore;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using ViewComponentSample.Models;

namespace ViewComponentSample.ViewComponents
{
    public class PriorityListViewComponent : ViewComponent
    {
        private readonly ToDoContext db;

        public PriorityListViewComponent(ToDoContext context)
        {
            db = context;
        }

        public async Task<IViewComponentResult> InvokeAsync(
            int maxPriority, bool isDone)
        {
            var items = await GetItemsAsync(maxPriority, isDone);
            return View(items);
        }

        private Task<List<TodoItem>> GetItemsAsync(int maxPriority, bool isDone)
        {
            return db.ToDo.Where(x => x.IsDone == isDone &&
                x.Priority <= maxPriority).ToListAsync();
        }
    }
}
```

Notes on the code:

- View component classes can be contained in **any** folder in the project.
- Because the class name `PriorityListViewComponent` ends with the suffix **ViewComponent**, the runtime will use the string "PriorityList" when referencing the class component from a view. I'll explain that in more detail later.

- The `[ViewComponent]` attribute can change the name used to reference a view component. For example, we could've named the class `xyz` and applied the `viewComponent` attribute:

```
[ViewComponent(Name = "PriorityList")]
public class XYZ : ViewComponent
```

- The `[ViewComponent]` attribute above tells the view component selector to use the name `PriorityList` when looking for the views associated with the component, and to use the string "PriorityList" when referencing the class component from a view. I'll explain that in more detail later.
- The component uses [dependency injection](#) to make the data context available.
- `InvokeAsync` exposes a method which can be called from a view, and it can take an arbitrary number of arguments.
- The `InvokeAsync` method returns the set of `ToDo` items that satisfy the `isDone` and `maxPriority` parameters.

### Create the view component Razor view

- Create the `Views/Shared/Components` folder. This folder **must** be named `Components`.
- Create the `Views/Shared/Components/PriorityList` folder. This folder name must match the name of the view component class, or the name of the class minus the suffix (if we followed convention and used the `ViewComponent` suffix in the class name). If you used the `viewComponent` attribute, the class name would need to match the attribute designation.
- Create a `Views/Shared/Components/PriorityList/Default.cshtml` Razor view:

```
@model IEnumerable<ViewComponentSample.Models.TodoItem>

<h3>Priority Items</h3>
<ul>
    @foreach (var todo in Model)
    {
        <li>@todo.Name</li>
    }
</ul>
```

The Razor view takes a list of `TodoItem` and displays them. If the view component `InvokeAsync` method doesn't pass the name of the view (as in our sample), `Default` is used for the view name by convention. Later in the tutorial, I'll show you how to pass the name of the view. To override the default styling for a specific controller, add a view to the controller-specific view folder (for example `Views/Todo/Components/PriorityList/Default.cshtml`).

If the view component is controller-specific, you can add it to the controller-specific folder (`Views/Todo/Components/PriorityList/Default.cshtml`).

- Add a `div` containing a call to the priority list component to the bottom of the `Views/Todo/index.cshtml` file:

```
</table>
<div>
    @await Component.InvokeAsync("PriorityList", new { maxPriority = 2, isDone = false })
</div>
```

The markup `@await Component.InvokeAsync` shows the syntax for calling view components. The first argument is

the name of the component we want to invoke or call. Subsequent parameters are passed to the component. `InvokeAsync` can take an arbitrary number of arguments.

Test the app. The following image shows the ToDo list and the priority items:

The screenshot shows a web browser window titled "localhost" at "localhost:1235". The page displays a "ToDo" list with 9 items, each with a checkbox, a priority value (1-4), and a task name. Below the list is a section titled "Todo view - Priority Items" containing a bulleted list of tasks with priorities 2, 3, and 6 checked.

IsDone	Priority	Name
<input checked="" type="checkbox"/>	1	Task 1
<input type="checkbox"/>	2	Task 2
<input type="checkbox"/>	3	Task 3
<input checked="" type="checkbox"/>	4	Task 4
<input type="checkbox"/>	5	Task 5
<input type="checkbox"/>	1	Task 6
<input checked="" type="checkbox"/>	2	Task 7
<input type="checkbox"/>	3	Task 8
<input type="checkbox"/>	4	Task 9

**Todo view - Priority Items**

- Task 2
- Task 6

You can also call the view component directly from the controller:

```
public IActionResult IndexVC()
{
    return ViewComponent("PriorityList", new { maxPriority = 3, isDone = false });
}
```

The screenshot shows a web browser window titled "localhost" at "http://localhost:1235/todo/IndexVC". The page displays a "Todo view - Priority Items" section containing a bulleted list of tasks with priorities 2, 3, 6, and 8 checked.

**Todo view - Priority Items**

- Task 2
- Task 3
- Task 6
- Task 8

### Specifying a view name

A complex view component might need to specify a non-default view under some conditions. The following code shows how to specify the "PVC" view from the `InvokeAsync` method. Update the `InvokeAsync` method in the `PriorityListViewComponent` class.

```
public async Task<IViewComponentResult> InvokeAsync(
    int maxPriority, bool isDone)
{
    string MyView = "Default";
    // If asking for all completed tasks, render with the "PVC" view.
    if (maxPriority > 3 && isDone == true)
    {
        MyView = "PVC";
    }
    var items = await GetItemsAsync(maxPriority, isDone);
    return View(MyView, items);
}
```

Copy the *Views/Shared/Components/PriorityList/Default.cshtml* file to a view named *Views/Shared/Components/PriorityList/PVC.cshtml*. Add a heading to indicate the PVC view is being used.

```
@model IEnumerable<ViewComponentSample.Models.TodoItem>

<h2> PVC Named Priority Component View</h2>
<h4>@ViewBag.PriorityMessage</h4>
<ul>
    @foreach (var todo in Model)
    {
        <li>@todo.Name</li>
    }
</ul>
```

Update *Views/ToDoList/Index.cshtml*:

```
@await Component.InvokeAsync("PriorityList", new { maxPriority = 4, isDone = true })
```

Run the app and verify PVC view.

IsDone	Priority	Name
<input checked="" type="checkbox"/>	1	Task 1
<input type="checkbox"/>	2	Task 2
<input type="checkbox"/>	3	Task 3
<input checked="" type="checkbox"/>	4	Task 4
<input type="checkbox"/>	5	Task 5
<input type="checkbox"/>	1	Task 6
<input checked="" type="checkbox"/>	2	Task 7
<input type="checkbox"/>	3	Task 8
<input type="checkbox"/>	4	Task 9

**PVC Named Priority Component View**

- Task 1
- Task 4
- Task 7

If the PVC view isn't rendered, verify you are calling the view component with a priority of 4 or higher.

#### Examine the view path

- Change the priority parameter to three or less so the priority view isn't returned.
- Temporarily rename the `Views/Todo/Components/PriorityList/Default.cshtml` to `1Default.cshtml`.
- Test the app, you'll get the following error:

```
An unhandled exception occurred while processing the request.  
InvalidOperationException: The view 'Components/PriorityList/Default' wasn't found. The following  
locations were searched:  
/Views/Todo/Components/PriorityList/Default.cshtml  
/Views/Shared/Components/PriorityList/Default.cshtml  
EnsureSuccessful
```

- Copy `Views/Todo/Components/PriorityList/1Default.cshtml` to `Views/Shared/Components/PriorityList/Default.cshtml`.
- Add some markup to the `Shared` Todo view component view to indicate the view is from the `Shared` folder.
- Test the **Shared** component view.

IsDone	Priority	Name
<input checked="" type="checkbox"/>	1	Task 1
<input type="checkbox"/>	2	Task 2
<input type="checkbox"/>	3	Task 3
<input checked="" type="checkbox"/>	4	Task 4
<input type="checkbox"/>	5	Task 5
<input type="checkbox"/>	1	Task 6
<input checked="" type="checkbox"/>	2	Task 7
<input type="checkbox"/>	3	Task 8
<input type="checkbox"/>	4	Task 9

**Shared**

- Task 1
- Task 7

### Avoiding magic strings

If you want compile time safety, you can replace the hard-coded view component name with the class name. Create the view component without the "ViewComponent" suffix:

```
using Microsoft.AspNetCore.Mvc;
using Microsoft.EntityFrameworkCore;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using ViewComponentSample.Models;

namespace ViewComponentSample.ViewComponents
{
    public class PriorityList : ViewComponent
    {
        private readonly ToDoContext db;

        public PriorityList(ToDoContext context)
        {
            db = context;
        }

        public async Task<IViewComponentResult> InvokeAsync(
            int maxPriority, bool isDone)
        {
            var items = await GetItemsAsync(maxPriority, isDone);
            return View(items);
        }

        private Task<List<TodoItem>> GetItemsAsync(int maxPriority, bool isDone)
        {
            return db.ToDo.Where(x => x.IsDone == isDone &&
                x.Priority <= maxPriority).ToListAsync();
        }
    }
}
```

Add a `using` statement to your Razor view file, and use the `nameof` operator:

```
@using ViewComponentSample.Models
@using ViewComponentSample.ViewComponents
@model IEnumerable<TodoItem>

<h2>ToDo nameof</h2>
<!-- Markup removed for brevity. -->

<div>

    @await Component.InvokeAsync(nameof(PriorityList), new { maxPriority = 4, isDone = true })
</div>
```

## Additional resources

- [Dependency injection into views](#)

# Handle requests with controllers in ASP.NET Core MVC

6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Steve Smith](#) and [Scott Addie](#)

Controllers, actions, and action results are a fundamental part of how developers build apps using ASP.NET Core MVC.

## What is a Controller?

A controller is used to define and group a set of actions. An action (or *action method*) is a method on a controller which handles requests. Controllers logically group similar actions together. This aggregation of actions allows common sets of rules, such as routing, caching, and authorization, to be applied collectively. Requests are mapped to actions through [routing](#).

By convention, controller classes:

- Reside in the project's root-level `Controllers` folder
- Inherit from `Microsoft.AspNetCore.Mvc.Controller`

A controller is an instantiable class in which at least one of the following conditions is true:

- The class name is suffixed with "Controller"
- The class inherits from a class whose name is suffixed with "Controller"
- The class is decorated with the `[Controller]` attribute

A controller class must not have an associated `[NonController]` attribute.

Controllers should follow the [Explicit Dependencies Principle](#). There are a couple of approaches to implementing this principle. If multiple controller actions require the same service, consider using [constructor injection](#) to request those dependencies. If the service is needed by only a single action method, consider using [Action Injection](#) to request the dependency.

Within the **Model-View-Controller** pattern, a controller is responsible for the initial processing of the request and instantiation of the model. Generally, business decisions should be performed within the model.

The controller takes the result of the model's processing (if any) and returns either the proper view and its associated view data or the result of the API call. Learn more at [Overview of ASP.NET Core MVC](#) and [Get started with ASP.NET Core MVC and Visual Studio](#).

The controller is a *UI-level* abstraction. Its responsibilities are to ensure request data is valid and to choose which view (or result for an API) should be returned. In well-factored apps, it doesn't directly include data access or business logic. Instead, the controller delegates to services handling these responsibilities.

## Defining Actions

Public methods on a controller, except those decorated with the `[NonAction]` attribute, are actions. Parameters on actions are bound to request data and are validated using [model binding](#). Model validation occurs for everything that's model-bound. The `ModelState.IsValid` property value indicates whether model binding and validation succeeded.

Action methods should contain logic for mapping a request to a business concern. Business concerns should typically be represented as services that the controller accesses through [dependency injection](#). Actions then map the result of the business action to an application state.

Actions can return anything, but frequently return an instance of `IActionResult` (or `Task<IActionResult>` for async methods) that produces a response. The action method is responsible for choosing *what kind of response*. The action result *does the responding*.

## Controller Helper Methods

Controllers usually inherit from `Controller`, although this isn't required. Deriving from `Controller` provides access to three categories of helper methods:

### 1. Methods resulting in an empty response body

No `Content-Type` HTTP response header is included, since the response body lacks content to describe.

There are two result types within this category: Redirect and HTTP Status Code.

- **HTTP Status Code**

This type returns an HTTP status code. A couple of helper methods of this type are `BadRequest`, `NotFound`, and `Ok`. For example, `return BadRequest();` produces a 400 status code when executed. When methods such as `BadRequest`, `NotFound`, and `Ok` are overloaded, they no longer qualify as HTTP Status Code responders, since content negotiation is taking place.

- **Redirect**

This type returns a redirect to an action or destination (using `Redirect`, `LocalRedirect`, `RedirectToAction`, or `RedirectToRoute`). For example, `return RedirectToAction("Complete", new {id = 123});` redirects to `Complete`, passing an anonymous object.

The Redirect result type differs from the HTTP Status Code type primarily in the addition of a `Location` HTTP response header.

### 2. Methods resulting in a non-empty response body with a predefined content type

Most helper methods in this category include a `ContentType` property, allowing you to set the `Content-Type` response header to describe the response body.

There are two result types within this category: [View](#) and [Formatted Response](#).

- **View**

This type returns a view which uses a model to render HTML. For example, `return View(customer);` passes a model to the view for data-binding.

- **Formatted Response**

This type returns JSON or a similar data exchange format to represent an object in a specific manner. For example, `return Json(customer);` serializes the provided object into JSON format.

Other common methods of this type include `File`, `PhysicalFile`, and `VirtualFile`. For example, `return PhysicalFile(customerFilePath, "text/xml");` returns an XML file described by a `Content-Type` response header value of "text/xml".

### 3. Methods resulting in a non-empty response body formatted in a content type negotiated with the client

This category is better known as **Content Negotiation**. Content negotiation applies whenever an action returns an `ObjectResult` type or something other than an `IActionResult` implementation. An action that returns a non-`IActionResult` implementation (for example, `object`) also returns a Formatted Response.

Some helper methods of this type include `BadRequest`, `CreatedAtRoute`, and `Ok`. Examples of these methods

include `return BadRequest(modelState);`, `return CreatedAtRoute("routename", values, newobject);`, and `return Ok(value);`, respectively. Note that `BadRequest` and `Ok` perform content negotiation only when passed a value; without being passed a value, they instead serve as HTTP Status Code result types. The `CreatedAtRoute` method, on the other hand, always performs content negotiation since its overloads all require that a value be passed.

## Cross-Cutting Concerns

Applications typically share parts of their workflow. Examples include an app that requires authentication to access the shopping cart, or an app that caches data on some pages. To perform logic before or after an action method, use a *filter*. Using [Filters](#) on cross-cutting concerns can reduce duplication, allowing them to follow the [Don't Repeat Yourself \(DRY\) principle](#).

Most filter attributes, such as `[Authorize]`, can be applied at the controller or action level depending upon the desired level of granularity.

Error handling and response caching are often cross-cutting concerns:

- [Handle errors](#)
- [Response Caching](#)

Many cross-cutting concerns can be handled using filters or custom [middleware](#).

# Routing to controller actions in ASP.NET Core

7/10/2018 • 30 minutes to read • [Edit Online](#)

By [Ryan Nowak](#) and [Rick Anderson](#)

ASP.NET Core MVC uses the Routing [middleware](#) to match the URLs of incoming requests and map them to actions. Routes are defined in startup code or attributes. Routes describe how URL paths should be matched to actions. Routes are also used to generate URLs (for links) sent out in responses.

Actions are either conventionally routed or attribute routed. Placing a route on the controller or the action makes it attribute routed. See [Mixed routing](#) for more information.

This document will explain the interactions between MVC and routing, and how typical MVC apps make use of routing features. See [Routing](#) for details on advanced routing.

## Setting up Routing Middleware

In your `Configure` method you may see code similar to:

```
app.UseMvc(routes =>
{
    routes.MapRoute("default", "{controller=Home}/{action=Index}/{id?}");
});
```

Inside the call to `UseMvc`, `MapRoute` is used to create a single route, which we'll refer to as the `default` route. Most MVC apps will use a route with a template similar to the `default` route.

The route template `"{controller=Home}/{action=Index}/{id?}"` can match a URL path like `/Products/Details/5` and will extract the route values `{ controller = Products, action = Details, id = 5 }` by tokenizing the path. MVC will attempt to locate a controller named `ProductsController` and run the action `Details`:

```
public class ProductsController : Controller
{
    public IActionResult Details(int id) { ... }
```

Note that in this example, model binding would use the value of `id = 5` to set the `id` parameter to `5` when invoking this action. See the [Model Binding](#) for more details.

Using the `default` route:

```
routes.MapRoute("default", "{controller=Home}/{action=Index}/{id?}");
```

The route template:

- `{controller=Home}` defines `Home` as the default `controller`
- `{action=Index}` defines `Index` as the default `action`
- `{id?}` defines `id` as optional

Default and optional route parameters don't need to be present in the URL path for a match. See [Route Template Reference](#) for a detailed description of route template syntax.

"`{controller=Home}/{action=Index}/{id?}"` can match the URL path `/` and will produce the route values `{ controller = Home, action = Index }`. The values for `controller` and `action` make use of the default values, `id` doesn't produce a value since there's no corresponding segment in the URL path. MVC would use these route values to select the `HomeController` and `Index` action:

```
public class HomeController : Controller
{
    public IActionResult Index() { ... }
```

Using this controller definition and route template, the `HomeController.Index` action would be executed for any of the following URL paths:

- `/Home/Index/17`
- `/Home/Index`
- `/Home`
- `/`

The convenience method `UseMvcWithDefaultRoute`:

```
app.UseMvcWithDefaultRoute();
```

Can be used to replace:

```
app.UseMvc(routes =>
{
    routes.MapRoute("default", "{controller=Home}/{action=Index}/{id?}");
});
```

`UseMvc` and `UseMvcWithDefaultRoute` add an instance of `RouterMiddleware` to the middleware pipeline. MVC doesn't interact directly with middleware, and uses routing to handle requests. MVC is connected to the routes through an instance of `MvcRouteHandler`. The code inside of `UseMvc` is similar to the following:

```
var routes = new RouteBuilder(app);

// Add connection to MVC, will be hooked up by calls to MapRoute.
routes.DefaultHandler = new MvcRouteHandler(...);

// Execute callback to register routes.
// routes.MapRoute("default", "{controller=Home}/{action=Index}/{id?}");

// Create route collection and add the middleware.
app.UseRouter(routes.Build());
```

`UseMvc` doesn't directly define any routes, it adds a placeholder to the route collection for the `attribute` route. The overload `UseMvc(Action<IRouteBuilder>)` lets you add your own routes and also supports attribute routing. `UseMvc` and all of its variations adds a placeholder for the attribute route - attribute routing is always available regardless of how you configure `UseMvc`. `UseMvcWithDefaultRoute` defines a default route and supports attribute routing. The [Attribute Routing](#) section includes more details on attribute routing.

# Conventional routing

The `default` route:

```
routes.MapRoute("default", "{controller=Home}/{action=Index}/{id?}");
```

is an example of a *conventional routing*. We call this style *conventional routing* because it establishes a *convention* for URL paths:

- the first path segment maps to the controller name
- the second maps to the action name.
- the third segment is used for an optional `id` used to map to a model entity

Using this `default` route, the URL path `/Products/List` maps to the `ProductsController.List` action, and `/Blog/Article/17` maps to `BlogController.Article`. This mapping is based on the controller and action names **only** and isn't based on namespaces, source file locations, or method parameters.

## TIP

Using conventional routing with the default route allows you to build the application quickly without having to come up with a new URL pattern for each action you define. For an application with CRUD style actions, having consistency for the URLs across your controllers can help simplify your code and make your UI more predictable.

## WARNING

The `id` is defined as optional by the route template, meaning that your actions can execute without the ID provided as part of the URL. Usually what will happen if `id` is omitted from the URL is that it will be set to `0` by model binding, and as a result no entity will be found in the database matching `id == 0`. Attribute routing can give you fine-grained control to make the ID required for some actions and not for others. By convention the documentation will include optional parameters like `id` when they're likely to appear in correct usage.

## Multiple routes

You can add multiple routes inside `UseMvc` by adding more calls to `MapRoute`. Doing so allows you to define multiple conventions, or to add conventional routes that are dedicated to a specific action, such as:

```
app.UseMvc(routes =>
{
    routes.MapRoute("blog", "blog/{*article}",
        defaults: new { controller = "Blog", action = "Article" });
    routes.MapRoute("default", "{controller=Home}/{action=Index}/{id?}");
});
```

The `blog` route here is a *dedicated conventional route*, meaning that it uses the conventional routing system, but is dedicated to a specific action. Since `controller` and `action` don't appear in the route template as parameters, they can only have the default values, and thus this route will always map to the action `BlogController.Article`.

Routes in the route collection are ordered, and will be processed in the order they're added. So in this example, the `blog` route will be tried before the `default` route.

## NOTE

Dedicated conventional routes often use catch-all route parameters like `{*article}` to capture the remaining portion of the URL path. This can make a route 'too greedy' meaning that it matches URLs that you intended to be matched by other routes. Put the 'greedy' routes later in the route table to solve this.

## Fallback

As part of request processing, MVC will verify that the route values can be used to find a controller and action in your application. If the route values don't match an action then the route isn't considered a match, and the next route will be tried. This is called *fallback*, and it's intended to simplify cases where conventional routes overlap.

### Disambiguating actions

When two actions match through routing, MVC must disambiguate to choose the 'best' candidate or else throw an exception. For example:

```
public class ProductsController : Controller
{
    public IActionResult Edit(int id) { ... }

    [HttpPost]
    public IActionResult Edit(int id, Product product) { ... }
}
```

This controller defines two actions that would match the URL path `/Products/Edit/17` and route data `{ controller = Products, action = Edit, id = 17 }`. This is a typical pattern for MVC controllers where `Edit(int)` shows a form to edit a product, and `Edit(int, Product)` processes the posted form. To make this possible MVC would need to choose `Edit(int, Product)` when the request is an HTTP `POST` and `Edit(int)` when the HTTP verb is anything else.

The `HttpPostAttribute` (`[HttpPost]`) is an implementation of `IActionConstraint` that will only allow the action to be selected when the HTTP verb is `POST`. The presence of an `IActionConstraint` makes the `Edit(int, Product)` a 'better' match than `Edit(int)`, so `Edit(int, Product)` will be tried first.

You will only need to write custom `IActionConstraint` implementations in specialized scenarios, but it's important to understand the role of attributes like `HttpPostAttribute` - similar attributes are defined for other HTTP verbs. In conventional routing it's common for actions to use the same action name when they're part of a `show form -> submit form` workflow. The convenience of this pattern will become more apparent after reviewing the [Understanding IActionConstraint](#) section.

If multiple routes match, and MVC can't find a 'best' route, it will throw an `AmbiguousActionException`.

## Route names

The strings `"blog"` and `"default"` in the following examples are route names:

```
app.UseMvc(routes =>
{
    routes.MapRoute("blog", "blog/{*article}",
        defaults: new { controller = "Blog", action = "Article" });
    routes.MapRoute("default", "{controller=Home}/{action=Index}/{id?}");
});
```

The route names give the route a logical name so that the named route can be used for URL generation. This greatly simplifies URL creation when the ordering of routes could make URL generation complicated.

Route names must be unique application-wide.

Route names have no impact on URL matching or handling of requests; they're used only for URL generation. [Routing](#) has more detailed information on URL generation including URL generation in MVC-specific helpers.

## Attribute routing

Attribute routing uses a set of attributes to map actions directly to route templates. In the following example, `app.UseMvc();` is used in the `Configure` method and no route is passed. The `HomeController` will match a set of URLs similar to what the default route `{controller=Home}/{action=Index}/{id?}` would match:

```
public class HomeController : Controller
{
    [Route("")]
    [Route("Home")]
    [Route("Home/Index")]
    public IActionResult Index()
    {
        return View();
    }
    [Route("Home/About")]
    public IActionResult About()
    {
        return View();
    }
    [Route("Home/Contact")]
    public IActionResult Contact()
    {
        return View();
    }
}
```

The `HomeController.Index()` action will be executed for any of the URL paths `/`, `/Home`, or `/Home/Index`.

### NOTE

This example highlights a key programming difference between attribute routing and conventional routing. Attribute routing requires more input to specify a route; the conventional default route handles routes more succinctly. However, attribute routing allows (and requires) precise control of which route templates apply to each action.

With attribute routing the controller name and action names play **no** role in which action is selected. This example will match the same URLs as the previous example.

```

public class MyDemoController : Controller
{
    [Route("")]
    [Route("Home")]
    [Route("Home/Index")]
    public IActionResult MyIndex()
    {
        return View("Index");
    }
    [Route("Home/About")]
    public IActionResult MyAbout()
    {
        return View("About");
    }
    [Route("Home/Contact")]
    public IActionResult MyContact()
    {
        return View("Contact");
    }
}

```

#### NOTE

The route templates above don't define route parameters for `action`, `area`, and `controller`. In fact, these route parameters are not allowed in attribute routes. Since the route template is already associated with an action, it wouldn't make sense to parse the action name from the URL.

## Attribute routing with `Http[Verb]` attributes

Attribute routing can also make use of the `Http[Verb]` attributes such as `HttpPostAttribute`. All of these attributes can accept a route template. This example shows two actions that match the same route template:

```

[HttpGet("/products")]
public IActionResult ListProducts()
{
    // ...
}

[HttpPost("/products")]
public IActionResult CreateProduct(...)
{
    // ...
}

```

For a URL path like `/products` the `ProductsApi.ListProducts` action will be executed when the HTTP verb is `GET` and `ProductsApi.CreateProduct` will be executed when the HTTP verb is `POST`. Attribute routing first matches the URL against the set of route templates defined by route attributes. Once a route template matches, `IActionConstraint` constraints are applied to determine which actions can be executed.

#### TIP

When building a REST API, it's rare that you will want to use `[Route(...)]` on an action method. It's better to use the more specific `Http*Verb*Attributes` to be precise about what your API supports. Clients of REST APIs are expected to know what paths and HTTP verbs map to specific logical operations.

Since an attribute route applies to a specific action, it's easy to make parameters required as part of the route template definition. In this example, `id` is required as part of the URL path.

```
public class ProductsApiController : Controller
{
    [HttpGet("/products/{id}", Name = "Products_List")]
    public IActionResult GetProduct(int id) { ... }
}
```

The `ProductsApi.GetProduct(int)` action will be executed for a URL path like `/products/3` but not for a URL path like `/products`. See [Routing](#) for a full description of route templates and related options.

## Route Name

The following code defines a *route name* of `Products_List`:

```
public class ProductsApiController : Controller
{
    [HttpGet("/products/{id}", Name = "Products_List")]
    public IActionResult GetProduct(int id) { ... }
}
```

Route names can be used to generate a URL based on a specific route. Route names have no impact on the URL matching behavior of routing and are only used for URL generation. Route names must be unique application-wide.

### NOTE

Contrast this with the conventional *default route*, which defines the `id` parameter as optional (`{id?}`). This ability to precisely specify APIs has advantages, such as allowing `/products` and `/products/5` to be dispatched to different actions.

## Combining routes

To make attribute routing less repetitive, route attributes on the controller are combined with route attributes on the individual actions. Any route templates defined on the controller are prepended to route templates on the actions. Placing a route attribute on the controller makes **all** actions in the controller use attribute routing.

```
[Route("products")]
public class ProductsApiController : Controller
{
    [HttpGet]
    public IActionResult ListProducts() { ... }

    [HttpGet("{id}")]
    public ActionResult GetProduct(int id) { ... }
}
```

In this example the URL path `/products` can match `ProductsApi.ListProducts`, and the URL path `/products/5` can match `ProductsApi.GetProduct(int)`. Both of these actions only match HTTP `GET` because they're decorated with the `HttpGetAttribute`.

Route templates applied to an action that begin with a `/` don't get combined with route templates applied to the controller. This example matches a set of URL paths similar to the *default route*.

```

[Route("Home")]
public class HomeController : Controller
{
    [Route("")]      // Combines to define the route template "Home"
    [Route("Index")] // Combines to define the route template "Home/Index"
    [Route("/")]     // Doesn't combine, defines the route template ""
    public IActionResult Index()
    {
        ViewData["Message"] = "Home index";
        var url = Url.Action("Index", "Home");
        ViewData["Message"] = "Home index" + "var url = Url.Action; = " + url;
        return View();
    }

    [Route("About")] // Combines to define the route template "Home/About"
    public IActionResult About()
    {
        return View();
    }
}

```

## Ordering attribute routes

In contrast to conventional routes which execute in a defined order, attribute routing builds a tree and matches all routes simultaneously. This behaves as-if the route entries were placed in an ideal ordering; the most specific routes have a chance to execute before the more general routes.

For example, a route like `blog/search/{topic}` is more specific than a route like `blog/{*article}`. Logically speaking the `blog/search/{topic}` route 'runs' first, by default, because that's the only sensible ordering. Using conventional routing, the developer is responsible for placing routes in the desired order.

Attribute routes can configure an order, using the `Order` property of all of the framework provided route attributes. Routes are processed according to an ascending sort of the `Order` property. The default order is `0`. Setting a route using `Order = -1` will run before routes that don't set an order. Setting a route using `Order = 1` will run after default route ordering.

### TIP

Avoid depending on `Order`. If your URL-space requires explicit order values to route correctly, then it's likely confusing to clients as well. In general attribute routing will select the correct route with URL matching. If the default order used for URL generation isn't working, using route name as an override is usually simpler than applying the `Order` property.

## Token replacement in route templates ([controller], [action], [area])

For convenience, attribute routes support *token replacement* by enclosing a token in square-braces (`[ ]`). The tokens `[action]`, `[area]`, and `[controller]` will be replaced with the values of the action name, area name, and controller name from the action where the route is defined. In this example the actions can match URL paths as described in the comments:

```
[Route("[controller]/[action]")]
public class ProductsController : Controller
{
    [HttpGet] // Matches '/Products/List'
    public IActionResult List() {
        // ...
    }

    [HttpGet("{id}")] // Matches '/Products/Edit/{id}'
    public IActionResult Edit(int id) {
        // ...
    }
}
```

Token replacement occurs as the last step of building the attribute routes. The above example will behave the same as the following code:

```
public class ProductsController : Controller
{
    [HttpGet("[controller]/[action]")] // Matches '/Products/List'
    public IActionResult List() {
        // ...
    }

    [HttpGet("[controller]/[action]/{id}")] // Matches '/Products/Edit/{id}'
    public IActionResult Edit(int id) {
        // ...
    }
}
```

Attribute routes can also be combined with inheritance. This is particularly powerful combined with token replacement.

```
[Route("api/[controller]")]
public abstract class MyBaseController : Controller { ... }

public class ProductsController : MyBaseController
{
    [HttpGet] // Matches '/api/Products'
    public IActionResult List() { ... }

    [HttpPut("{id}")] // Matches '/api/Products/{id}'
    public IActionResult Edit(int id) { ... }
}
```

Token replacement also applies to route names defined by attribute routes.

`[Route("[controller]/[action]", Name="[controller]_[action]")]` will generate a unique route name for each action.

To match the literal token replacement delimiter `[` or `]`, escape it by repeating the character (`[[` or `]]`).

## Multiple Routes

Attribute routing supports defining multiple routes that reach the same action. The most common usage of this is to mimic the behavior of the *default conventional route* as shown in the following example:

```
[Route("[controller]")]
public class ProductsController : Controller
{
    [Route("")]      // Matches 'Products'
    [Route("Index")] // Matches 'Products/Index'
    public IActionResult Index()
}
```

Putting multiple route attributes on the controller means that each one will combine with each of the route attributes on the action methods.

```
[Route("Store")]
[Route("[controller]")]
public class ProductsController : Controller
{
    [HttpPost("Buy")]      // Matches 'Products/Buy' and 'Store/Buy'
    [HttpPost("Checkout")] // Matches 'Products/Checkout' and 'Store/Checkout'
    public IActionResult Buy()
}
```

When multiple route attributes (that implement `IActionConstraint`) are placed on an action, then each action constraint combines with the route template from the attribute that defined it.

```
[Route("api/[controller]")]
public class ProductsController : Controller
{
    [HttpPut("Buy")]      // Matches PUT 'api/Products/Buy'
    [HttpPost("Checkout")] // Matches POST 'api/Products/Checkout'
    public IActionResult Buy()
}
```

#### TIP

While using multiple routes on actions can seem powerful, it's better to keep your application's URL space simple and well-defined. Use multiple routes on actions only where needed, for example to support existing clients.

### Specifying attribute route optional parameters, default values, and constraints

Attribute routes support the same inline syntax as conventional routes to specify optional parameters, default values, and constraints.

```
[HttpPost("product/{id:int}")]
public IActionResult ShowProduct(int id)
{
    // ...
}
```

See [Route Template Reference](#) for a detailed description of route template syntax.

#### Custom route attributes using `IRouteTemplateProvider`

All of the route attributes provided in the framework (`[Route(...)]`, `[HttpGet(...)]`, etc.) implement the `IRouteTemplateProvider` interface. MVC looks for attributes on controller classes and action methods when the app starts and uses the ones that implement `IRouteTemplateProvider` to build the initial set of routes.

You can implement `IRouteTemplateProvider` to define your own route attributes. Each `IRouteTemplateProvider` allows you to define a single route with a custom route template, order, and name:

```
public class MyApiControllerAttribute : Attribute, IRouteTemplateProvider
{
    public string Template => "api/[controller]";

    public int? Order { get; set; }

    public string Name { get; set; }
}
```

The attribute from the above example automatically sets the `Template` to `"api/[controller]"` when `[MyApiController]` is applied.

### Using Application Model to customize attribute routes

The *application model* is an object model created at startup with all of the metadata used by MVC to route and execute your actions. The *application model* includes all of the data gathered from route attributes (through `IRouteTemplateProvider`). You can write *conventions* to modify the application model at startup time to customize how routing behaves. This section shows a simple example of customizing routing using application model.

```

using Microsoft.AspNetCore.Mvc.ApplicationModels;
using System.Linq;
using System.Text;
public class NamespaceRoutingConvention : IControllerModelConvention
{
    private readonly string _baseNamespace;

    public NamespaceRoutingConvention(string baseNamespace)
    {
        _baseNamespace = baseNamespace;
    }

    public void Apply(ControllerModel controller)
    {
        var hasRouteAttributes = controller.Selectors.Any(selector =>
            selector.AttributeRouteModel != null);
        if (hasRouteAttributes)
        {
            // This controller manually defined some routes, so treat this
            // as an override and not apply the convention here.
            return;
        }

        // Use the namespace and controller name to infer a route for the controller.
        //
        // Example:
        //
        // controller.ControllerTypeInfo -> "My.Application.Admin.UsersController"
        // baseNamespace -> "My.Application"
        //
        // template => "Admin/[controller]"
        //
        // This makes your routes roughly line up with the folder structure of your project.
        //
        var namespc = controller.ControllerType.Namespace;
        if (namespc == null)
            return;
        var template = new StringBuilder();
        template.Append(namespc, _baseNamespace.Length + 1,
            namespc.Length - _baseNamespace.Length - 1);
        template.Replace('.', '/');
        template.Append("/[controller]");

        foreach (var selector in controller.Selectors)
        {
            selector.AttributeRouteModel = new AttributeRouteModel()
            {
                Template = template.ToString()
            };
        }
    }
}

```

## Mixed routing: Attribute routing vs conventional routing

MVC applications can mix the use of conventional routing and attribute routing. It's typical to use conventional routes for controllers serving HTML pages for browsers, and attribute routing for controllers serving REST APIs.

Actions are either conventionally routed or attribute routed. Placing a route on the controller or the action makes it attribute routed. Actions that define attribute routes cannot be reached through the conventional routes and vice-versa. **Any** route attribute on the controller makes all actions in the controller attribute routed.

## NOTE

What distinguishes the two types of routing systems is the process applied after a URL matches a route template. In conventional routing, the route values from the match are used to choose the action and controller from a lookup table of all conventional routed actions. In attribute routing, each template is already associated with an action, and no further lookup is needed.

# URL Generation

MVC applications can use routing's URL generation features to generate URL links to actions. Generating URLs eliminates hardcoding URLs, making your code more robust and maintainable. This section focuses on the URL generation features provided by MVC and will only cover basics of how URL generation works. See [Routing](#) for a detailed description of URL generation.

The `IUrlHelper` interface is the underlying piece of infrastructure between MVC and routing for URL generation. You'll find an instance of `IUrlHelper` available through the `Url` property in controllers, views, and view components.

In this example, the `IUrlHelper` interface is used through the `Controller.Url` property to generate a URL to another action.

```
using Microsoft.AspNetCore.Mvc;

public class UrlGenerationController : Controller
{
    public IActionResult Source()
    {
        // Generates /UrlGeneration/Destination
        var url = Url.Action("Destination");
        return Content($"Go check out {url}, it's really great.");
    }

    public IActionResult Destination()
    {
        return View();
    }
}
```

If the application is using the default conventional route, the value of the `url` variable will be the URL path string `/UrlGeneration/Destination`. This URL path is created by routing by combining the route values from the current request (ambient values), with the values passed to `Url.Action` and substituting those values into the route template:

```
ambient values: { controller = "UrlGeneration", action = "Source" }
values passed to Url.Action: { controller = "UrlGeneration", action = "Destination" }
route template: {controller}/{action}/{id?}

result: /UrlGeneration/Destination
```

Each route parameter in the route template has its value substituted by matching names with the values and ambient values. A route parameter that doesn't have a value can use a default value if it has one, or be skipped if it's optional (as in the case of `id` in this example). URL generation will fail if any required route parameter doesn't have a corresponding value. If URL generation fails for a route, the next route is tried until all routes have been tried or a match is found.

The example of `Url.Action` above assumes conventional routing, but URL generation works similarly with

attribute routing, though the concepts are different. With conventional routing, the route values are used to expand a template, and the route values for `controller` and `action` usually appear in that template - this works because the URLs matched by routing adhere to a *convention*. In attribute routing, the route values for `controller` and `action` are not allowed to appear in the template - they're instead used to look up which template to use.

This example uses attribute routing:

```
// In Startup class
public void Configure(IApplicationBuilder app)
{
    app.UseMvc();
}

using Microsoft.AspNetCore.Mvc;

public class UrlGenerationController : Controller
{
    [HttpGet("")]
    public IActionResult Source()
    {
        var url = Url.Action("Destination"); // Generates /custom/url/to/destination
        return Content($"Go check out {url}, it's really great.");
    }

    [HttpGet("custom/url/to/destination")]
    public IActionResult Destination() {
        return View();
    }
}
```

MVC builds a lookup table of all attribute routed actions and will match the `controller` and `action` values to select the route template to use for URL generation. In the sample above, `custom/url/to/destination` is generated.

### Generating URLs by action name

`Url.Action` (`IUrlHelper` . `Action`) and all related overloads all are based on that idea that you want to specify what you're linking to by specifying a controller name and action name.

#### NOTE

When using `Url.Action`, the current route values for `controller` and `action` are specified for you - the value of `controller` and `action` are part of both *ambient values and values*. The method `Url.Action`, always uses the current values of `action` and `controller` and will generate a URL path that routes to the current action.

Routing attempts to use the values in ambient values to fill in information that you didn't provide when generating a URL. Using a route like `{a}/{b}/{c}/{d}` and ambient values

`{ a = Alice, b = Bob, c = Carol, d = David }`, routing has enough information to generate a URL without any additional values - since all route parameters have a value. If you added the value `{ d = Donovan }`, the value `{ d = David }` would be ignored, and the generated URL path would be `Alice/Bob/Carol/Donovan`.

### WARNING

URL paths are hierarchical. In the example above, if you added the value `{ c = Cheryl }`, both of the values `{ c = Carol, d = David }` would be ignored. In this case we no longer have a value for `d` and URL generation will fail. You would need to specify the desired value of `c` and `d`. You might expect to hit this problem with the default route (`{controller}/{action}/{id?}`) - but you will rarely encounter this behavior in practice as `Url.Action` will always explicitly specify a `controller` and `action` value.

Longer overloads of `Url.Action` also take an additional *route values* object to provide values for route parameters other than `controller` and `action`. You will most commonly see this used with `id` like `Url.Action("Buy", "Products", new { id = 17 })`. By convention the *route values* object is usually an object of anonymous type, but it can also be an `IDictionary<>` or a *plain old .NET object*. Any additional route values that don't match route parameters are put in the query string.

```
using Microsoft.AspNetCore.Mvc;

public class TestController : Controller
{
    public IActionResult Index()
    {
        // Generates /Products/Buy/17?color=red
        var url = Url.Action("Buy", "Products", new { id = 17, color = "red" });
        return Content(url);
    }
}
```

### TIP

To create an absolute URL, use an overload that accepts a `protocol`:

```
Url.Action("Buy", "Products", new { id = 17 }, protocol: Request.Scheme)
```

## Generating URLs by route

The code above demonstrated generating a URL by passing in the controller and action name. `IUrlHelper` also provides the `Url.RouteUrl` family of methods. These methods are similar to `Url.Action`, but they don't copy the current values of `action` and `controller` to the route values. The most common usage is to specify a route name to use a specific route to generate the URL, generally *without* specifying a controller or action name.

```
using Microsoft.AspNetCore.Mvc;

public class UrlGenerationController : Controller
{
    [HttpGet("")]
    public IActionResult Source()
    {
        var url = Url.RouteUrl("Destination_Route"); // Generates /custom/url/to/destination
        return Content($"See {url}, it's really great.");
    }

    [HttpGet("custom/url/to/destination", Name = "Destination_Route")]
    public IActionResult Destination()
    {
        return View();
    }
}
```

## Generating URLs in HTML

`IHtmlHelper` provides the `HtmlHelper` methods `Html.BeginForm` and `Html.ActionLink` to generate `<form>` and `<a>` elements respectively. These methods use the `Url.Action` method to generate a URL and they accept similar arguments. The `Url.RouteUrl` companions for `HtmlHelper` are `Html.BeginRouteForm` and `Html.RouteLink` which have similar functionality.

TagHelpers generate URLs through the `form` TagHelper and the `<a>` TagHelper. Both of these use `IUrlHelper` for their implementation. See [Working with Forms](#) for more information.

Inside views, the `IUrlHelper` is available through the `Url` property for any ad-hoc URL generation not covered by the above.

## Generating URLs in Action Results

The examples above have shown using `IUrlHelper` in a controller, while the most common usage in a controller is to generate a URL as part of an action result.

The `ControllerBase` and `Controller` base classes provide convenience methods for action results that reference another action. One typical usage is to redirect after accepting user input.

```
public Task<IActionResult> Edit(int id, Customer customer)
{
    if (ModelState.IsValid)
    {
        // Update DB with new details.
        return RedirectToAction("Index");
    }
}
```

The action results factory methods follow a similar pattern to the methods on `IUrlHelper`.

## Special case for dedicated conventional routes

Conventional routing can use a special kind of route definition called a *dedicated conventional route*. In the example below, the route named `blog` is a dedicated conventional route.

```
app.UseMvc(routes =>
{
    routes.MapRoute("blog", "blog/{*article}",
        defaults: new { controller = "Blog", action = "Article" });
    routes.MapRoute("default", "{controller=Home}/{action=Index}/{id?}");
});
```

Using these route definitions, `Url.Action("Index", "Home")` will generate the URL path `/` with the `default` route, but why? You might guess the route values `{ controller = Home, action = Index }` would be enough to generate a URL using `blog`, and the result would be `/blog?action=Index&controller=Home`.

Dedicated conventional routes rely on a special behavior of default values that don't have a corresponding route parameter that prevents the route from being "too greedy" with URL generation. In this case the default values are `{ controller = Blog, action = Article }`, and neither `controller` nor `action` appears as a route parameter. When routing performs URL generation, the values provided must match the default values. URL generation using `blog` will fail because the values `{ controller = Home, action = Index }` don't match `{ controller = Blog, action = Article }`. Routing then falls back to try `default`, which succeeds.

## Areas

[Areas](#) are an MVC feature used to organize related functionality into a group as a separate routing-namespace (for controller actions) and folder structure (for views). Using areas allows an application to have multiple controllers with the same name - as long as they have different *areas*. Using areas creates a

hierarchy for the purpose of routing by adding another route parameter, `area` to `controller` and `action`. This section will discuss how routing interacts with areas - see [Areas](#) for details about how areas are used with views.

The following example configures MVC to use the default conventional route and an *area route* for an area named `Blog`:

```
app.UseMvc(routes =>
{
    routes.MapAreaRoute("blog_route", "Blog",
        "Manage/{controller}/{action}/{id?}");
    routes.MapRoute("default_route", "{controller}/{action}/{id?}");
});
```

When matching a URL path like `/Manage/Users/AddUser`, the first route will produce the route values `{ area = Blog, controller = Users, action = AddUser }`. The `area` route value is produced by a default value for `area`, in fact the route created by `MapAreaRoute` is equivalent to the following:

```
app.UseMvc(routes =>
{
    routes.MapRoute("blog_route", "Manage/{controller}/{action}/{id?}",
        defaults: new { area = "Blog" }, constraints: new { area = "Blog" });
    routes.MapRoute("default_route", "{controller}/{action}/{id?}");
});
```

`MapAreaRoute` creates a route using both a default value and constraint for `area` using the provided area name, in this case `Blog`. The default value ensures that the route always produces `{ area = Blog, ... }`, the constraint requires the value `{ area = Blog, ... }` for URL generation.

#### TIP

Conventional routing is order-dependent. In general, routes with areas should be placed earlier in the route table as they're more specific than routes without an area.

Using the above example, the route values would match the following action:

```
using Microsoft.AspNetCore.Mvc;

namespace MyApp.Namespace1
{
    [Area("Blog")]
    public class UsersController : Controller
    {
        public IActionResult AddUser()
        {
            return View();
        }
    }
}
```

The `[AreaAttribute]` is what denotes a controller as part of an area, we say that this controller is in the `Blog` area. Controllers without an `[Area]` attribute are not members of any area, and will **not** match when the `area` route value is provided by routing. In the following example, only the first controller listed can match the route values `{ area = Blog, controller = Users, action = AddUser }`.

```
using Microsoft.AspNetCore.Mvc;

namespace MyApp.Namespace1
{
    [Area("Blog")]
    public class UsersController : Controller
    {
        public IActionResult AddUser()
        {
            return View();
        }
    }
}
```

```
using Microsoft.AspNetCore.Mvc;

namespace MyApp.Namespace2
{
    // Matches { area = Zebra, controller = Users, action = AddUser }
    [Area("Zebra")]
    public class UsersController : Controller
    {
        public IActionResult AddUser()
        {
            return View();
        }
    }
}
```

```
using Microsoft.AspNetCore.Mvc;

namespace MyApp.Namespace3
{
    // Matches { area = string.Empty, controller = Users, action = AddUser }
    // Matches { area = null, controller = Users, action = AddUser }
    // Matches { controller = Users, action = AddUser }
    public class UsersController : Controller
    {
        public IActionResult AddUser()
        {
            return View();
        }
    }
}
```

#### NOTE

The namespace of each controller is shown here for completeness - otherwise the controllers would have a naming conflict and generate a compiler error. Class namespaces have no effect on MVC's routing.

The first two controllers are members of areas, and only match when their respective area name is provided by the `area` route value. The third controller isn't a member of any area, and can only match when no value for `area` is provided by routing.

#### NOTE

In terms of matching *no value*, the absence of the `area` value is the same as if the value for `area` were null or the empty string.

When executing an action inside an area, the route value for `area` will be available as an *ambient value* for routing to use for URL generation. This means that by default areas act *sticky* for URL generation as demonstrated by the following sample.

```
app.UseMvc(routes =>
{
    routes.MapAreaRoute("duck_route", "Duck",
        "Manage/{controller}/{action}/{id?}");
    routes.MapRoute("default", "Manage/{controller=Home}/{action=Index}/{id?}");
});
```

```
using Microsoft.AspNetCore.Mvc;

namespace MyApp.Namespace4
{
    [Area("Duck")]
    public class UsersController : Controller
    {
        public IActionResult GenerateURLInArea()
        {
            // Uses the 'ambient' value of area
            var url = Url.Action("Index", "Home");
            // returns /Manage
            return Content(url);
        }

        public IActionResult GenerateURLOutsideOfArea()
        {
            // Uses the empty value for area
            var url = Url.Action("Index", "Home", new { area = "" });
            // returns /Manage/Home/Index
            return Content(url);
        }
    }
}
```

## Understanding `IActionConstraint`

#### NOTE

This section is a deep-dive on framework internals and how MVC chooses an action to execute. A typical application won't need a custom `IActionConstraint`.

You have likely already used `IActionConstraint` even if you're not familiar with the interface. The `[HttpGet]` Attribute and similar `[Http-VERB]` attributes implement `IActionConstraint` in order to limit the execution of an action method.

```

public class ProductsController : Controller
{
    [HttpGet]
    public IActionResult Edit() { }

    public IActionResult Edit(...) { }
}

```

Assuming the default conventional route, the URL path `/Products/Edit` would produce the values `{ controller = Products, action = Edit }`, which would match **both** of the actions shown here. In `IActionConstraint` terminology we would say that both of these actions are considered candidates - as they both match the route data.

When the `HttpGetAttribute` executes, it will say that `Edit()` is a match for `GET` and isn't a match for any other HTTP verb. The `Edit(...)` action doesn't have any constraints defined, and so will match any HTTP verb. So assuming a `POST` - only `Edit(...)` matches. But, for a `GET` both actions can still match - however, an action with an `IActionConstraint` is always considered *better* than an action without. So because `Edit()` has `[HttpGet]` it's considered more specific, and will be selected if both actions can match.

Conceptually, `IActionConstraint` is a form of *overloading*, but instead of overloading methods with the same name, it's overloading between actions that match the same URL. Attribute routing also uses `IActionConstraint` and can result in actions from different controllers both being considered candidates.

## Implementing `IActionConstraint`

The simplest way to implement an `IActionConstraint` is to create a class derived from `System.Attribute` and place it on your actions and controllers. MVC will automatically discover any `IActionConstraint` that are applied as attributes. You can use the application model to apply constraints, and this is probably the most flexible approach as it allows you to metaprogram how they're applied.

In the following example a constraint chooses an action based on a *country code* from the route data. The [full sample on GitHub](#).

```

public class CountrySpecificAttribute : Attribute, IActionConstraint
{
    private readonly string _countryCode;

    public CountrySpecificAttribute(string countryCode)
    {
        _countryCode = countryCode;
    }

    public int Order
    {
        get
        {
            return 0;
        }
    }

    public bool Accept(ActionConstraintContext context)
    {
        return string.Equals(
            context.RouteContext.RouteData.Values["country"].ToString(),
            _countryCode,
            StringComparison.OrdinalIgnoreCase);
    }
}

```

You are responsible for implementing the `Accept` method and choosing an 'Order' for the constraint to

execute. In this case, the `Accept` method returns `true` to denote the action is a match when the `country` route value matches. This is different from a `RouteValueAttribute` in that it allows fallback to a non-attributed action. The sample shows that if you define an `en-US` action then a country code like `fr-FR` will fall back to a more generic controller that doesn't have `[CountrySpecific(...)]` applied.

The `Order` property decides which *stage* the constraint is part of. Action constraints run in groups based on the `Order`. For example, all of the framework provided HTTP method attributes use the same `Order` value so that they run in the same stage. You can have as many stages as you need to implement your desired policies.

**TIP**

To decide on a value for `Order` think about whether or not your constraint should be applied before HTTP methods. Lower numbers run first.

# File uploads in ASP.NET Core

6/21/2018 • 8 minutes to read • [Edit Online](#)

By [Steve Smith](#)

ASP.NET MVC actions support uploading of one or more files using simple model binding for smaller files or streaming for larger files.

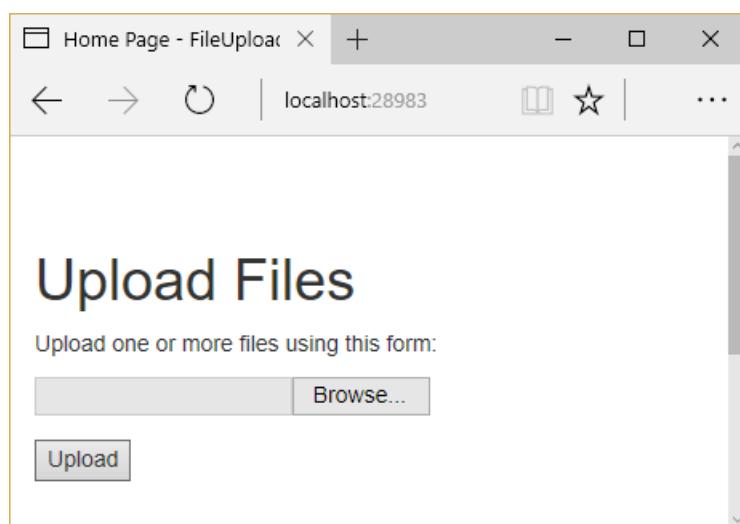
[View or download sample from GitHub](#)

## Uploading small files with model binding

To upload small files, you can use a multi-part HTML form or construct a POST request using JavaScript. An example form using Razor, which supports multiple uploaded files, is shown below:

```
<form method="post" enctype="multipart/form-data" asp-controller="UploadFiles" asp-action="Index">
    <div class="form-group">
        <div class="col-md-10">
            <p>Upload one or more files using this form:</p>
            <input type="file" name="files" multiple />
        </div>
    </div>
    <div class="form-group">
        <div class="col-md-10">
            <input type="submit" value="Upload" />
        </div>
    </div>
</form>
```

In order to support file uploads, HTML forms must specify an `enctype` of `multipart/form-data`. The `files` input element shown above supports uploading multiple files. Omit the `multiple` attribute on this input element to allow just a single file to be uploaded. The above markup renders in a browser as:



The individual files uploaded to the server can be accessed through [Model Binding](#) using the `IFormFile` interface. `IFormFile` has the following structure:

```

public interface IFormFile
{
    string ContentType { get; }
    string ContentDisposition { get; }
    IHeaderDictionary Headers { get; }
    long Length { get; }
    string Name { get; }
    string FileName { get; }
    Stream OpenReadStream();
    void CopyTo(Stream target);
    Task CopyToAsync(Stream target, CancellationToken cancellationToken = null);
}

```

### WARNING

Don't rely on or trust the `FileName` property without validation. The `FileName` property should only be used for display purposes.

When uploading files using model binding and the `IFormFile` interface, the action method can accept either a single `IFormFile` or an `IEnumerable<IFormFile>` (or `List<IFormFile>`) representing several files. The following example loops through one or more uploaded files, saves them to the local file system, and returns the total number and size of files uploaded.

**Warning:** The following code uses `GetTempFileName`, which throws an `IOException` if more than 65535 files are created without deleting previous temporary files. A real app should either delete temporary files or use `GetTempPath` and `GetRandomFileName` to create temporary file names. The 65535 files limit is per server, so another app on the server can use up all 65535 files.

```

[HttpPost("UploadFiles")]
public async Task<IActionResult> Post(List<IFormFile> files)
{
    long size = files.Sum(f => f.Length);

    // full path to file in temp location
    var filePath = Path.GetTempFileName();

    foreach (var formFile in files)
    {
        if (formFile.Length > 0)
        {
            using (var stream = new FileStream(filePath, FileMode.Create))
            {
                await formFile.CopyToAsync(stream);
            }
        }
    }

    // process uploaded files
    // Don't rely on or trust the FileName property without validation.

    return Ok(new { count = files.Count, size, filePath });
}

```

Files uploaded using the `IFormFile` technique are buffered in memory or on disk on the web server before being processed. Inside the action method, the `IFormFile` contents are accessible as a stream. In addition to the local file system, files can be streamed to [Azure Blob storage](#) or [Entity Framework](#).

To store binary file data in a database using Entity Framework, define a property of type `byte[]` on the entity:

```
public class ApplicationUser : IdentityUser
{
    public byte[] AvatarImage { get; set; }
}
```

Specify a.viewmodel property of type `IFormFile`:

```
public class RegisterViewModel
{
    // other properties omitted

    public IFormFile AvatarImage { get; set; }
}
```

#### NOTE

`IFormFile` can be used directly as an action method parameter or as a.viewmodel property, as shown above.

Copy the `IFormFile` to a stream and save it to the byte array:

```
// POST: /Account/Register
[HttpPost]
[AllowAnonymous]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Register(RegisterViewModel model)
{
    ViewData["ReturnUrl"] = returnUrl;
    if (ModelState.IsValid)
    {
        var user = new ApplicationUser {
            UserName = model.Email,
            Email = model.Email
        };
        using (var memoryStream = new MemoryStream())
        {
            await model.AvatarImage.CopyToAsync(memoryStream);
            user.AvatarImage = memoryStream.ToArray();
        }
        // additional logic omitted

        // Don't rely on or trust the model.AvatarImage.FileName property
        // without validation.
    }
}
```

#### NOTE

Use caution when storing binary data in relational databases, as it can adversely impact performance.

## Uploading large files with streaming

If the size or frequency of file uploads is causing resource problems for the app, consider streaming the file upload rather than buffering it in its entirety, as the model binding approach shown above does. While using `IFormFile` and model binding is a much simpler solution, streaming requires a number of steps to implement properly.

## NOTE

Any single buffered file exceeding 64KB will be moved from RAM to a temp file on disk on the server. The resources (disk, RAM) used by file uploads depend on the number and size of concurrent file uploads. Streaming isn't so much about perf, it's about scale. If you try to buffer too many uploads, your site will crash when it runs out of memory or disk space.

The following example demonstrates using JavaScript/Angular to stream to a controller action. The file's antiforgery token is generated using a custom filter attribute and passed in HTTP headers instead of in the request body. Because the action method processes the uploaded data directly, model binding is disabled by another filter. Within the action, the form's contents are read using a `MultipartReader`, which reads each individual `MultipartSection`, processing the file or storing the contents as appropriate. Once all sections have been read, the action performs its own model binding.

The initial action loads the form and saves an antiforgery token in a cookie (via the

`GenerateAntiforgeryTokenCookieForAjax` attribute):

```
[HttpGet]
[GenerateAntiforgeryTokenCookieForAjax]
public IActionResult Index()
{
    return View();
}
```

The attribute uses ASP.NET Core's built-in [Antiforgery](#) support to set a cookie with a request token:

```
public class GenerateAntiforgeryTokenCookieForAjaxAttribute : ActionFilterAttribute
{
    public override void OnActionExecuted(ActionExecutedContext context)
    {
        var antiforgery = context.HttpContext.RequestServices.GetService<IAntiforgery>();

        // We can send the request token as a JavaScript-readable cookie,
        // and Angular will use it by default.
        var tokens = antiforgery.GetAndStoreTokens(context.HttpContext);
        context.HttpContext.Response.Cookies.Append(
            "XSRF-TOKEN",
            tokens.RequestToken,
            new CookieOptions() { HttpOnly = false });
    }
}
```

Angular automatically passes an antiforgery token in a request header named `X-XSRF-TOKEN`. The ASP.NET Core MVC app is configured to refer to this header in its configuration in `Startup.cs`:

```
public void ConfigureServices(IServiceCollection services)
{
    // Angular's default header name for sending the XSRF token.
    services.AddAntiforgery(options => options.HeaderName = "X-XSRF-TOKEN");

    services.AddMvc();
}
```

The `DisableFormValueModelBinding` attribute, shown below, is used to disable model binding for the `Upload` action method.

```
[AttributeUsage(AttributeTargets.Class | AttributeTargets.Method)]
public class DisableFormValueModelBindingAttribute : Attribute, IResourceFilter
{
    public void OnResourceExecuting(ResourceExecutingContext context)
    {
        var factories = context.ValueProviderFactories;
        factories.RemoveType<FormValueProviderFactory>();
        factories.RemoveType<JQueryFormValueProviderFactory>();
    }

    public void OnResourceExecuted(ResourceExecutedContext context)
    {
    }
}
```

Since model binding is disabled, the `Upload` action method doesn't accept parameters. It works directly with the `Request` property of  `ControllerBase`. A `MultipartReader` is used to read each section. The file is saved with a GUID filename and the key/value data is stored in a `KeyValueAccumulator`. Once all sections have been read, the contents of the `KeyValueAccumulator` are used to bind the form data to a model type.

The complete `Upload` method is shown below:

**Warning:** The following code uses `GetTempFileName`, which throws an `IOException` if more than 65535 files are created without deleting previous temporary files. A real app should either delete temporary files or use `GetTempPath` and `GetRandomFileName` to create temporary file names. The 65535 files limit is per server, so another app on the server can use up all 65535 files.

```
// 1. Disable the form value model binding here to take control of handling
//     potentially large files.
// 2. Typically antiforgery tokens are sent in request body, but since we
//     do not want to read the request body early, the tokens are made to be
//     sent via headers. The antiforgery token filter first looks for tokens
//     in the request header and then falls back to reading the body.

[HttpPost]
[DisableFormValueModelBinding]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Upload()
{
    if (!MultipartRequestHelper.IsMultipartContentType(Request.ContentType))
    {
        return BadRequest($"Expected a multipart request, but got {Request.ContentType}");
    }

    // Used to accumulate all the form url encoded key value pairs in the
    // request.
    var formAccumulator = new KeyValueAccumulator();
    string targetFilePath = null;

    var boundary = MultipartRequestHelper.GetBoundary(
        MediaTypeHeaderValue.Parse(Request.ContentType),
        _defaultFormOptions.MultipartBoundaryLengthLimit);
    var reader = new MultipartReader(boundary, HttpContext.Request.Body);

    var section = await reader.ReadNextSectionAsync();
    while (section != null)
    {
        ContentDispositionHeaderValue contentDisposition;
        var hasContentDispositionHeader = ContentDispositionHeaderValue.TryParse(section.ContentDisposition,
            out contentDisposition);

        if (hasContentDispositionHeader)
        {
            if (MultipartRequestHelper.HasFileContentDisposition(contentDisposition))
            {
```

```

        targetFilePath = Path.GetTempFileName();
        using (var targetStream = System.IO.File.Create(targetFilePath))
        {
            await section.Body.CopyToAsync(targetStream);

            _logger.LogInformation($"Copied the uploaded file '{targetFilePath}'");
        }
    }
    else if (MultipartRequestHelper.HasFormDataContentDisposition(contentDisposition))
    {
        // Content-Disposition: form-data; name="key"
        //
        // value

        // Do not limit the key name length here because the
        // multipart headers length limit is already in effect.
        var key = HeaderUtilities.RemoveQuotes(contentDisposition.Name);
        var encoding = GetEncoding(section);
        using (var streamReader = new StreamReader(
            section.Body,
            encoding,
            detectEncodingFromByteOrderMarks: true,
            bufferSize: 1024,
            leaveOpen: true))
        {
            // The value length limit is enforced by MultipartBodyLengthLimit
            var value = await streamReader.ReadToEndAsync();
            if (String.Equals(value, "undefined", StringComparison.OrdinalIgnoreCase))
            {
                value = String.Empty;
            }
            formAccumulator.Append(key, value);

            if (formAccumulator.ValueCount > _defaultFormOptions.ValueCountLimit)
            {
                throw new InvalidDataException($"Form key count limit
{_defaultFormOptions.ValueCountLimit} exceeded.");
            }
        }
    }

    // Drains any remaining section body that has not been consumed and
    // reads the headers for the next section.
    section = await reader.ReadNextSectionAsync();
}

// Bind form data to a model
var user = new User();
var formValueProvider = new FormValueProvider(
    BindingSource.Form,
    new FormCollection(formAccumulator.GetResults()),
    CultureInfo.CurrentCulture);

var bindingSuccessful = await TryUpdateModelAsync(user, prefix: "",
    valueProvider: formValueProvider);
if (!bindingSuccessful)
{
    if (!ModelState.IsValid)
    {
        return BadRequest(ModelState);
    }
}

var uploadedData = new UploadedData()
{
    Name = user.Name,
    Age = user.Age,
    Zipcode = user.Zipcode
}

```

```
        Zipcode = user.Zipcode,
        FilePath = targetFilePath
    );
    return Json(uploadedData);
}
```

## Troubleshooting

Below are some common problems encountered when working with uploading files and their possible solutions.

### Unexpected Not Found error with IIS

The following error indicates your file upload exceeds the server's configured `maxAllowedContentLength` :

```
HTTP 404.13 - Not Found
The request filtering module is configured to deny a request that exceeds the request content length.
```

The default setting is `30000000`, which is approximately 28.6MB. The value can be customized by editing `web.config`:

```
<system.webServer>
  <security>
    <requestFiltering>
      <!-- This will handle requests up to 50MB -->
      <requestLimits maxAllowedContentLength="52428800" />
    </requestFiltering>
  </security>
</system.webServer>
```

This setting only applies to IIS. The behavior doesn't occur by default when hosting on Kestrel. For more information, see [Request Limits <requestLimits>](#).

### Null Reference Exception with IFormFile

If your controller is accepting uploaded files using `IFormFile` but you find that the value is always null, confirm that your HTML form is specifying an `enctype` value of `multipart/form-data`. If this attribute isn't set on the `<form>` element, the file upload won't occur and any bound `IFormFile` arguments will be null.

# Dependency injection into controllers in ASP.NET Core

6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Steve Smith](#)

ASP.NET Core MVC controllers should request their dependencies explicitly via their constructors. In some instances, individual controller actions may require a service, and it may not make sense to request at the controller level. In this case, you can also choose to inject a service as a parameter on the action method.

[View or download sample code \(how to download\)](#)

## Dependency Injection

Dependency injection is a technique that follows the [Dependency Inversion Principle](#), allowing for applications to be composed of loosely coupled modules. ASP.NET Core has built-in support for [dependency injection](#), which makes applications easier to test and maintain.

## Constructor Injection

ASP.NET Core's built-in support for constructor-based dependency injection extends to MVC controllers. By simply adding a service type to your controller as a constructor parameter, ASP.NET Core will attempt to resolve that type using its built in service container. Services are typically, but not always, defined using interfaces. For example, if your application has business logic that depends on the current time, you can inject a service that retrieves the time (rather than hard-coding it), which would allow your tests to pass in implementations that use a set time.

```
using System;

namespace ControllerDI.Interfaces
{
    public interface IDateTime
    {
        DateTime Now { get; }
    }
}
```

Implementing an interface like this one so that it uses the system clock at runtime is trivial:

```
using System;
using ControllerDI.Interfaces;

namespace ControllerDI.Services
{
    public class SystemDateTime : IDateTime
    {
        public DateTime Now
        {
            get { return DateTime.Now; }
        }
    }
}
```

With this in place, we can use the service in our controller. In this case, we have added some logic to the `HomeController` `Index` method to display a greeting to the user based on the time of day.

```
using ControllerDI.Interfaces;
using Microsoft.AspNetCore.Mvc;

namespace ControllerDI.Controllers
{
    public class HomeController : Controller
    {
        private readonly IDateTime _dateTime;

        public HomeController(IDateTime dateTime)
        {
            _dateTime = dateTime;
        }

        public IActionResult Index()
        {
            var serverTime = _dateTime.Now;
            if (serverTime.Hour < 12)
            {
                ViewData["Message"] = "It's morning here - Good Morning!";
            }
            else if (serverTime.Hour < 17)
            {
                ViewData["Message"] = "It's afternoon here - Good Afternoon!";
            }
            else
            {
                ViewData["Message"] = "It's evening here - Good Evening!";
            }
            return View();
        }
    }
}
```

If we run the application now, we will most likely encounter an error:

```
An unhandled exception occurred while processing the request.

InvalidOperationException: Unable to resolve service for type 'ControllerDI.Interfaces.IDateTime' while
attempting to activate 'ControllerDI.Controllers.HomeController'.
Microsoft.Extensions.DependencyInjection.ActivatorUtilities.GetService(IServiceProvider sp, Type type, Type
requiredBy, Boolean isDefaultParameterRequired)
```

This error occurs when we have not configured a service in the `ConfigureServices` method in our `Startup` class. To specify that requests for `IDateTime` should be resolved using an instance of `SystemDateTime`, add the highlighted line in the listing below to your `ConfigureServices` method:

```
public void ConfigureServices(IServiceCollection services)
{
    // Add application services.
    services.AddTransient<IDateTime, SystemDateTime>();
}
```

#### NOTE

This particular service could be implemented using any of several different lifetime options (`Transient`, `Scoped`, or `Singleton`). See [Dependency Injection](#) to understand how each of these scope options will affect the behavior of your service.

Once the service has been configured, running the application and navigating to the home page should display the time-based message as expected:



## A Message From The Server

It's afternoon here - Good Afternoon!

#### TIP

See [Test controller logic](#) to learn how to explicitly request dependencies <http://deviq.com/explicit-dependencies-principle/> in controllers makes code easier to test.

ASP.NET Core's built-in dependency injection supports having only a single constructor for classes requesting services. If you have more than one constructor, you may get an exception stating:

An unhandled exception occurred while processing the request.

```
InvalidOperationException: Multiple constructors accepting all given argument types have been found in type 'ControllerDI.Controllers.HomeController'. There should only be one applicable constructor.  
Microsoft.Extensions.DependencyInjection.ActivatorUtilities.FindApplicableConstructor(Type instanceType,  
Type[] argumentTypes, ConstructorInfo& matchingConstructor, Nullable`1[]& parameterMap)
```

As the error message states, you can correct this problem having just a single constructor. You can also [replace the default dependency injection support with a third party implementation](#), many of which support multiple constructors.

## Action Injection with FromServices

Sometimes you don't need a service for more than one action within your controller. In this case, it may make sense to inject the service as a parameter to the action method. This is done by marking the parameter with the attribute `[FromServices]` as shown here:

```
public IActionResult About([FromServices] IDateTime dateTime)  
{  
    ViewData["Message"] = "Currently on the server the time is " + dateTime.Now;  
  
    return View();  
}
```

## Accessing Settings from a Controller

Accessing application or configuration settings from within a controller is a common pattern. This access should use the Options pattern described in [configuration](#). You generally shouldn't request settings directly from your controller using dependency injection. A better approach is to request an `IOptions<T>` instance, where `T` is the

configuration class you need.

To work with the options pattern, you need to create a class that represents the options, such as this one:

```
namespace ControllerDI.Model
{
    public class SampleWebSettings
    {
        public string Title { get; set; }
        public int Updates { get; set; }
    }
}
```

Then you need to configure the application to use the options model and add your configuration class to the services collection in `ConfigureServices`:

```
public Startup(IHostingEnvironment env)
{
    var builder = new ConfigurationBuilder()
        .SetBasePath(env.ContentRootPath)
        .AddJsonFile("samplewebsettings.json");
    Configuration = builder.Build();
}

public IConfigurationRoot Configuration { get; set; }

// This method gets called by the runtime. Use this method to add services to the container.
// For more information on how to configure your application, visit http://go.microsoft.com/fwlink/?LinkID=398940
public void ConfigureServices(IServiceCollection services)
{
    // Required to use the Options<T> pattern
    services.AddOptions();

    // Add settings from configuration
    services.Configure<SampleWebSettings>(Configuration);

    // Uncomment to add settings from code
    //services.Configure<SampleWebSettings>(settings =>
    //{
    //    settings.Updates = 17;
    //});

    services.AddMvc();

    // Add application services.
    services.AddTransient<IDateTime, SystemDateTime>();
}
```

#### NOTE

In the above listing, we are configuring the application to read the settings from a JSON-formatted file. You can also configure the settings entirely in code, as is shown in the commented code above. See [Configuration](#) for further configuration options.

Once you've specified a strongly-typed configuration object (in this case, `SampleWebSettings`) and added it to the services collection, you can request it from any Controller or Action method by requesting an instance of `IOptions<T>` (in this case, `IOptions<SampleWebSettings>`). The following code shows how one would request the settings from a controller:

```
public class SettingsController : Controller
{
    private readonly SampleWebSettings _settings;

    public SettingsController(IOptions<SampleWebSettings> settingsOptions)
    {
        _settings = settingsOptions.Value;
    }

    public IActionResult Index()
    {
        ViewData["Title"] = _settings.Title;
        ViewData["Updates"] = _settings.Updates;
        return View();
    }
}
```

Following the Options pattern allows settings and configuration to be decoupled from one another, and ensures the controller is following [separation of concerns](#), since it doesn't need to know how or where to find the settings information. It also makes the controller easier to unit test [Test controller logic](#), since there's no [static cling](#) or direct instantiation of settings classes within the controller class.

# Test controller logic in ASP.NET Core

6/21/2018 • 17 minutes to read • [Edit Online](#)

By [Steve Smith](#)

Controllers in ASP.NET MVC apps should be small and focused on user-interface concerns. Large controllers that deal with non-UI concerns are more difficult to test and maintain.

[View or download sample from GitHub](#)

## Testing controllers

Controllers are a central part of any ASP.NET Core MVC application. As such, you should have confidence they behave as intended for your app. Automated tests can provide you with this confidence and can detect errors before they reach production. It's important to avoid placing unnecessary responsibilities within your controllers and ensure your tests focus only on controller responsibilities.

Controller logic should be minimal and not be focused on business logic or infrastructure concerns (for example, data access). Test controller logic, not the framework. Test how the controller *behaves* based on valid or invalid inputs. Test controller responses based on the result of the business operation it performs.

Typical controller responsibilities:

- Verify `ModelState.IsValid`.
- Return an error response if `ModelState` is invalid.
- Retrieve a business entity from persistence.
- Perform an action on the business entity.
- Save the business entity to persistence.
- Return an appropriate `IActionResult`.

## Unit testing

[Unit testing](#) involves testing a part of an app in isolation from its infrastructure and dependencies. When unit testing controller logic, only the contents of a single action is tested, not the behavior of its dependencies or of the framework itself. As you unit test your controller actions, make sure you focus only on its behavior. A controller unit test avoids things like [filters](#), [routing](#), or [model binding](#). By focusing on testing just one thing, unit tests are generally simple to write and quick to run. A well-written set of unit tests can be run frequently without much overhead. However, unit tests don't detect issues in the interaction between components, which is the purpose of [integration tests](#).

If you're writing custom filters, routes, etc, you should unit test them, but not as part of your tests on a particular controller action. They should be tested in isolation.

### TIP

[Create and run unit tests with Visual Studio.](#)

To demonstrate unit testing, review the following controller. It displays a list of brainstorming sessions and allows new brainstorming sessions to be created with a POST:

```

using System;
using System.ComponentModel.DataAnnotations;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using TestingControllersSample.Core.Interfaces;
using TestingControllersSample.Core.Model;
using TestingControllersSample.ViewModels;

namespace TestingControllersSample.Controllers
{
    public class HomeController : Controller
    {
        private readonly IBrainstormSessionRepository _sessionRepository;

        public HomeController(IBrainstormSessionRepository sessionRepository)
        {
            _sessionRepository = sessionRepository;
        }

        public async Task<IActionResult> Index()
        {
            var sessionList = await _sessionRepository.ListAsync();

            var model = sessionList.Select(session => new StormSessionViewModel()
            {
                Id = session.Id,
                DateCreated = session.DateCreated,
                Name = session.Name,
                IdeaCount = session.Ideas.Count
            });

            return View(model);
        }

        public class NewSessionModel
        {
            [Required]
            public string SessionName { get; set; }
        }

        [HttpPost]
        public async Task<IActionResult> Index(NewSessionModel model)
        {
            if (!ModelState.IsValid)
            {
                return BadRequest(ModelState);
            }
            else
            {
                await _sessionRepository.AddAsync(new BrainstormSession()
                {
                    DateCreated = DateTimeOffset.Now,
                    Name = model.SessionName
                });
            }

            return RedirectToAction(actionName: nameof(Index));
        }
    }
}

```

The controller is following the [explicit dependencies principle](#), expecting dependency injection to provide it with an instance of `IBrainstormSessionRepository`. This makes it fairly easy to test using a mock object framework, like [Moq](#). The `HTTP GET Index` method has no looping or branching and only calls one method. To test this `Index`

method, we need to verify that a `ViewResult` is returned, with a `ViewModel` from the repository's `List` method.

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Moq;
using TestingControllersSample.Controllers;
using TestingControllersSample.Core.Interfaces;
using TestingControllersSample.Core.Model;
using TestingControllersSample.ViewModels;
using Xunit;

namespace TestingControllersSample.Tests.UnitTests
{
    public class HomeControllerTests
    {
        [Fact]
        public async Task Index_ReturnsAViewResult_WithAListOfBrainstormSessions()
        {
            // Arrange
            var mockRepo = new Mock<IBrainstormSessionRepository>();
            mockRepo.Setup(repo => repo.ListAsync()).Returns(Task.FromResult(GetTestSessions()));
            var controller = new HomeController(mockRepo.Object);

            // Act
            var result = await controller.Index();

            // Assert
            var viewResult = Assert.IsType<ViewResult>(result);
            var model = Assert.IsAssignableFrom<IEnumerable<StormSessionViewModel>>(
                viewResult.ViewData.Model);
            Assert.Equal(2, model.Count());
        }

        private List<BrainstormSession> GetTestSessions()
        {
            var sessions = new List<BrainstormSession>();
            sessions.Add(new BrainstormSession()
            {
                DateCreated = new DateTime(2016, 7, 2),
                Id = 1,
                Name = "Test One"
            });
            sessions.Add(new BrainstormSession()
            {
                DateCreated = new DateTime(2016, 7, 1),
                Id = 2,
                Name = "Test Two"
            });
            return sessions;
        }
    }
}
```

The `HomeController` `HTTP POST Index` method (shown above) should verify:

- The action method returns a Bad Request `viewResult` with the appropriate data when `ModelState.IsValid` is `false`
- The `Add` method on the repository is called and a `RedirectToActionResult` is returned with the correct arguments when `ModelState.IsValid` is true.

Invalid model state can be tested by adding errors using `AddModelError` as shown in the first test below.

```

[Fact]
public async Task IndexPost_ReturnsBadRequestResult_WhenModelStateIsInvalid()
{
    // Arrange
    var mockRepo = new Mock<IBrainstormSessionRepository>();
    mockRepo.Setup(repo => repo.ListAsync()).Returns(Task.FromResult(GetTestSessions()));
    var controller = new HomeController(mockRepo.Object);
    controller.ModelState.AddModelError("SessionName", "Required");
    var newSession = new HomeController.NewSessionModel();

    // Act
    var result = await controller.Index(newSession);

    // Assert
    var badRequestResult = Assert.IsType<BadRequestObjectResult>(result);
    Assert.IsType<SerializableError>(badRequestResult.Value);
}

[Fact]
public async Task IndexPost_ReturnsARedirectAndAddsSession_WhenModelStateIsValid()
{
    // Arrange
    var mockRepo = new Mock<IBrainstormSessionRepository>();
    mockRepo.Setup(repo => repo.AddAsync(It.IsAny<BrainstormSession>()))
        .Returns(Task.CompletedTask)
        .Verifiable();
    var controller = new HomeController(mockRepo.Object);
    var newSession = new HomeController.NewSessionModel()
    {
        SessionName = "Test Name"
    };

    // Act
    var result = await controller.Index(newSession);

    // Assert
    var redirectToActionResult = Assert.IsType<RedirectToActionResult>(result);
    Assert.Null(redirectToActionResult.ControllerName);
    Assert.Equal("Index", redirectToActionResult.ActionName);
    mockRepo.Verify();
}

```

The first test confirms when `ModelState` isn't valid, the same `ViewResult` is returned as for a `GET` request. Note that the test doesn't attempt to pass in an invalid model. That wouldn't work anyway since model binding isn't running (though an [integration test](#) would use exercise model binding). In this case, model binding isn't being tested. These unit tests are only testing what the code in the action method does.

The second test verifies that when `ModelState` is valid, a new `BrainstormSession` is added (via the repository), and the method returns a `RedirectToActionResult` with the expected properties. Mocked calls that aren't called are normally ignored, but calling `Verifiable` at the end of the setup call allows it to be verified in the test. This is done with the call to `mockRepo.Verify`, which will fail the test if the expected method wasn't called.

#### NOTE

The Moq library used in this sample makes it easy to mix verifiable, or "strict", mocks with non-verifiable mocks (also called "loose" mocks or stubs). Learn more about [customizing Mock behavior with Moq](#).

Another controller in the app displays information related to a particular brainstorming session. It includes some logic to deal with invalid id values:

```

using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using TestingControllersSample.Core.Interfaces;
using TestingControllersSample.ViewModels;

namespace TestingControllersSample.Controllers
{
    public class SessionController : Controller
    {
        private readonly IBrainstormSessionRepository _sessionRepository;

        public SessionController(IBrainstormSessionRepository sessionRepository)
        {
            _sessionRepository = sessionRepository;
        }

        public async Task<IActionResult> Index(int? id)
        {
            if (!id.HasValue)
            {
                return RedirectToAction(actionName: nameof(Index), controllerName: "Home");
            }

            var session = await _sessionRepository.GetByIdAsync(id.Value);
            if (session == null)
            {
                return Content("Session not found.");
            }

            var viewModel = new StormSessionViewModel()
            {
                DateCreated = session.DateCreated,
                Name = session.Name,
                Id = session.Id
            };

            return View(viewModel);
        }
    }
}

```

The controller action has three cases to test, one for each `return` statement:

```

using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Moq;
using TestingControllersSample.Controllers;
using TestingControllersSample.Core.Interfaces;
using TestingControllersSample.Core.Model;
using TestingControllersSample.ViewModels;
using Xunit;

namespace TestingControllersSample.Tests.UnitTests
{
    public class SessionControllerTests
    {
        [Fact]
        public async Task IndexReturnsARedirectToIndexHomeWhenIdIsNull()
        {
            // Arrange
            var controller = new SessionController(sessionRepository: null);

            // Act

```

```

        var result = await controller.Index(id: null);

        // Assert
        var redirectToActionResult = Assert.IsType<RedirectToActionResult>(result);
        Assert.Equal("Home", redirectToActionResult.ControllerName);
        Assert.Equal("Index", redirectToActionResult.ActionName);
    }

    [Fact]
    public async Task IndexReturnsContentWithSessionNotFoundWhenSessionNotFound()
    {
        // Arrange
        int testSessionId = 1;
        var mockRepo = new Mock<IBrainstormSessionRepository>();
        mockRepo.Setup(repo => repo.GetByIdAsync(testSessionId))
            .Returns(Task.FromResult((BrainstormSession)null));
        var controller = new SessionController(mockRepo.Object);

        // Act
        var result = await controller.Index(testSessionId);

        // Assert
        var contentResult = Assert.IsType<ContentResult>(result);
        Assert.Equal("Session not found.", contentResult.Content);
    }

    [Fact]
    public async Task IndexReturnsViewResultWithStormSessionViewModel()
    {
        // Arrange
        int testSessionId = 1;
        var mockRepo = new Mock<IBrainstormSessionRepository>();
        mockRepo.Setup(repo => repo.GetByIdAsync(testSessionId))
            .Returns(Task.FromResult(GetTestSessions().FirstOrDefault(s => s.Id == testSessionId)));
        var controller = new SessionController(mockRepo.Object);

        // Act
        var result = await controller.Index(testSessionId);

        // Assert
        var viewResult = Assert.IsType<ViewResult>(result);
        var model = Assert.IsType<StormSessionViewModel>(viewResult.ViewData.Model);
        Assert.Equal("Test One", model.Name);
        Assert.Equal(2, model.DateCreated.Day);
        Assert.Equal(testSessionId, model.Id);
    }

    private List<BrainstormSession> GetTestSessions()
    {
        var sessions = new List<BrainstormSession>();
        sessions.Add(new BrainstormSession()
        {
            DateCreated = new DateTime(2016, 7, 2),
            Id = 1,
            Name = "Test One"
        });
        sessions.Add(new BrainstormSession()
        {
            DateCreated = new DateTime(2016, 7, 1),
            Id = 2,
            Name = "Test Two"
        });
        return sessions;
    }
}
}

```

The app exposes functionality as a web API (a list of ideas associated with a brainstorming session and a method for adding new ideas to a session):

```
using System;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using TestingControllersSample.ClientModels;
using TestingControllersSample.Core.Interfaces;
using TestingControllersSample.Core.Model;

namespace TestingControllersSample.Api
{
    [Route("api/ideas")]
    public class IdeasController : Controller
    {
        private readonly IBrainstormSessionRepository _sessionRepository;

        public IdeasController(IBrainstormSessionRepository sessionRepository)
        {
            _sessionRepository = sessionRepository;
        }

        [HttpGet("forsession/{sessionId}")]
        public async Task<IActionResult> ForSession(int sessionId)
        {
            var session = await _sessionRepository.GetByIdAsync(sessionId);
            if (session == null)
            {
                return NotFound(sessionId);
            }

            var result = session.Ideas.Select(idea => new IdeaDTO()
            {
                Id = idea.Id,
                Name = idea.Name,
                Description = idea.Description,
                DateCreated = idea.DateCreated
            }).ToList();

            return Ok(result);
        }

        [HttpPost("create")]
        public async Task<IActionResult> Create([FromBody]NewIdeaModel model)
        {
            if (!ModelState.IsValid)
            {
                return BadRequest(ModelState);
            }

            var session = await _sessionRepository.GetByIdAsync(model.SessionId);
            if (session == null)
            {
                return NotFound(model.SessionId);
            }

            var idea = new Idea()
            {
                DateCreated = DateTimeOffset.Now,
                Description = model.Description,
                Name = model.Name
            };
            session.AddIdea(idea);

            await _sessionRepository.UpdateAsync(session);
        }
    }
}
```

```
        return OK(session);
    }
}
```

The `ForSession` method returns a list of `IdeaDTO` types. Avoid returning your business domain entities directly via API calls, since frequently they include more data than the API client requires, and they unnecessarily couple your app's internal domain model with the API you expose externally. Mapping between domain entities and the types you will return over the wire can be done manually (using a LINQ `Select` as shown here) or using a library like [AutoMapper](#).

The unit tests for the `Create` and `ForSession` API methods:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Moq;
using TestingControllersSample.Api;
using TestingControllersSample.ClientModels;
using TestingControllersSample.Core.Interfaces;
using TestingControllersSample.Core.Model;
using Xunit;

namespace TestingControllersSample.Tests.UnitTests
{
    public class ApiIdeasControllerTests
    {
        [Fact]
        public async Task Create_ReturnsBadRequest_GivenInvalidModel()
        {
            // Arrange & Act
            var mockRepo = new Mock<IBrainstormSessionRepository>();
            var controller = new IdeasController(mockRepo.Object);
            controller.ModelState.AddModelError("error", "some error");

            // Act
            var result = await controller.Create(model: null);

            // Assert
            Assert.IsType<BadRequestObjectResult>(result);
        }

        [Fact]
        public async Task Create_ReturnsHttpNotFound_ForInvalidSession()
        {
            // Arrange
            int testSessionId = 123;
            var mockRepo = new Mock<IBrainstormSessionRepository>();
            mockRepo.Setup(repo => repo.GetByIdAsync(testSessionId))
                .Returns(Task.FromResult((BrainstormSession)null));
            var controller = new IdeasController(mockRepo.Object);

            // Act
            var result = await controller.Create(new NewIdeaModel());

            // Assert
            Assert.IsType<NotFoundObjectResult>(result);
        }

        [Fact]
        public async Task Create_ReturnsNewlyCreatedIdeaForSession()
        {
            // Arrange
            int testSessionId = 123;
```

```

        string testName = "test name";
        string testDescription = "test description";
        var testSession = GetTestSession();
        var mockRepo = new Mock<IBrainstormSessionRepository>();
        mockRepo.Setup(repo => repo.GetByIdAsync(testSessionId))
            .Returns(Task.FromResult(testSession));
        var controller = new IdeasController(mockRepo.Object);

        var newIdea = new NewIdeaModel()
        {
            Description = testDescription,
            Name = testName,
            SessionId = testSessionId
        };
        mockRepo.Setup(repo => repo.UpdateAsync(testSession))
            .Returns(Task.CompletedTask)
            .Verifiable();

        // Act
        var result = await controller.Create(newIdea);

        // Assert
        var okResult = Assert.IsType<OkObjectResult>(result);
        var returnSession = Assert.IsType<BrainstormSession>(okResult.Value);
        mockRepo.Verify();
        Assert.Equal(2, returnSession.Ideas.Count());
        Assert.Equal(testName, returnSession.Ideas.LastOrDefault().Name);
        Assert.Equal(testDescription, returnSession.Ideas.LastOrDefault().Description);
    }

    private BrainstormSession GetTestSession()
    {
        var session = new BrainstormSession()
        {
            DateCreated = new DateTime(2016, 7, 2),
            Id = 1,
            Name = "Test One"
        };

        var idea = new Idea() { Name = "One" };
        session.AddIdea(idea);
        return session;
    }
}
}

```

As stated previously, to test the behavior of the method when `ModelState` is invalid, add a model error to the controller as part of the test. Don't try to test model validation or model binding in your unit tests - just test your action method's behavior when confronted with a particular `ModelState` value.

The second test depends on the repository returning null, so the mock repository is configured to return null. There's no need to create a test database (in memory or otherwise) and construct a query that will return this result - it can be done in a single statement as shown.

The last test verifies that the repository's `Update` method is called. As we did previously, the mock is called with `Verifiable` and then the mocked repository's `Verify` method is called to confirm the verifiable method was executed. It's not a unit test responsibility to ensure that the `Update` method saved the data; that can be done with an integration test.

## Integration testing

[Integration tests](#) is done to ensure separate modules within your app work correctly together. Generally, anything you can test with a unit test, you can also test with an integration test, but the reverse isn't true. However,

integration tests tend to be much slower than unit tests. Thus, it's best to test whatever you can with unit tests, and use integration tests for scenarios that involve multiple collaborators.

Although they may still be useful, mock objects are rarely used in integration tests. In unit testing, mock objects are an effective way to control how collaborators outside of the unit being tested should behave for the purposes of the test. In an integration test, real collaborators are used to confirm the whole subsystem works together correctly.

## Application state

One important consideration when performing integration testing is how to set your app's state. Tests need to run independent of one another, and so each test should start with the app in a known state. If your app doesn't use a database or have any persistence, this may not be an issue. However, most real-world apps persist their state to some kind of data store, so any modifications made by one test could impact another test unless the data store is reset. Using the built-in `TestServer`, it's very straightforward to host ASP.NET Core apps within our integration tests, but that doesn't necessarily grant access to the data it will use. If you're using an actual database, one approach is to have the app connect to a test database, which your tests can access and ensure is reset to a known state before each test executes.

In this sample application, I'm using Entity Framework Core's `InMemoryDatabase` support, so I can't just connect to it from my test project. Instead, I expose an `InitializeDatabase` method from the app's `Startup` class, which I call when the app starts up if it's in the `Development` environment. My integration tests automatically benefit from this as long as they set the environment to `Development`. I don't have to worry about resetting the database, since the `InMemoryDatabase` is reset each time the app restarts.

The `Startup` class:

```
using System;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;
using TestingControllersSample.Core.Interfaces;
using TestingControllersSample.Core.Model;
using TestingControllersSample.Infrastructure;

namespace TestingControllersSample
{
    public class Startup
    {
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<AppDbContext>(
                optionsBuilder => optionsBuilder.UseInMemoryDatabase("InMemoryDb"));

            services.AddMvc();

            services.AddScoped<IBrainstormSessionRepository,
                EFStormSessionRepository>();
        }

        public void Configure(IApplicationBuilder app,
            IHostingEnvironment env,
            ILoggerFactory loggerFactory)
        {
            if (env.IsDevelopment())
            {
                var repository = app.ApplicationServices.GetService<IBrainstormSessionRepository>();
                InitializeDatabaseAsync(repository).Wait();
            }
        }
    }
}
```

```
        app.UseStaticFiles();

        app.UseMvcWithDefaultRoute();
    }

    public async Task InitializeDatabaseAsync(IBrainstormSessionRepository repo)
    {
        var sessionList = await repo.ListAsync();
        if (!sessionList.Any())
        {
            await repo.AddAsync(GetTestSession());
        }
    }

    public static BrainstormSession GetTestSession()
    {
        var session = new BrainstormSession()
        {
            Name = "Test Session 1",
            DateCreated = new DateTime(2016, 8, 1)
        };
        var idea = new Idea()
        {
            DateCreated = new DateTime(2016, 8, 1),
            Description = "Totally awesome idea",
            Name = "Awesome idea"
        };
        session.AddIdea(idea);
        return session;
    }
}
```

You'll see the `GetTestSession` method used frequently in the integration tests below.

## Accessing views

Each integration test class configures the `TestServer` that will run the ASP.NET Core app. By default, `TestServer` hosts the web app in the folder where it's running - in this case, the test project folder. Thus, when you attempt to test controller actions that return `ViewResult`, you may see this error:

The view 'Index' wasn't found. The following locations were searched:  
(list of locations)

To correct this issue, you need to configure the server's content root, so it can locate the views for the project being tested. This is done by a call to `UseContentRoot` in the `TestFixture` class, shown below:

```
using System;
using System.IO;
using System.Net.Http;
using System.Reflection;
using Microsoft.AspNetCore.Hosting;
using Microsoft.AspNetCore.Mvc.ApplicationParts;
using Microsoft.AspNetCore.Mvc.Controllers;
using Microsoft.AspNetCore.Mvc.ViewComponents;
using Microsoft.AspNetCore.TestHost;
using Microsoft.Extensions.DependencyInjection;

namespace TestingControllersSample.Tests.IntegrationTests
{
    /// <summary>
    /// A test fixture which hosts the target project (project we wish to test) in an in-memory server.
    /// </summary>
    /// <typeparam name="TStartup">Target project's startup type</typeparam>
    public classTestFixture<TStartup> : IDisposable
```

```

{
    private readonly TestServer _server;

    public TestFixture()
        : this(Path.Combine("src"))
    {
    }

    protected TestFixture(string relativeTargetProjectParentDir)
    {
        var startupAssembly = typeof(TStartup).GetTypeInfo().Assembly;
        var contentRoot = GetProjectPath(relativeTargetProjectParentDir, startupAssembly);

        var builder = new WebHostBuilder()
            .UseContentRoot(contentRoot)
            .ConfigureServices(InitializeServices)
            .UseEnvironment("Development")
            .UseStartup(typeof(TStartup));

        _server = new TestServer(builder);

        Client = _server.CreateClient();
        Client.BaseAddress = new Uri("http://localhost");
    }

    public HttpClient Client { get; }

    public void Dispose()
    {
        Client.Dispose();
        _server.Dispose();
    }

    protected virtual void InitializeServices(IServiceCollection services)
    {
        var startupAssembly = typeof(TStartup).GetTypeInfo().Assembly;

        // Inject a custom application part manager.
        // Overrides AddMvcCore() because it uses TryAdd().
        var manager = new ApplicationPartManager();
        manager.ApplicationParts.Add(new AssemblyPart(startupAssembly));
        manager.FeatureProviders.Add(new ControllerFeatureProvider());
        manager.FeatureProviders.Add(new ViewComponentFeatureProvider());

        services.AddSingleton(manager);
    }

    /// <summary>
    /// Gets the full path to the target project that we wish to test
    /// </summary>
    /// <param name="projectRelativePath">
    /// The parent directory of the target project.
    /// e.g. src, samples, test, or test/Websites
    /// </param>
    /// <param name="startupAssembly">The target project's assembly.</param>
    /// <returns>The full path to the target project.</returns>
    private static string GetProjectPath(string projectRelativePath, Assembly startupAssembly)
    {
        // Get name of the target project which we want to test
        var projectName = startupAssembly.GetName().Name;

        // Get currently executing test project path
        var applicationBasePath = System.AppContext.BaseDirectory;

        // Find the path to the target project
        var directoryInfo = new DirectoryInfo(applicationBasePath);
        do
        {
            directoryInfo = directoryInfo.Parent;
        }

```

```
    var projectDirectoryInfo = new DirectoryInfo(Path.Combine(directoryInfo.FullName,
projectRelativePath));
        if (projectDirectoryInfo.Exists)
        {
            var projectFileInfo = new FileInfo(Path.Combine(projectDirectoryInfo.FullName, projectName,
 $"{projectName}.csproj"));
            if (projectFileInfo.Exists)
            {
                return Path.Combine(projectDirectoryInfo.FullName, projectName);
            }
        }
    }
    while (directoryInfo.Parent != null);

    throw new Exception($"Project root could not be located using the application root
{applicationBasePath}.");
}
}
}
```

The `TestFixture` class is responsible for configuring and creating the `TestServer`, setting up an `HttpClient` to communicate with the `TestServer`. Each of the integration tests uses the `Client` property to connect to the test server and make a request.

```

using System;
using System.Collections.Generic;
using System.Net;
using System.Net.Http;
using System.Threading.Tasks;
using Xunit;

namespace TestingControllersSample.Tests.IntegrationTests
{
    public class HomeControllerTests : IClassFixture<TestFixture<TestingControllersSample.Startup>>
    {
        private readonly HttpClient _client;

        public HomeControllerTests(TestFixture<TestingControllersSample.Startup> fixture)
        {
            _client = fixture.Client;
        }

        [Fact]
        public async Task ReturnsInitialListOfBrainstormSessions()
        {
            // Arrange - get a session known to exist
            var testSession = Startup.GetTestSession();

            // Act
            var response = await _client.GetAsync("/");

            // Assert
            response.EnsureSuccessStatusCode();
            var responseString = await response.Content.ReadAsStringAsync();
            Assert.Contains(testSession.Name, responseString);
        }

        [Fact]
        public async Task PostAddsNewBrainstormSession()
        {
            // Arrange
            string testSessionName = Guid.NewGuid().ToString();
            var data = new Dictionary<string, string>();
            data.Add("SessionName", testSessionName);
            var content = new FormUrlEncodedContent(data);

            // Act
            var response = await _client.PostAsync("/", content);

            // Assert
            Assert.Equal(HttpStatusCode.Redirect, response.StatusCode);
            Assert.Equal("/", response.Headers.Location.ToString());
        }
    }
}

```

In the first test above, the `responseString` holds the actual rendered HTML from the View, which can be inspected to confirm it contains expected results.

The second test constructs a form POST with a unique session name and POSTs it to the app, then verifies that the expected redirect is returned.

## API methods

If your app exposes web APIs, it's a good idea to have automated tests confirm they execute as expected. The built-in `TestServer` makes it easy to test web APIs. If your API methods are using model binding, you should always check `ModelState.IsValid`, and integration tests are the right place to confirm that your model validation is working properly.

The following set of tests target the `Create` method in the `IdeasController` class shown above:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Net;
using System.Net.Http;
using System.Threading.Tasks;
using Newtonsoft.Json;
using TestingControllersSample.ClientModels;
using TestingControllersSample.Core.Model;
using Xunit;

namespace TestingControllersSample.Tests.IntegrationTests
{
    public class ApiIdeasControllerTests : IClassFixture<TestFixture<TestingControllersSample.Startup>>
    {
        internal class NewIdeaDto
        {
            public NewIdeaDto(string name, string description, int sessionId)
            {
                Name = name;
                Description = description;
                SessionId = sessionId;
            }

            public string Name { get; set; }
            public string Description { get; set; }
            public int SessionId { get; set; }
        }

        private readonly HttpClient _client;

        public ApiIdeasControllerTests(TestFixture<TestingControllersSample.Startup> fixture)
        {
            _client = fixture.Client;
        }

        [Fact]
        public async Task CreatePostReturnsBadRequestForMissingNameValue()
        {
            // Arrange
            var newIdea = new NewIdeaDto("", "Description", 1);

            // Act
            var response = await _client.PostAsJsonAsync("/api/ideas/create", newIdea);

            // Assert
            Assert.Equal(HttpStatusCode.BadRequest, response.StatusCode);
        }

        [Fact]
        public async Task CreatePostReturnsBadRequestForMissingDescriptionValue()
        {
            // Arrange
            var newIdea = new NewIdeaDto("Name", "", 1);

            // Act
            var response = await _client.PostAsJsonAsync("/api/ideas/create", newIdea);

            // Assert
            Assert.Equal(HttpStatusCode.BadRequest, response.StatusCode);
        }

        [Fact]
        public async Task CreatePostReturnsBadRequestForSessionIdValueTooSmall()
        {
            // Arrange
        }
    }
}
```

```

    // ...
    var newIdea = new NewIdeaDto("Name", "Description", 0);

    // Act
    var response = await _client.PostAsJsonAsync("/api/ideas/create", newIdea);

    // Assert
    Assert.Equal(HttpStatusCode.BadRequest, response.StatusCode);
}

[Fact]
public async Task CreatePostReturnsBadRequestForSessionIdValueTooLarge()
{
    // Arrange
    var newIdea = new NewIdeaDto("Name", "Description", 1000001);

    // Act
    var response = await _client.PostAsJsonAsync("/api/ideas/create", newIdea);

    // Assert
    Assert.Equal(HttpStatusCode.BadRequest, response.StatusCode);
}

[Fact]
public async Task CreatePostReturnsNotFoundForInvalidSession()
{
    // Arrange
    var newIdea = new NewIdeaDto("Name", "Description", 123);

    // Act
    var response = await _client.PostAsJsonAsync("/api/ideas/create", newIdea);

    // Assert
    Assert.Equal(HttpStatusCode.NotFound, response.StatusCode);
}

[Fact]
public async Task CreatePostReturnsCreatedIdeaWithCorrectInputs()
{
    // Arrange
    var testIdeaName = Guid.NewGuid().ToString();
    var newIdea = new NewIdeaDto(testIdeaName, "Description", 1);

    // Act
    var response = await _client.PostAsJsonAsync("/api/ideas/create", newIdea);

    // Assert
    response.EnsureSuccessStatusCode();
    var returnedSession = await response.Content.ReadAsJsonAsync<BrainstormSession>();
    Assert.Equal(2, returnedSession.Ideas.Count);
    Assert.Contains(testIdeaName, returnedSession.Ideas.Select(i => i.Name).ToList());
}

[Fact]
public async Task ForSessionReturnsNotFoundForBadSessionId()
{
    // Arrange & Act
    var response = await _client.GetAsync("/api/ideas/forsession/500");

    // Assert
    Assert.Equal(HttpStatusCode.NotFound, response.StatusCode);
}

[Fact]
public async Task ForSessionReturnsIdeasForValidSessionId()
{
    // Arrange
    var testSession = Startup.GetTestSession();

    // Act

```

```
// Act
var response = await _client.GetAsync("/api/ideas/forsession/1");

// Assert
response.EnsureSuccessStatusCode();
var ideaList = JsonConvert.DeserializeObject<List<IdeaDTO>>(
    await response.Content.ReadAsStringAsync());
var firstIdea = ideaList.First();
Assert.Equal(testSession.Ideas.First().Name, firstIdea.Name);
}
}
}
```

Unlike integration tests of actions that returns HTML views, web API methods that return results can usually be deserialized as strongly typed objects, as the last test above shows. In this case, the test deserializes the result to a `BrainstormSession` instance, and confirms that the idea was correctly added to its collection of ideas.

You'll find additional examples of integration tests in this article's [sample project](#).

# Advanced topics for ASP.NET Core MVC

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- [Work with the application model](#)
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# Work with the application model in ASP.NET Core

6/21/2018 • 10 minutes to read • [Edit Online](#)

By [Steve Smith](#)

ASP.NET Core MVC defines an *application model* representing the components of an MVC app. You can read and manipulate this model to modify how MVC elements behave. By default, MVC follows certain conventions to determine which classes are considered to be controllers, which methods on those classes are actions, and how parameters and routing behave. You can customize this behavior to suit your app's needs by creating your own conventions and applying them globally or as attributes.

## Models and Providers

The ASP.NET Core MVC application model include both abstract interfaces and concrete implementation classes that describe an MVC application. This model is the result of MVC discovering the app's controllers, actions, action parameters, routes, and filters according to default conventions. By working with the application model, you can modify your app to follow different conventions from the default MVC behavior. The parameters, names, routes, and filters are all used as configuration data for actions and controllers.

The ASP.NET Core MVC Application Model has the following structure:

- `ApplicationModel`
  - `Controllers (ControllerModel)`
  - `Actions (ActionModel)`
  - `Parameters (ParameterModel)`

Each level of the model has access to a common `Properties` collection, and lower levels can access and overwrite property values set by higher levels in the hierarchy. The properties are persisted to the `ActionDescriptor.Properties` when the actions are created. Then when a request is being handled, any properties a convention added or modified can be accessed through `ActionContext.ActionDescriptor.Properties`. Using properties is a great way to configure your filters, model binders, etc. on a per-action basis.

### NOTE

The `ActionDescriptor.Properties` collection isn't thread safe (for writes) once app startup has finished. Conventions are the best way to safely add data to this collection.

## `IApplicationModelProvider`

ASP.NET Core MVC loads the application model using a provider pattern, defined by the `IApplicationModelProvider` interface. This section covers some of the internal implementation details of how this provider functions. This is an advanced topic - most apps that leverage the application model should do so by working with conventions.

Implementations of the `IApplicationModelProvider` interface "wrap" one another, with each implementation calling `OnProvidersExecuting` in ascending order based on its `Order` property. The `OnProvidersExecuted` method is then called in reverse order. The framework defines several providers:

First (`order=-1000`):

- `DefaultApplicationModelProvider`

Then (`Order=-990`):

- `AuthorizationApplicationModelProvider`
- `CorsApplicationModelProvider`

#### NOTE

The order in which two providers with the same value for `Order` are called is undefined, and therefore shouldn't be relied upon.

#### NOTE

`IApplicationModelProvider` is an advanced concept for framework authors to extend. In general, apps should use conventions and frameworks should use providers. The key distinction is that providers always run before conventions.

The `DefaultApplicationModelProvider` establishes many of the default behaviors used by ASP.NET Core MVC. Its responsibilities include:

- Adding global filters to the context
- Adding controllers to the context
- Adding public controller methods as actions
- Adding action method parameters to the context
- Applying route and other attributes

Some built-in behaviors are implemented by the `DefaultApplicationModelProvider`. This provider is responsible for constructing the `ControllerModel`, which in turn references `ActionModel`, `PropertyModel`, and `ParameterModel` instances. The `DefaultApplicationModelProvider` class is an internal framework implementation detail that can and will change in the future.

The `AuthorizationApplicationModelProvider` is responsible for applying the behavior associated with the `AuthorizeFilter` and `AllowAnonymousFilter` attributes. [Learn more about these attributes](#).

The `CorsApplicationModelProvider` implements behavior associated with the `IEnableCorsAttribute` and `IDisableCorsAttribute`, and the `DisableCorsAuthorizationFilter`. [Learn more about CORS](#).

## Conventions

The application model defines convention abstractions that provide a simpler way to customize the behavior of the models than overriding the entire model or provider. These abstractions are the recommended way to modify your app's behavior. Conventions provide a way for you to write code that will dynamically apply customizations. While `filters` provide a means of modifying the framework's behavior, customizations let you control how the whole app is wired together.

The following conventions are available:

- `IApplicationModelConvention`
- `IControllerModelConvention`
- `IActionModelConvention`
- `IParameterModelConvention`

Conventions are applied by adding them to MVC options or by implementing `Attribute`s and applying them to controllers, actions, or action parameters (similar to `Filters`). Unlike filters, conventions are only executed when the app is starting, not as part of each request.

## Sample: Modifying the ApplicationModel

The following convention is used to add a property to the application model.

```
using Microsoft.AspNetCore.Mvc.ApplicationModels;

namespace AppModelSample.Conventions
{
    public class ApplicationDescription : IApplicationModelConvention
    {
        private readonly string _description;

        public ApplicationDescription(string description)
        {
            _description = description;
        }

        public void Apply(ApplicationModel application)
        {
            application.Properties["description"] = _description;
        }
    }
}
```

Application model conventions are applied as options when MVC is added in `ConfigureServices` in `Startup`.

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc(options =>
    {
        options.Conventions.Add(new ApplicationDescription("My Application Description"));
        options.Conventions.Add(new NamespaceRoutingConvention());
        //options.Conventions.Add(new IdsMustBeInRouteParameterModelConvention());
    });
}
```

Properties are accessible from the `ActionDescriptor` properties collection within controller actions:

```
public class AppModelController : Controller
{
    public string Description()
    {
        return "Description: " + ControllerContext.ActionDescriptor.Properties["description"];
    }
}
```

## Sample: Modifying the ControllerModel Description

As in the previous example, the controller model can also be modified to include custom properties. These will override existing properties with the same name specified in the application model. The following convention attribute adds a description at the controller level:

```

using System;
using Microsoft.AspNetCore.Mvc.ApplicationModels;

namespace AppModelSample.Conventions
{
    public class ControllerDescriptionAttribute : Attribute, IControllerModelConvention
    {
        private readonly string _description;

        public ControllerDescriptionAttribute(string description)
        {
            _description = description;
        }

        public void Apply(ControllerModel controllerModel)
        {
            controllerModel.Properties["description"] = _description;
        }
    }
}

```

This convention is applied as an attribute on a controller.

```

[ControllerDescription("Controller Description")]
public class DescriptionAttributesController : Controller
{
    public string Index()
    {
        return "Description: " + ControllerContext.ActionDescriptor.Properties["description"];
    }
}

```

The "description" property is accessed in the same manner as in previous examples.

### Sample: Modifying the ActionModel Description

A separate attribute convention can be applied to individual actions, overriding behavior already applied at the application or controller level.

```

using System;
using Microsoft.AspNetCore.Mvc.ApplicationModels;

namespace AppModelSample.Conventions
{
    public class ActionDescriptionAttribute : Attribute, IActionModelConvention
    {
        private readonly string _description;

        public ActionDescriptionAttribute(string description)
        {
            _description = description;
        }

        public void Apply(ActionModel actionModel)
        {
            actionModel.Properties["description"] = _description;
        }
    }
}

```

Applying this to an action within the previous example's controller demonstrates how it overrides the controller-level convention:

```
[ControllerDescription("Controller Description")]
public class DescriptionAttributesController : Controller
{
    public string Index()
    {
        return "Description: " + ControllerContext.ActionDescriptor.Properties["description"];
    }

    [ActionDescription("Action Description")]
    public string UseActionDescriptionAttribute()
    {
        return "Description: " + ControllerContext.ActionDescriptor.Properties["description"];
    }
}
```

### Sample: Modifying the ParameterModel

The following convention can be applied to action parameters to modify their `BindingInfo`. The following convention requires that the parameter be a route parameter; other potential binding sources (such as query string values) are ignored.

```
using System;
using Microsoft.AspNetCore.Mvc.ApplicationModels;
using Microsoft.AspNetCore.Mvc.ModelBinding;

namespace AppModelSample.Conventions
{
    public class MustBeInRouteParameterModelConvention : Attribute, IParameterModelConvention
    {
        public void Apply(ParameterModel model)
        {
            if (model.BindingInfo == null)
            {
                model.BindingInfo = new BindingInfo();
            }
            model.BindingInfo.BindingSource = BindingSource.Path;
        }
    }
}
```

The attribute may be applied to any action parameter:

```
public class ParameterModelController : Controller
{
    // Will bind: /ParameterModel/.GetById/123
    // WON'T bind: /ParameterModel/.GetById?id=123
    public string GetById([MustBeInRouteParameterModelConvention]int id)
    {
        return $"Bound to id: {id}";
    }
}
```

### Sample: Modifying the ActionModel Name

The following convention modifies the `ActionModel` to update the *name* of the action to which it's applied. The new name is provided as a parameter to the attribute. This new name is used by routing, so it will affect the route used to reach this action method.

```

using System;
using Microsoft.AspNetCore.Mvc.ApplicationModels;

namespace AppModelSample.Conventions
{
    public class CustomActionNameAttribute : Attribute, IActionModelConvention
    {
        private readonly string _actionName;

        public CustomActionNameAttribute(string actionName)
        {
            _actionName = actionName;
        }

        public void Apply(ActionModel actionModel)
        {
            // this name will be used by routing
            actionModel.ActionName = _actionName;
        }
    }
}

```

This attribute is applied to an action method in the `HomeController`:

```

// Route: /Home/MyCoolAction
[CustomActionName("MyCoolAction")]
public string SomeName()
{
    return ControllerContext.ActionDescriptor.ActionName;
}

```

Even though the method name is `SomeName`, the attribute overrides the MVC convention of using the method name and replaces the action name with `MyCoolAction`. Thus, the route used to reach this action is `/Home/MyCoolAction`.

#### **NOTE**

This example is essentially the same as using the built-in `ActionName` attribute.

### **Sample: Custom Routing Convention**

You can use an `IApplicationModelConvention` to customize how routing works. For example, the following convention will incorporate Controllers' namespaces into their routes, replacing `.` in the namespace with `/` in the route:

```

using Microsoft.AspNetCore.Mvc.ApplicationModels;
using System.Linq;

namespace AppModelSample.Conventions
{
    public class NamespaceRoutingConvention : IApplicationModelConvention
    {
        public void Apply(ApplicationModel application)
        {
            foreach (var controller in application.Controllers)
            {
                var hasAttributeRouteModels = controller.Selectors
                    .Any(selector => selector.AttributeRouteModel != null);

                if (!hasAttributeRouteModels
                    && controller.ControllerName.Contains("Namespace")) // affect one controller in this
sample
                {
                    // Replace the . in the namespace with a / to create the attribute route
                    // Ex: MySite.Admin namespace will correspond to MySite/Admin attribute route
                    // Then attach [controller], [action] and optional {id?} token.
                    // [Controller] and [action] is replaced with the controller and action
                    // name to generate the final template
                    controller.Selectors[0].AttributeRouteModel = new AttributeRouteModel()
                    {
                        Template = controller.ControllerType.Namespace.Replace('.', '/') +
"/[controller]/[action]/{id?}"
                    };
                }
            }

            // You can continue to put attribute route templates for the controller actions depending on the
way you want them to behave
        }
    }
}

```

The convention is added as an option in Startup.

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc(options =>
    {
        options.Conventions.Add(new ApplicationDescription("My Application Description"));
        options.Conventions.Add(new NamespaceRoutingConvention());
        //options.Conventions.Add(new IdsMustBeInRouteParameterModelConvention());
    });
}

```

#### TIP

You can add conventions to your [middleware](#) by accessing `MvcOptions` using  
`services.Configure<MvcOptions>(c => c.Conventions.Add(YOURCONVENTION));`

This sample applies this convention to routes that are not using attribute routing where the controller has "Namespace" in its name. The following controller demonstrates this convention:

```
using Microsoft.AspNetCore.Mvc;

namespace AppModelSample.Controllers
{
    public class NamespaceRoutingController : Controller
    {
        // using NamespaceRoutingConvention
        // route: /AppModelSample/Controllers/NamespaceRouting/Index
        public string Index()
        {
            return "This demonstrates namespace routing.";
        }
    }
}
```

## Application Model Usage in WebApiCompatShim

ASP.NET Core MVC uses a different set of conventions from ASP.NET Web API 2. Using custom conventions, you can modify an ASP.NET Core MVC app's behavior to be consistent with that of a Web API app. Microsoft ships the [WebApiCompatShim](#) specifically for this purpose.

### NOTE

Learn more about [migration from ASP.NET Web API](#).

To use the Web API Compatibility Shim, you need to add the package to your project and then add the conventions to MVC by calling `AddWebApiConventions` in `Startup`:

```
services.AddMvc().AddWebApiConventions();
```

The conventions provided by the shim are only applied to parts of the app that have had certain attributes applied to them. The following four attributes are used to control which controllers should have their conventions modified by the shim's conventions:

- [UseWebApiActionConventionsAttribute](#)
- [UseWebApiOverloadingAttribute](#)
- [UseWebApiParameterConventionsAttribute](#)
- [UseWebApiRoutesAttribute](#)

### Action Conventions

The `UseWebApiActionConventionsAttribute` is used to map the HTTP method to actions based on their name (for instance, `Get` would map to `HttpGet`). It only applies to actions that don't use attribute routing.

### Overloading

The `UseWebApiOverloadingAttribute` is used to apply the `WebApiOverloadingApplicationModelConvention` convention. This convention adds an `overloadActionConstraint` to the action selection process, which limits candidate actions to those for which the request satisfies all non-optional parameters.

### Parameter Conventions

The `UseWebApiParameterConventionsAttribute` is used to apply the `WebApiParameterConventionsApplicationModelConvention` action convention. This convention specifies that simple types used as action parameters are bound from the URI by default, while complex types are bound from the request body.

## Routes

The `UseWebApiRoutesAttribute` controls whether the `WebApiApplicationModelConvention` controller convention is applied. When enabled, this convention is used to add support for `areas` to the route.

In addition to a set of conventions, the compatibility package includes a `System.Web.Http.ApiController` base class that replaces the one provided by Web API. This allows your controllers written for Web API and inheriting from its `ApiController` to work as they were designed, while running on ASP.NET Core MVC. This base controller class is decorated with all of the `UseWebApi*` attributes listed above. The `ApiController` exposes properties, methods, and result types that are compatible with those found in Web API.

## Using ApiExplorer to Document Your App

The application model exposes an `ApiExplorer` property at each level that can be used to traverse the app's structure. This can be used to [generate help pages for your Web APIs using tools like Swagger](#). The `ApiExplorer` property exposes an `IsVisible` property that can be set to specify which parts of your app's model should be exposed. You can configure this setting using a convention:

```
using Microsoft.AspNetCore.Mvc.ApplicationModels;

namespace AppModelSample.Conventions
{
    public class EnableApiExplorerApplicationConvention : IApplicationModelConvention
    {
        public void Apply(ApplicationModel application)
        {
            application.ApiExplorer.IsVisible = true;
        }
    }
}
```

Using this approach (and additional conventions if required), you can enable or disable API visibility at any level within your app.

# Filters in ASP.NET Core

6/21/2018 • 19 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [Tom Dykstra](#), and [Steve Smith](#)

*Filters* in ASP.NET Core MVC allow you to run code before or after specific stages in the request processing pipeline.

## IMPORTANT

This topic does **not** apply to Razor Pages. ASP.NET Core 2.1 and later supports [IPageFilter](#) and [IAsyncPageFilter](#) for Razor Pages. For more information, see [Filter methods for Razor Pages](#).

Built-in filters handle tasks such as:

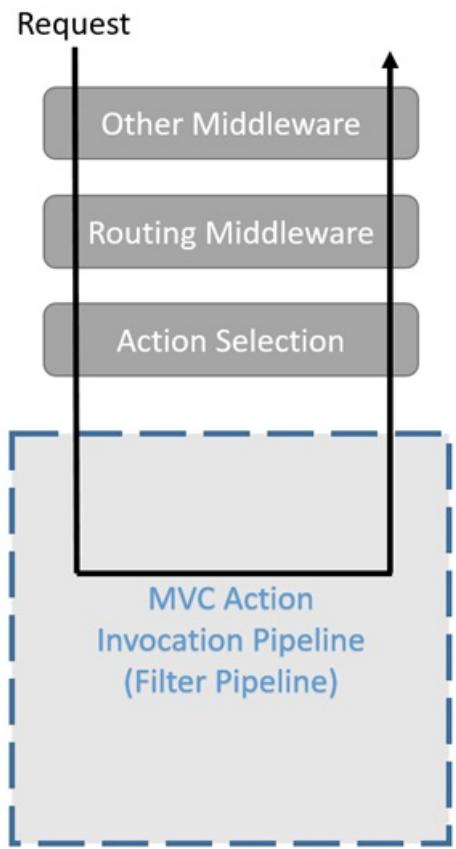
- Authorization (preventing access to resources a user isn't authorized for).
- Ensuring that all requests use HTTPS.
- Response caching (short-circuiting the request pipeline to return a cached response).

Custom filters can be created to handle cross-cutting concerns. Filters can avoid duplicating code across actions. For example, an error handling exception filter could consolidate error handling.

[View or download sample from GitHub](#).

## How do filters work?

Filters run within the *MVC action invocation pipeline*, sometimes referred to as the *filter pipeline*. The filter pipeline runs after MVC selects the action to execute.

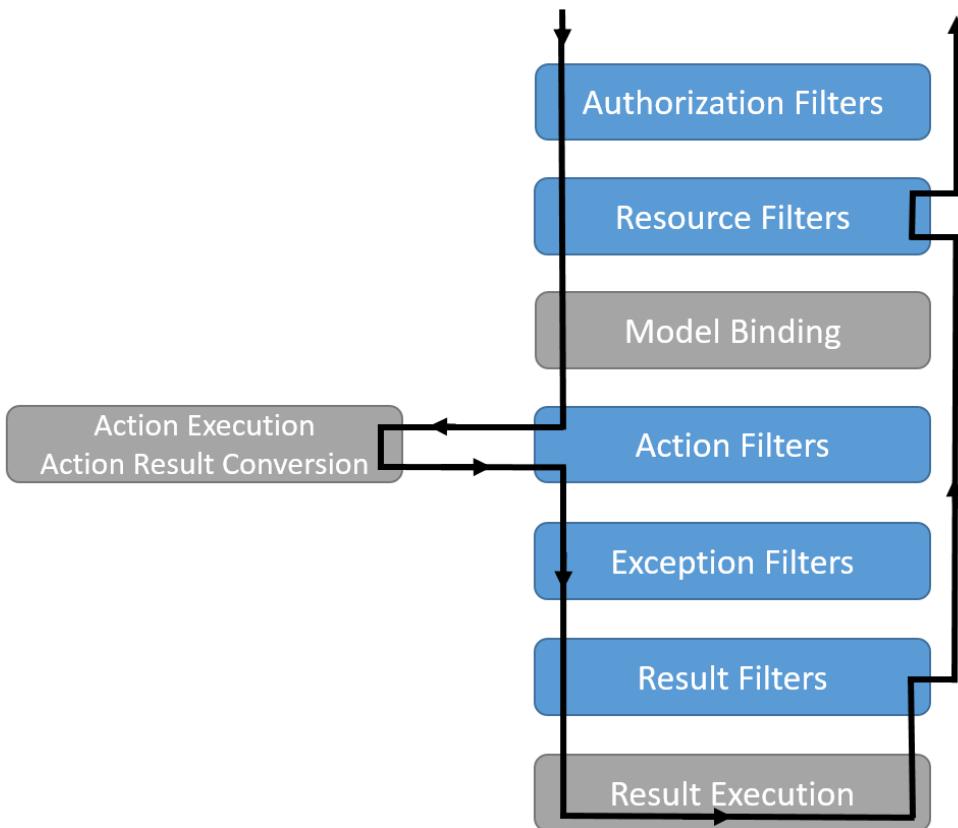


## Filter types

Each filter type is executed at a different stage in the filter pipeline.

- **Authorization filters** run first and are used to determine whether the current user is authorized for the current request. They can short-circuit the pipeline if a request is unauthorized.
- **Resource filters** are the first to handle a request after authorization. They can run code before the rest of the filter pipeline, and after the rest of the pipeline has completed. They're useful to implement caching or otherwise short-circuit the filter pipeline for performance reasons. They run before model binding, so they can influence model binding.
- **Action filters** can run code immediately before and after an individual action method is called. They can be used to manipulate the arguments passed into an action and the result returned from the action.
- **Exception filters** are used to apply global policies to unhandled exceptions that occur before anything has been written to the response body.
- **Result filters** can run code immediately before and after the execution of individual action results. They run only when the action method has executed successfully. They are useful for logic that must surround view or formatter execution.

The following diagram shows how these filter types interact in the filter pipeline.



## Implementation

Filters support both synchronous and asynchronous implementations through different interface definitions.

Synchronous filters that can run code both before and after their pipeline stage define `OnStageExecuting` and `OnStageExecuted` methods. For example, `OnActionExecuting` is called before the action method is called, and `OnActionExecuted` is called after the action method returns.

```

using FiltersSample.Helper;
using Microsoft.AspNetCore.Mvc.Filters;

namespace FiltersSample.Filters
{
    public class SampleActionFilter : IActionFilter
    {
        public void OnActionExecuting(ActionExecutingContext context)
        {
            // do something before the action executes
        }

        public void OnActionExecuted(ActionExecutedContext context)
        {
            // do something after the action executes
        }
    }
}

```

Asynchronous filters define a single `OnStageExecutionAsync` method. This method takes a `FilterTypeExecutionDelegate` delegate which executes the filter's pipeline stage. For example, `ActionExecutionDelegate` calls the action method or next action filter, and you can execute code before and after you call it.

```
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc.Filters;

namespace FiltersSample.Filters
{
    public class SampleAsyncActionFilter : IAsyncActionFilter
    {
        public async Task OnActionExecutionAsync(
            ActionExecutingContext context,
            ActionExecutionDelegate next)
        {
            // do something before the action executes
            var resultContext = await next();
            // do something after the action executes; resultContext.Result will be set
        }
    }
}
```

You can implement interfaces for multiple filter stages in a single class. For example, the [ActionFilterAttribute](#) class implements `IActionFilter`, `IResultFilter`, and their async equivalents.

#### NOTE

Implement **either** the synchronous or the async version of a filter interface, not both. The framework checks first to see if the filter implements the async interface, and if so, it calls that. If not, it calls the synchronous interface's method(s). If you were to implement both interfaces on one class, only the async method would be called. When using abstract classes like [ActionFilterAttribute](#) you would override only the synchronous methods or the async method for each filter type.

## IFilterFactory

`IFilterFactory` implements `IFilterMetadata`. Therefore, an `IFilterFactory` instance can be used as an `IFilterMetadata` instance anywhere in the filter pipeline. When the framework prepares to invoke the filter, it attempts to cast it to an `IFilterFactory`. If that cast succeeds, the `CreateInstance` method is called to create the `IFilterMetadata` instance that will be invoked. This provides a flexible design, since the precise filter pipeline doesn't need to be set explicitly when the app starts.

You can implement `IFilterFactory` on your own attribute implementations as another approach to creating filters:

```

public class AddHeaderWithFactoryAttribute : Attribute, IFilterFactory
{
    // Implement IFilterFactory
    public IFilterMetadata CreateInstance(IServiceProvider serviceProvider)
    {
        return new InternalAddHeaderFilter();
    }

    private class InternalAddHeaderFilter : IResultFilter
    {
        public void OnResultExecuting(ResultExecutingContext context)
        {
            context.HttpContext.Response.Headers.Add(
                "Internal", new string[] { "Header Added" });
        }

        public void OnResultExecuted(ResultExecutedContext context)
        {
        }
    }

    public bool IsReusable
    {
        get
        {
            return false;
        }
    }
}

```

## Built-in filter attributes

The framework includes built-in attribute-based filters that you can subclass and customize. For example, the following Result filter adds a header to the response.

```

using Microsoft.AspNetCore.Mvc.Filters;

namespace FiltersSample.Filters
{
    public class AddHeaderAttribute : ResultFilterAttribute
    {
        private readonly string _name;
        private readonly string _value;

        public AddHeaderAttribute(string name, string value)
        {
            _name = name;
            _value = value;
        }

        public override void OnResultExecuting(ResultExecutingContext context)
        {
            context.HttpContext.Response.Headers.Add(
                _name, new string[] { _value });
            base.OnResultExecuting(context);
        }
    }
}

```

Attributes allow filters to accept arguments, as shown in the example above. You would add this attribute to a controller or action method and specify the name and value of the HTTP header:

```
[AddHeader("Author", "Steve Smith @ardalis")]
public class SampleController : Controller
{
    public IActionResult Index()
    {
        return Content("Examine the headers using developer tools.");
    }

    [ShortCircuitingResourceFilter]
    public IActionResult SomeResource()
    {
        return Content("Successful access to resource - header should be set.");
    }
}
```

The result of the `Index` action is shown below - the response headers are displayed on the bottom right.

The screenshot shows the Microsoft Edge DevTools Network tab. The URL is `localhost:5000/sample`. The Headers section shows the following:

- Request URL: `http://localhost:5000/sample`
- Request Method: `GET`
- Status Code: `200 / OK`
- Response Headers** (selected):
  - `Author: Steve Smith @ardalis`
  - `Content-Type: text/plain; charset=utf-8`

At the bottom, it shows 0 errors, 1 request, 0 B transferred, and 30.45 ms taken (DOMContentLoaded: 47 ms, load: 54 ms).

Several of the filter interfaces have corresponding attributes that can be used as base classes for custom implementations.

Filter attributes:

- `ActionFilterAttribute`
- `ExceptionFilterAttribute`
- `ResultFilterAttribute`
- `FormatFilterAttribute`
- `ServiceFilterAttribute`
- `TypeFilterAttribute`

`TypeFilterAttribute` and `ServiceFilterAttribute` are explained later in this article.

## Filter scopes and order of execution

A filter can be added to the pipeline at one of three *scopes*. You can add a filter to a particular action method or to a controller class by using an attribute. Or you can register a filter globally for all controllers and actions.

Filters are added globally by adding it to the `MvcOptions.Filters` collection in `ConfigureServices`:

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc(options =>
    {
        options.Filters.Add(new AddHeaderAttribute("GlobalAddHeader",
            "Result filter added to MvcOptions.Filters")); // an instance
        options.Filters.Add(typeof(SampleActionFilter)); // by type
        options.Filters.Add(new SampleGlobalActionFilter()); // an instance
    });

    services.AddScoped<AddHeaderFilterWithDi>();
}

```

## Default order of execution

When there are multiple filters for a particular stage of the pipeline, scope determines the default order of filter execution. Global filters surround class filters, which in turn surround method filters. This is sometimes referred to as "Russian doll" nesting, as each increase in scope is wrapped around the previous scope, like a [nesting doll](#). You generally get the desired overriding behavior without having to explicitly determine ordering.

As a result of this nesting, the *after* code of filters runs in the reverse order of the *before* code. The sequence looks like this:

- The *before* code of filters applied globally
  - The *before* code of filters applied to controllers
    - The *before* code of filters applied to action methods
    - The *after* code of filters applied to action methods
  - The *after* code of filters applied to controllers
- The *after* code of filters applied globally

Here's an example that illustrates the order in which filter methods are called for synchronous Action filters.

SEQUENCE	FILTER SCOPE	FILTER METHOD
1	Global	OnActionExecuting
2	Controller	OnActionExecuting
3	Method	OnActionExecuting
4	Method	OnActionExecuted
5	Controller	OnActionExecuted
6	Global	OnActionExecuted

This sequence shows:

- The method filter is nested within the controller filter.
- The controller filter is nested within the global filter.

To put it another way, if you're inside an async filter's `OnStageExecutionAsync` method, all of the filters with a tighter scope run while your code is on the stack.

## NOTE

Every controller that inherits from the `Controller` base class includes `OnActionExecuting` and `OnActionExecuted` methods. These methods wrap the filters that run for a given action: `OnActionExecuting` is called before any of the filters, and `OnActionExecuted` is called after all of the filters.

## Overriding the default order

You can override the default sequence of execution by implementing `IOrderedFilter`. This interface exposes an `Order` property that takes precedence over scope to determine the order of execution. A filter with a lower `Order` value will have its *before* code executed before that of a filter with a higher value of `Order`. A filter with a lower `Order` value will have its *after* code executed after that of a filter with a higher `Order` value. You can set the `Order` property by using a constructor parameter:

```
[MyFilter(Name = "Controller Level Attribute", Order=1)]
```

If you have the same 3 Action filters shown in the preceding example but set the `Order` property of the controller and global filters to 1 and 2 respectively, the order of execution would be reversed.

SEQUENCE	FILTER SCOPE	ORDER PROPERTY	FILTER METHOD
1	Method	0	<code>OnActionExecuting</code>
2	Controller	1	<code>OnActionExecuting</code>
3	Global	2	<code>OnActionExecuting</code>
4	Global	2	<code>OnActionExecuted</code>
5	Controller	1	<code>OnActionExecuted</code>
6	Method	0	<code>OnActionExecuted</code>

The `Order` property trumps scope when determining the order in which filters will run. Filters are sorted first by order, then scope is used to break ties. All of the built-in filters implement `IOrderedFilter` and set the default `Order` value to 0. For built-in filters, scope determines order unless you set `Order` to a non-zero value.

## Cancellation and short circuiting

You can short-circuit the filter pipeline at any point by setting the `Result` property on the `context` parameter provided to the filter method. For instance, the following Resource filter prevents the rest of the pipeline from executing.

```

using System;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.Filters;

namespace FiltersSample.Filters
{
    public class ShortCircuitingResourceFilterAttribute : Attribute,
        IResourceFilter
    {
        public void OnResourceExecuting(ResourceExecutingContext context)
        {
            context.Result = new ContentResult()
            {
                Content = "Resource unavailable - header should not be set"
            };
        }

        public void OnResourceExecuted(ResourceExecutedContext context)
        {
        }
    }
}

```

In the following code, both the `ShortCircuitingResourceFilter` and the `AddHeader` filter target the `SomeResource` action method. The `ShortCircuitingResourceFilter`:

- Runs first, because it's a Resource Filter and `AddHeader` is an Action Filter.
- Short-circuits the rest of the pipeline.

Therefore the `AddHeader` filter never runs for the `SomeResource` action. This behavior would be the same if both filters were applied at the action method level, provided the `ShortCircuitingResourceFilter` ran first. The `ShortCircuitingResourceFilter` runs first because of its filter type, or by explicit use of `Order` property.

```

[AddHeader("Author", "Steve Smith @ardalis")]
public class SampleController : Controller
{
    public IActionResult Index()
    {
        return Content("Examine the headers using developer tools.");
    }

    [ShortCircuitingResourceFilter]
    public IActionResult SomeResource()
    {
        return Content("Successful access to resource - header should be set.");
    }
}

```

## Dependency injection

Filters can be added by type or by instance. If you add an instance, that instance will be used for every request. If you add a type, it will be type-activated, meaning an instance will be created for each request and any constructor dependencies will be populated by [dependency injection](#) (DI). Adding a filter by type is equivalent to `filters.Add(new TypeFilterAttribute(typeof(MyFilter)))`.

Filters that are implemented as attributes and added directly to controller classes or action methods cannot have constructor dependencies provided by [dependency injection](#) (DI). This is because attributes must have their constructor parameters supplied where they're applied. This is a limitation of how attributes work.

If your filters have dependencies that you need to access from DI, there are several supported approaches. You can apply your filter to a class or action method using one of the following:

- `ServiceFilterAttribute`
- `TypeFilterAttribute`
- `IFilterFactory` implemented on your attribute

#### NOTE

One dependency you might want to get from DI is a logger. However, avoid creating and using filters purely for logging purposes, since the [built-in framework logging features](#) may already provide what you need. If you're going to add logging to your filters, it should focus on business domain concerns or behavior specific to your filter, rather than MVC actions or other framework events.

### ServiceFilterAttribute

A `ServiceFilter` retrieves an instance of the filter from DI. You add the filter to the container in `ConfigureServices`, and reference it in a `ServiceFilter` attribute

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc(options =>
    {
        options.Filters.Add(new AddHeaderAttribute("GlobalAddHeader",
            "Result filter added to MvcOptions.Filters")); // an instance
        options.Filters.Add(typeof(SampleActionFilter)); // by type
        options.Filters.Add(new SampleGlobalActionFilter()); // an instance
    });

    services.AddScoped<AddHeaderFilterWithDi>();
}
```

```
[ServiceFilter(typeof(AddHeaderFilterWithDi))]
public IActionResult Index()
{
    return View();
}
```

Using `ServiceFilter` without registering the filter type results in an exception:

```
System.InvalidOperationException: No service for type
'FiltersSample.Filters.AddHeaderFilterWithDI' has been registered.
```

`ServiceFilterAttribute` implements `IFilterFactory`. `IFilterFactory` exposes the `CreateInstance` method for creating an `IFilterMetadata` instance. The `CreateInstance` method loads the specified type from the services container (DI).

### TypeFilterAttribute

`TypeFilterAttribute` is similar to `ServiceFilterAttribute`, but its type isn't resolved directly from the DI container. It instantiates the type by using `Microsoft.Extensions.DependencyInjection.ObjectFactory`.

Because of this difference:

- Types that are referenced using the `TypeFilterAttribute` don't need to be registered with the container first. They do have their dependencies fulfilled by the container.
- `TypeFilterAttribute` can optionally accept constructor arguments for the type.

The following example demonstrates how to pass arguments to a type using `TypeFilterAttribute`:

```
[TypeFilter(typeof(AddHeaderAttribute),
    Arguments = new object[] { "Author", "Steve Smith (@ardalis)" })]
public IActionResult Hi(string name)
{
    return Content($"Hi {name}");
}
```

If you have a filter that:

- Doesn't require any arguments.
- Has constructor dependencies that need to be filled by DI.

You can use your own named attribute on classes and methods instead of `[TypeFilter(typeof(FilterType))]`.

The following filter shows how this can be implemented:

```
public class SampleActionFilterAttribute : TypeFilterAttribute
{
    public SampleActionFilterAttribute():base(typeof(SampleActionFilterImpl))
    {
    }

    private class SampleActionFilterImpl : IActionFilter
    {
        private readonly ILogger _logger;
        public SampleActionFilterImpl	ILoggerFactory loggerFactory)
        {
            _logger = loggerFactory.CreateLogger<SampleActionFilterAttribute>();
        }

        public void OnActionExecuting(ActionExecutingContext context)
        {
            _logger.LogInformation("Business action starting...");
            // perform some business logic work
        }

        public void OnActionExecuted(ActionExecutedContext context)
        {
            // perform some business logic work
            _logger.LogInformation("Business action completed.");
        }
    }
}
```

This filter can be applied to classes or methods using the `[SampleActionFilter]` syntax, instead of having to use `[TypeFilter]` or `[ServiceFilter]`.

## Authorization filters

\*Authorization filters:

- Control access to action methods.
- Are the first filters to be executed within the filter pipeline.
- Have a before method, but no after method.

You should only write a custom authorization filter if you are writing your own authorization framework. Prefer configuring your authorization policies or writing a custom authorization policy over writing a custom filter. The built-in filter implementation is just responsible for calling the authorization system.

You shouldn't throw exceptions within authorization filters, since nothing will handle the exception (exception

filters won't handle them). Consider issuing a challenge when an exception occurs.

Learn more about [Authorization](#).

## Resource filters

- Implement either the `IResourceFilter` or `IAsyncResourceFilter` interface,
- Their execution wraps most of the filter pipeline.
- Only [Authorization filters](#) run before Resource filters.

Resource filters are useful to short-circuit most of the work a request is doing. For example, a caching filter can avoid the rest of the pipeline if the response is in the cache.

The [short circuiting resource filter](#) shown earlier is one example of a resource filter. Another example is [DisableFormValueModelBindingAttribute](#):

- It prevents model binding from accessing the form data.
- It's useful for large file uploads and want to prevent the form from being read into memory.

## Action filters

*Action filters:*

- Implement either the `IActionFilter` or `IAsyncActionFilter` interface.
- Their execution surrounds the execution of action methods.

Here's a sample action filter:

```
public class SampleActionFilter : IActionFilter
{
    public void OnActionExecuting(ActionExecutingContext context)
    {
        // do something before the action executes
    }

    public void OnActionExecuted(ActionExecutedContext context)
    {
        // do something after the action executes
    }
}
```

The [ActionExecutingContext](#) provides the following properties:

- `ActionArguments` - lets you manipulate the inputs to the action.
- `Controller` - lets you manipulate the controller instance.
- `Result` - setting this short-circuits execution of the action method and subsequent action filters. Throwing an exception also prevents execution of the action method and subsequent filters, but is treated as a failure instead of a successful result.

The [ActionExecutedContext](#) provides `Controller` and `Result` plus the following properties:

- `Canceled` - will be true if the action execution was short-circuited by another filter.
- `Exception` - will be non-null if the action or a subsequent action filter threw an exception. Setting this property to null effectively 'handles' an exception, and `Result` will be executed as if it were returned from the action method normally.

For an `IAsyncActionFilter`, a call to the `ActionExecutionDelegate`:

- Executes any subsequent action filters and the action method.
- returns `ActionExecutedContext`.

To short-circuit, assign `ActionExecutingContext.Result` to some result instance and don't call the `ActionExecutionDelegate`.

The framework provides an abstract `ActionFilterAttribute` that you can subclass.

You can use an action filter to validate model state and return any errors if the state is invalid:

```
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.Filters;

namespace FiltersSample.Filters
{
    public class ValidateModelAttribute : ActionFilterAttribute
    {
        public override void OnActionExecuting(ActionExecutingContext context)
        {
            if (!context.ModelState.IsValid)
            {
                context.Result = new BadRequestObjectResult(context.ModelState);
            }
        }
    }
}
```

The `OnActionExecuted` method runs after the action method and can see and manipulate the results of the action through the `ActionExecutedContext.Result` property. `ActionExecutedContext.Canceled` will be set to true if the action execution was short-circuited by another filter. `ActionExecutedContext.Exception` will be set to a non-null value if the action or a subsequent action filter threw an exception. Setting `ActionExecutedContext.Exception` to null:

- Effectively 'handles' an exception.
- `ActionExecutedContext.Result` is executed as if it were returned normally from the action method.

## Exception filters

*Exception filters* implement either the `IExceptionFilter` or `IAsyncExceptionFilter` interface. They can be used to implement common error handling policies for an app.

The following sample exception filter uses a custom developer error view to display details about exceptions that occur when the app is in development:

```

public class CustomExceptionFilterAttribute : ExceptionFilterAttribute
{
    private readonly IHostingEnvironment _hostingEnvironment;
    private readonly IMetadataProvider _modelMetadataProvider;

    public CustomExceptionFilterAttribute(
        IHostingEnvironment hostingEnvironment,
        IMetadataProvider modelMetadataProvider)
    {
        _hostingEnvironment = hostingEnvironment;
        _modelMetadataProvider = modelMetadataProvider;
    }

    public override void OnException(ExceptionContext context)
    {
        if (!_hostingEnvironment.IsDevelopment())
        {
            // do nothing
            return;
        }
        var result = new ViewResult {ViewName = "CustomError"};
        result.ViewData = new ViewDataDictionary(_modelMetadataProvider, context.ModelState);
        result.ViewData.Add("Exception", context.Exception);
        // TODO: Pass additional detailed data via ViewData
        context.Result = result;
    }
}

```

## Exception filters:

- Don't have before and after events.
- Implement `OnException` or `OnExceptionAsync`.
- Handle unhandled exceptions that occur in controller creation, [model binding](#), action filters, or action methods.
- Do not catch exceptions that occur in Resource filters, Result filters, or MVC Result execution.

To handle an exception, set the `ExceptionContext.ExceptionHandled` property to true or write a response. This stops propagation of the exception. An Exception filter can't turn an exception into a "success". Only an Action filter can do that.

### NOTE

In ASP.NET Core 1.1, the response isn't sent if you set `ExceptionHandled` to true **and** write a response. In that scenario, ASP.NET Core 1.0 does send the response, and ASP.NET Core 1.1.2 will return to the 1.0 behavior. For more information, see [issue #5594](#) in the GitHub repository.

## Exception filters:

- Are good for trapping exceptions that occur within MVC actions.
- Are not as flexible as error handling middleware.

Prefer middleware for exception handling. Use exception filters only where you need to do error handling *differently* based on which MVC action was chosen. For example, your app might have action methods for both API endpoints and for views/HTML. The API endpoints could return error information as JSON, while the view-based actions could return an error page as HTML.

The `ExceptionFilterAttribute` can be subclassed.

## Result filters

- Implement either the `IResultFilter` or `IAsyncResultFilter` interface.
- Their execution surrounds the execution of action results.

Here's an example of a Result filter that adds an HTTP header.

```
public class AddHeaderFilterWithDi : IResultFilter
{
    private ILogger _logger;
    public AddHeaderFilterWithDi	ILoggerFactory loggerFactory)
    {
        _logger = loggerFactory.CreateLogger<AddHeaderFilterWithDi>();
    }

    public void OnResultExecuting(ResultExecutingContext context)
    {
        var headerName = "OnResultExecuting";
        context.HttpContext.Response.Headers.Add(
            headerName, new string[] { "ResultExecutingSuccessfully" });
        _logger.LogInformation($"Header added: {headerName}");
    }

    public void OnResultExecuted(ResultExecutedContext context)
    {
        // Can't add to headers here because response has already begun.
    }
}
```

The kind of result being executed depends on the action in question. An MVC action returning a view would include all razor processing as part of the `ViewResult` being executed. An API method might perform some serialization as part of the execution of the result. Learn more about [action results](#)

Result filters are only executed for successful results - when the action or action filters produce an action result. Result filters are not executed when exception filters handle an exception.

The `OnResultExecuting` method can short-circuit execution of the action result and subsequent result filters by setting `ResultExecutingContext.Cancel` to true. You should generally write to the response object when short-circuiting to avoid generating an empty response. Throwing an exception will:

- Prevent execution of the action result and subsequent filters.
- Be treated as a failure instead of a successful result.

When the `OnResultExecuted` method runs, the response has likely been sent to the client and cannot be changed further (unless an exception was thrown). `ResultExecutedContext.Canceled` will be set to true if the action result execution was short-circuited by another filter.

`ResultExecutedContext.Exception` will be set to a non-null value if the action result or a subsequent result filter threw an exception. Setting `Exception` to null effectively 'handles' an exception and prevents the exception from being rethrown by MVC later in the pipeline. When you're handling an exception in a result filter, you might not be able to write any data to the response. If the action result throws partway through its execution, and the headers have already been flushed to the client, there's no reliable mechanism to send a failure code.

For an `IAsyncResultFilter` a call to `await next` on the `ResultExecutionDelegate` executes any subsequent result filters and the action result. To short-circuit, set `ResultExecutingContext.Cancel` to true and don't call the `ResultExecutionDelegate`.

The framework provides an abstract `ResultFilterAttribute` that you can subclass. The `AddHeaderAttribute` class shown earlier is an example of a result filter attribute.

# Using middleware in the filter pipeline

Resource filters work like [middleware](#) in that they surround the execution of everything that comes later in the pipeline. But filters differ from middleware in that they're part of MVC, which means that they have access to MVC context and constructs.

In ASP.NET Core 1.1, you can use middleware in the filter pipeline. You might want to do that if you have a middleware component that needs access to MVC route data, or one that should run only for certain controllers or actions.

To use middleware as a filter, create a type with a `Configure` method that specifies the middleware that you want to inject into the filter pipeline. Here's an example that uses the localization middleware to establish the current culture for a request:

```
public class LocalizationPipeline
{
    public void Configure(IApplicationBuilder applicationBuilder)
    {
        var supportedCultures = new[]
        {
            new CultureInfo("en-US"),
            new CultureInfo("fr")
        };

        var options = new RequestLocalizationOptions
        {

            DefaultRequestCulture = new RequestCulture(culture: "en-US", uiCulture: "en-US"),
            SupportedCultures = supportedCultures,
            SupportedUICultures = supportedCultures
        };
        options.RequestCultureProviders = new[]
        { new RouteDataRequestCultureProvider() { Options = options } };

        applicationBuilder.UseRequestLocalization(options);
    }
}
```

You can then use the `MiddlewareFilterAttribute` to run the middleware for a selected controller or action or globally:

```
[Route("{culture}/{controller}/{action}")]
[MiddlewareFilter(typeof(LocalizationPipeline))]
public IActionResult CultureFromRouteData()
{
    return Content($"CurrentCulture:{CultureInfo.CurrentCulture.Name},"
        + $"CurrentUICulture:{CultureInfo.CurrentUICulture.Name}");
}
```

Middleware filters run at the same stage of the filter pipeline as Resource filters, before model binding and after the rest of the pipeline.

## Next actions

To experiment with filters, [download, test and modify the sample](#).

# Areas in ASP.NET Core

6/21/2018 • 4 minutes to read • [Edit Online](#)

By [Dhananjay Kumar](#) and [Rick Anderson](#)

Areas are an ASP.NET MVC feature used to organize related functionality into a group as a separate namespace (for routing) and folder structure (for views). Using areas creates a hierarchy for the purpose of routing by adding another route parameter, `area`, to `controller` and `action`.

Areas provide a way to partition a large ASP.NET Core MVC Web app into smaller functional groupings. An area is effectively an MVC structure inside an application. In an MVC project, logical components like Model, Controller, and View are kept in different folders, and MVC uses naming conventions to create the relationship between these components. For a large app, it may be advantageous to partition the app into separate high level areas of functionality. For instance, an e-commerce app with multiple business units, such as checkout, billing, and search etc. Each of these units have their own logical component views, controllers, and models. In this scenario, you can use Areas to physically partition the business components in the same project.

An area can be defined as smaller functional units in an ASP.NET Core MVC project with its own set of controllers, views, and models.

Consider using Areas in an MVC project when:

- Your application is made of multiple high-level functional components that should be logically separated
- You want to partition your MVC project so that each functional area can be worked on independently

Area features:

- An ASP.NET Core MVC app can have any number of areas
- Each area has its own controllers, models, and views
- Allows you to organize large MVC projects into multiple high-level components that can be worked on independently
- Supports multiple controllers with the same name - as long as they have different *areas*

Let's take a look at an example to illustrate how Areas are created and used. Let's say you have a store app that has two distinct groupings of controllers and views: Products and Services. A typical folder structure for that using MVC areas looks like below:

- Project name
  - Areas
    - Products
      - Controllers
        - HomeController.cs
        - ManageController.cs
      - Views
        - Home

- Index.cshtml
- Manage
  - Index.cshtml
- Services
  - Controllers
    - HomeController.cs
  - Views
    - Home
      - Index.cshtml

When MVC tries to render a view in an Area, by default, it tries to look in the following locations:

```
/Areas/<Area-Name>/Views/<Controller-Name>/<Action-Name>.cshtml
/Areas/<Area-Name>/Views/Shared/<Action-Name>.cshtml
/Views/Shared/<Action-Name>.cshtml
```

These are the default locations which can be changed via the `AreaViewLocationFormats` on the `Microsoft.AspNetCore.Mvc.Razor.RazorViewEngineOptions`.

For example, in the below code instead of having the folder name as 'Areas', it has been changed to 'Categories'.

```
services.Configure<RazorViewEngineOptions>(options =>
{
    options.AreaViewLocationFormats.Clear();
    options.AreaViewLocationFormats.Add("/Categories/{2}/Views/{1}/{0}.cshtml");
    options.AreaViewLocationFormats.Add("/Categories/{2}/Views/Shared/{0}.cshtml");
    options.AreaViewLocationFormats.Add("/Views/Shared/{0}.cshtml");
});
```

One thing to note is that the structure of the *Views* folder is the only one which is considered important here and the content of the rest of the folders like *Controllers* and *Models* does **not** matter. For example, you need not have a *Controllers* and *Models* folder at all. This works because the content of *Controllers* and *Models* is just code which gets compiled into a .dll where as the content of the *Views* isn't until a request to that view has been made.

Once you've defined the folder hierarchy, you need to tell MVC that each controller is associated with an area. You do that by decorating the controller name with the `[Area]` attribute.

```

...
namespace MyStore.Areas.Products.Controllers
{
    [Area("Products")]
    public class HomeController : Controller
    {
        // GET: /Products/Home/Index
        public IActionResult Index()
        {
            return View();
        }

        // GET: /Products/Home/Create
        public IActionResult Create()
        {
            return View();
        }
    }
}

```

Set up a route definition that works with your newly created areas. The [Route to controller actions](#) article goes into detail about how to create route definitions, including using conventional routes versus attribute routes. In this example, we'll use a conventional route. To do so, open the *Startup.cs* file and modify it by adding the `areaRoute` named route definition below.

```

...
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "areaRoute",
        template: "{area:exists}/{controller=Home}/{action=Index}/{id?}");

    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});

```

Browsing to `http://<yourApp>/products`, the `Index` action method of the `HomeController` in the `Products` area will be invoked.

## Link Generation

- Generating links from an action within an area based controller to another action within the same controller.

Let's say the current request's path is like `/Products/Home/Create`

HtmlHelper syntax: `@Html.ActionLink("Go to Product's Home Page", "Index")`

TagHelper syntax: `<a asp-action="Index">Go to Product's Home Page</a>`

Note that we need not supply the 'area' and 'controller' values here as they're already available in the context of the current request. These kind of values are called `ambient` values.

- Generating links from an action within an area based controller to another action on a different controller

Let's say the current request's path is like `/Products/Home/Create`

HtmlHelper syntax: `@Html.ActionLink("Go to Manage Products Home Page", "Index", "Manage")`

TagHelper syntax: `<a asp-controller="Manage" asp-action="Index">Go to Manage Products Home Page</a>`

Note that here the ambient value of an 'area' is used but the 'controller' value is specified explicitly above.

- Generating links from an action within an area based controller to another action on a different controller and a different area.

Let's say the current request's path is like `/Products/Home/Create`

HtmlHelper syntax:

```
@Html.ActionLink("Go to Services Home Page", "Index", "Home", new { area = "Services" })
```

TagHelper syntax:

```
<a asp-area="Services" asp-controller="Home" asp-action="Index">Go to Services Home Page</a>
```

Note that here no ambient values are used.

- Generating links from an action within an area based controller to another action on a different controller and **not** in an area.

HtmlHelper syntax:

```
@Html.ActionLink("Go to Manage Products Home Page", "Index", "Home", new { area = "" })
```

TagHelper syntax:

```
<a asp-area="" asp-controller="Manage" asp-action="Index">Go to Manage Products Home Page</a>
```

Since we want to generate links to a non-area based controller action, we empty the ambient value for 'area' here.

## Publishing Areas

All `*.cshtml` and `wwwroot/**` files are published to output when `<Project Sdk="Microsoft.NET.Sdk.Web">` is included in the `.csproj` file.

# Application Parts in ASP.NET Core

6/21/2018 • 4 minutes to read • [Edit Online](#)

[View or download sample code \(how to download\)](#)

An *Application Part* is an abstraction over the resources of an application, from which MVC features like controllers, view components, or tag helpers may be discovered. One example of an application part is an `AssemblyPart`, which encapsulates an assembly reference and exposes types and compilation references. *Feature providers* work with application parts to populate the features of an ASP.NET Core MVC app. The main use case for application parts is to allow you to configure your app to discover (or avoid loading) MVC features from an assembly.

## Introducing Application Parts

MVC apps load their features from [application parts](#). In particular, the `AssemblyPart` class represents an application part that's backed by an assembly. You can use these classes to discover and load MVC features, such as controllers, view components, tag helpers, and razor compilation sources. The [ApplicationPartManager](#) is responsible for tracking the application parts and feature providers available to the MVC app. You can interact with the `ApplicationPartManager` in `Startup` when you configure MVC:

```
// create an assembly part from a class's assembly
var assembly = typeof(Startup).GetTypeInfo().Assembly;
services.AddMvc()
    .AddApplicationPart(assembly);

// OR
var assembly = typeof(Startup).GetTypeInfo().Assembly;
var part = new AssemblyPart(assembly);
services.AddMvc()
    .ConfigureApplicationPartManager(apm => apm.ApplicationParts.Add(part));
```

By default MVC will search the dependency tree and find controllers (even in other assemblies). To load an arbitrary assembly (for instance, from a plugin that isn't referenced at compile time), you can use an application part.

You can use application parts to *avoid* looking for controllers in a particular assembly or location. You can control which parts (or assemblies) are available to the app by modifying the `ApplicationParts` collection of the `ApplicationPartManager`. The order of the entries in the `ApplicationParts` collection isn't important. It's important to fully configure the `ApplicationPartManager` before using it to configure services in the container. For example, you should fully configure the `ApplicationPartManager` before invoking `AddControllersAsServices`. Failing to do so, will mean that controllers in application parts added after that method call won't be affected (won't get registered as services) which might result in incorrect behavior of your application.

If you have an assembly that contains controllers you don't want to be used, remove it from the `ApplicationPartManager`:

```

services.AddMvc()
    .ConfigureApplicationPartManager(apm =>
{
    var dependentLibrary = apm.ApplicationParts
        .FirstOrDefault(part => part.Name == "DependentLibrary");

    if (dependentLibrary != null)
    {
        p.ApplicationParts.Remove(dependentLibrary);
    }
})

```

In addition to your project's assembly and its dependent assemblies, the `ApplicationPartManager` will include parts for `Microsoft.AspNetCore.Mvc.TagHelpers` and `Microsoft.AspNetCore.Mvc.Razor` by default.

## Application Feature Providers

Application Feature Providers examine application parts and provide features for those parts. There are built-in feature providers for the following MVC features:

- [Controllers](#)
- [Metadata Reference](#)
- [Tag Helpers](#)
- [View Components](#)

Feature providers inherit from `IApplicationFeatureProvider<T>`, where `T` is the type of the feature. You can implement your own feature providers for any of MVC's feature types listed above. The order of feature providers in the `ApplicationPartManager.FeatureProviders` collection can be important, since later providers can react to actions taken by previous providers.

### Sample: Generic controller feature

By default, ASP.NET Core MVC ignores generic controllers (for example, `SomeController<T>`). This sample uses a controller feature provider that runs after the default provider and adds generic controller instances for a specified list of types (defined in `EntityTypes.Types`):

```

public class GenericControllerFeatureProvider : IApplicationFeatureProvider<ControllerFeature>
{
    public void PopulateFeature(IEnumerable<ApplicationPart> parts, ControllerFeature feature)
    {
        // This is designed to run after the default ControllerTypeProvider,
        // so the list of 'real' controllers has already been populated.
        foreach (var entityType in EntityTypes.Types)
        {
            var typeName = entityType.Name + "Controller";
            if (!feature.Controllers.Any(t => t.Name == typeName))
            {
                // There's no 'real' controller for this entity, so add the generic version.
                var controllerType = typeof(GenericController<>)
                    .MakeGenericType(entityType.AsType()).GetTypeInfo();
                feature.Controllers.Add(controllerType);
            }
        }
    }
}

```

The entity types:

```

public static class EntityTypes
{
    public static IReadOnlyList<TypeInfo> Types => new List<TypeInfo>()
    {
        typeof(Sprocket).GetTypeInfo(),
        typeof(Widget).GetTypeInfo(),
    };

    public class Sprocket { }
    public class Widget { }
}

```

The feature provider is added in `Startup`:

```

services.AddMvc()
    .ConfigureApplicationPartManager(apm =>
        apm.FeatureProviders.Add(new GenericControllerFeatureProvider()));

```

By default, the generic controller names used for routing would be of the form `GenericController`1[Widget]` instead of `Widget`. The following attribute is used to modify the name to correspond to the generic type used by the controller:

```

using Microsoft.AspNetCore.Mvc.ApplicationModels;
using System;

namespace AppPartsSample
{
    // Used to set the controller name for routing purposes. Without this convention the
    // names would be like 'GenericController`1[Widget]' instead of 'Widget'.
    //
    // Conventions can be applied as attributes or added to MvcOptions.Conventions.
    [AttributeUsage(AttributeTargets.Class, AllowMultiple = false, Inherited = true)]
    public class GenericControllerNameConvention : Attribute, IControllerModelConvention
    {
        public void Apply(ControllerModel controller)
        {
            if (controller.ControllerType.GetGenericTypeDefinition() !=
                typeof(GenericController<>))
            {
                // Not a GenericController, ignore.
                return;
            }

            var entityType = controller.ControllerType.GenericTypeArguments[0];
            controller.ControllerName = entityType.Name;
        }
    }
}

```

The `GenericController` class:

```
using Microsoft.AspNetCore.Mvc;

namespace AppPartsSample
{
    [GenericControllerNameConvention] // Sets the controller name based on typeof(T).Name
    public class GenericController<T> : Controller
    {
        public IActionResult Index()
        {
            return Content($"Hello from a generic {typeof(T).Name} controller.");
        }
    }
}
```

The result, when a matching route is requested:



### Sample: Display available features

You can iterate through the populated features available to your app by requesting an [ApplicationPartManager](#) through [dependency injection](#) and using it to populate instances of the appropriate features:

```
using AppPartsSample.ViewModels;
using Microsoft.AspNetCore.Mvc;
using Microsoft.AspNetCore.Mvc.ApplicationParts;
using Microsoft.AspNetCore.Mvc.Controllers;
using System.Linq;
using Microsoft.AspNetCore.Mvc.Razor.Compilation;
using Microsoft.AspNetCore.Mvc.Razor.TagHelpers;
using Microsoft.AspNetCore.Mvc.ViewComponents;

namespace AppPartsSample.Controllers
{
    public class FeaturesController : Controller
    {
        private readonly ApplicationPartManager _partManager;

        public FeaturesController(ApplicationPartManager partManager)
        {
            _partManager = partManager;
        }

        public IActionResult Index()
        {
            var viewModel = new FeaturesViewModel();

            var controllerFeature = new ControllerFeature();
            _partManager.PopulateFeature(controllerFeature);
            viewModel.Controllers = controllerFeature.Controllers.ToList();

            var metaDataReferenceFeature = new MetadataReferenceFeature();
            _partManager.PopulateFeature(metaDataReferenceFeature);
            viewModel.MetadataReferences = metaDataReferenceFeature.MetadataReferences
                .ToList();

            var tagHelperFeature = new TagHelperFeature();
            _partManager.PopulateFeature(tagHelperFeature);
            viewModel.TagHelpers = tagHelperFeature.TagHelpers.ToList();

            var viewComponentFeature = new ViewComponentFeature();
            _partManager.PopulateFeature(viewComponentFeature);
            viewModel.ViewComponents = viewComponentFeature.ViewComponents.ToList();

            return View(viewModel);
        }
    }
}
```

Example output:

Home Page - AppPartS: X +

localhost:28431/Features

Back Forward Refresh Home Stop More

# Features

**Controllers:**

- FeaturesController
- HomeController
- HelloController
- GenericController`1
- GenericController`1

**Metadata References:**

- C:\dev\ssmith\github.com\aspnet-docs\aspnetcore\mvc\extensibility\app-parts\sample\src\AppPartSample\bin\Debug\netcoreapp1.0\AppPartSample.dll
- C:\Users\steve\_000\.nuget\packages\Microsoft.AspNetCore.Antiforgery\1.0.1\lib\netstandard1.3\Microsoft.AspNetCore.Antiforgery.dll
- C:\Users\steve\_000\.nuget\packages\Microsoft.AspNetCore.Authorization\1.0.0

**Tag Helpers:**

- AnchorTagHelper
- CacheTagHelper
- DistributedCacheTagHelper
- EnvironmentTagHelper
- FormTagHelper

**View Components:**

- AnchorTagHelper
- CacheTagHelper
- DistributedCacheTagHelper
- EnvironmentTagHelper
- FormTagHelper

[Home](#)

# Custom Model Binding in ASP.NET Core

6/21/2018 • 6 minutes to read • [Edit Online](#)

By [Steve Smith](#)

Model binding allows controller actions to work directly with model types (passed in as method arguments), rather than HTTP requests. Mapping between incoming request data and application models is handled by model binders. Developers can extend the built-in model binding functionality by implementing custom model binders (though typically, you don't need to write your own provider).

[View or download sample from GitHub](#)

## Default model binder limitations

The default model binders support most of the common .NET Core data types and should meet most developers' needs. They expect to bind text-based input from the request directly to model types. You might need to transform the input prior to binding it. For example, when you have a key that can be used to look up model data. You can use a custom model binder to fetch data based on the key.

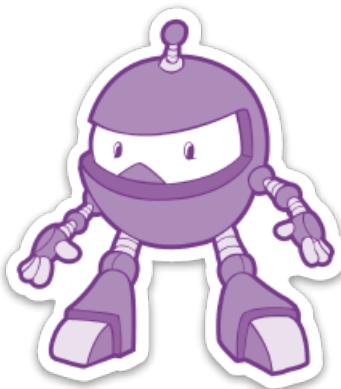
## Model binding review

Model binding uses specific definitions for the types it operates on. A *simple type* is converted from a single string in the input. A *complex type* is converted from multiple input values. The framework determines the difference based on the existence of a `TypeConverter`. We recommended you create a type converter if you have a simple `string -> SomeType` mapping that doesn't require external resources.

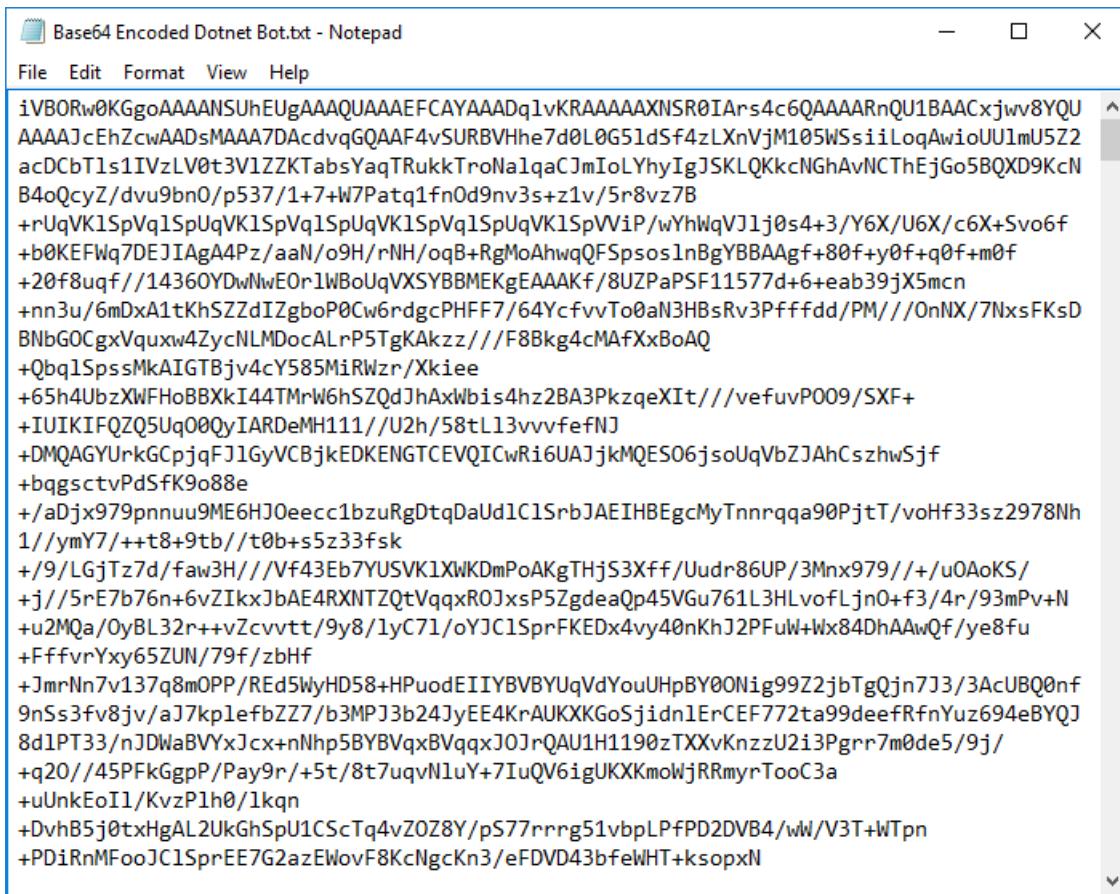
Before creating your own custom model binder, it's worth reviewing how existing model binders are implemented. Consider the `ByteArrayModelBinder` which can be used to convert base64-encoded strings into byte arrays. The byte arrays are often stored as files or database BLOB fields.

### Working with the `ByteArrayModelBinder`

Base64-encoded strings can be used to represent binary data. For example, the following image can be encoded as a string.



A small portion of the encoded string is shown in the following image:



A screenshot of a Windows Notepad window titled "Base64 Encoded Dotnet Bot.txt - Notepad". The window contains a single line of extremely long base64-encoded text. The text starts with "iVBORw0KGgoAAAANSUhEUgAAAQAAAECAYAAAdq1vKRAAAAXNSR0IArs4c6QAAAARnQU1BAACxjwv8YQU" and continues for several hundred characters.

Follow the instructions in the [sample's README](#) to convert the base64-encoded string into a file.

ASP.NET Core MVC can take a base64-encoded strings and use a `ByteArrayModelBinder` to convert it into a byte array. The `ByteArrayModelBinderProvider` which implements `IModelBinderProvider` maps `byte[]` arguments to `ByteArrayModelBinder`:

```
public IModelBinder GetBinder(ModelBinderProviderContext context)
{
    if (context == null)
    {
        throw new ArgumentNullException(nameof(context));
    }

    if (context.Metadata.ModelType == typeof(byte[]))
    {
        return new ByteArrayModelBinder();
    }

    return null;
}
```

When creating your own custom model binder, you can implement your own `IModelBinderProvider` type, or use the `ModelBinderAttribute`.

The following example shows how to use `ByteArrayModelBinder` to convert a base64-encoded string to a `byte[]` and save the result to a file:

```
// POST: api/image
[HttpPost]
public void Post(byte[] file, string filename)
{
    string filePath = Path.Combine(_env.ContentRootPath, "wwwroot/images/upload", filename);
    if (System.IO.File.Exists(filePath)) return;
    System.IO.File.WriteAllBytes(filePath, file);
}
```

You can POST a base64-encoded string to this api method using a tool like [Postman](#):

The screenshot shows the Postman application interface. The top navigation bar includes 'Runner', 'Import', 'Builder' (which is highlighted), 'Team Library', and various status indicators. The main workspace shows a POST request to 'http://localhost:64513/api/image'. The 'Body' tab is active, showing form-data fields: 'file' (selected) with a long base64 string value and 'filename' with the value 'bot.png'. Other options like 'x-www-form-urlencoded', 'raw', and 'binary' are available. Below the body, the 'Headers' tab (with 3 items) and 'Tests' tab are visible. The bottom status bar indicates 'Status: 200 OK' and 'Time: 38 ms'. The preview pane shows a single item in the list.

As long as the binder can bind request data to appropriately named properties or arguments, model binding will succeed. The following example shows how to use `ByteArrayModelBinder` with a view model:

```
[HttpPost("Profile")]
public void SaveProfile(ProfileViewModel model)
{
    string filePath = Path.Combine(_env.ContentRootPath, "wwwroot/images/upload", model.FileName);
    if (System.IO.File.Exists(model.FileName)) return;
    System.IO.File.WriteAllBytes(filePath, model.File);
}

public class ProfileViewModel
{
    public byte[] File { get; set; }
    public string FileName { get; set; }
}
```

## Custom model binder sample

In this section we'll implement a custom model binder that:

- Converts incoming request data into strongly typed key arguments.
- Uses Entity Framework Core to fetch the associated entity.
- Passes the associated entity as an argument to the action method.

The following sample uses the `ModelBinder` attribute on the `Author` model:

```
using CustomModelBindingSample.Binders;
using Microsoft.AspNetCore.Mvc;
using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;

namespace CustomModelBindingSample.Data
{
    [ModelBinder(BinderType = typeof(AuthorEntityBinder))]
    public class Author
    {
        public int Id { get; set; }
        public string Name { get; set; }
        public string GitHub { get; set; }
        public string Twitter { get; set; }
        public string BlogUrl { get; set; }
    }
}
```

In the preceding code, the `ModelBinder` attribute specifies the type of `IModelBinder` that should be used to bind `Author` action parameters.

The `AuthorEntityBinder` is used to bind an `Author` parameter by fetching the entity from a data source using Entity Framework Core and an `authorId`:

```

public class AuthorEntityBinder : IModelBinder
{
    private readonly AppDbContext _db;
    public AuthorEntityBinder(AppDbContext db)
    {
        _db = db;
    }

    public Task BindModelAsync(ModelBindingContext bindingContext)
    {
        if (bindingContext == null)
        {
            throw new ArgumentNullException(nameof(bindingContext));
        }

        // Specify a default argument name if none is set by ModelBinderAttribute
        var modelName = bindingContext.BinderModelName;
        if (string.IsNullOrEmpty(modelName))
        {
            modelName = "authorId";
        }

        // Try to fetch the value of the argument by name
        var valueProviderResult =
            bindingContext.ValueProvider.GetValue(modelName);

        if (valueProviderResult == ValueProviderResult.None)
        {
            return Task.CompletedTask;
        }

        bindingContext.ModelState.SetModelValue(modelName,
            valueProviderResult);

        var value = valueProviderResult.FirstValue;

        // Check if the argument value is null or empty
        if (string.IsNullOrEmpty(value))
        {
            return Task.CompletedTask;
        }

        int id = 0;
        if (!int.TryParse(value, out id))
        {
            // Non-integer arguments result in model state errors
            bindingContext.ModelState.TryAddModelError(
                bindingContext.ModelName,
                "Author Id must be an integer.");
            return Task.CompletedTask;
        }

        // Model will be null if not found, including for
        // out of range id values (0, -3, etc.)
        var model = _db.Authors.Find(id);
        bindingContext.Result = ModelBindingResult.Success(model);
        return Task.CompletedTask;
    }
}

```

The following code shows how to use the `AuthorEntityBinder` in an action method:

```
[HttpGet("get/{authorId}")]  
public IActionResult Get(Author author)  
{  
    return Ok(author);  
}
```

The `ModelBinder` attribute can be used to apply the `AuthorEntityBinder` to parameters that don't use default conventions:

```
[HttpGet("{id}")]  
public IActionResult GetById([ModelBinder(Name = "id")]Author author)  
{  
    if (author == null)  
    {  
        return NotFound();  
    }  
    if (!ModelState.IsValid)  
    {  
        return BadRequest(ModelState);  
    }  
    return Ok(author);  
}
```

In this example, since the name of the argument isn't the default `authorId`, it's specified on the parameter using `ModelBinder` attribute. Note that both the controller and action method are simplified compared to looking up the entity in the action method. The logic to fetch the author using Entity Framework Core is moved to the model binder. This can be considerable simplification when you have several methods that bind to the author model, and can help you to follow the [DRY principle](#).

You can apply the `ModelBinder` attribute to individual model properties (such as on a viewmodel) or to action method parameters to specify a certain model binder or model name for just that type or action.

### Implementing a ModelBinderProvider

Instead of applying an attribute, you can implement `IModelBinderProvider`. This is how the built-in framework binders are implemented. When you specify the type your binder operates on, you specify the type of argument it produces, **not** the input your binder accepts. The following binder provider works with the `AuthorEntityBinder`. When it's added to MVC's collection of providers, you don't need to use the `ModelBinder` attribute on `Author` or `Author` typed parameters.

```

using CustomModelBindingSample.Data;
using Microsoft.AspNetCore.Mvc.ModelBinding;
using Microsoft.AspNetCore.Mvc.ModelBinding.Binders;
using System;

namespace CustomModelBindingSample.Binders
{
    public class AuthorEntityBinderProvider : IModelBinderProvider
    {
        public IModelBinder GetBinder(ModelBinderProviderContext context)
        {
            if (context == null)
            {
                throw new ArgumentNullException(nameof(context));
            }

            if (context.Metadata.ModelType == typeof(Author))
            {
                return new BinderTypeModelBinder(typeof(AuthorEntityBinder));
            }

            return null;
        }
    }
}

```

Note: The preceding code returns a `BinderTypeModelBinder`. `BinderTypeModelBinder` acts as a factory for model binders and provides dependency injection (DI). The `AuthorEntityBinder` requires DI to access EF Core. Use `BinderTypeModelBinder` if your model binder requires services from DI.

To use a custom model binder provider, add it in `ConfigureServices`:

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<AppDbContext>(options => options.UseInMemoryDatabase());

    services.AddMvc(options =>
    {
        // add custom binder to beginning of collection
        options.ModelBinderProviders.Insert(0, new AuthorEntityBinderProvider());
    });
}

```

When evaluating model binders, the collection of providers is examined in order. The first provider that returns a binder is used.

The following image shows the default model binders from the debugger.

Name	Value
options.ModelBind	Count = 14
[0]	{Microsoft.AspNetCore.Mvc.ModelBinding.BindersBinderTypeModelBinderProvider}
[1]	{Microsoft.AspNetCore.Mvc.ModelBinding.BindersServicesModelBinderProvider}
[2]	{Microsoft.AspNetCore.Mvc.ModelBinding.BindersBodyModelBinderProvider}
[3]	{Microsoft.AspNetCore.Mvc.ModelBinding.BindersHeaderModelBinderProvider}
[4]	{Microsoft.AspNetCore.Mvc.ModelBinding.BindersSimpleTypeModelBinderProvider}
[5]	{Microsoft.AspNetCore.Mvc.ModelBinding.BindersCancellationTokenModelBinderProvider}
[6]	{Microsoft.AspNetCore.Mvc.ModelBinding.BindersByteArrayModelBinderProvider}
[7]	{Microsoft.AspNetCore.Mvc.ModelBinding.BindersFormFileModelBinderProvider}
[8]	{Microsoft.AspNetCore.Mvc.ModelBinding.BindersFormCollectionModelBinderProvider}
[9]	{Microsoft.AspNetCore.Mvc.ModelBinding.BindersKeyValuePairModelBinderProvider}
[10]	{Microsoft.AspNetCore.Mvc.ModelBinding.BindersDictionaryModelBinderProvider}
[11]	{Microsoft.AspNetCore.Mvc.ModelBinding.BindersArrayModelBinderProvider}
[12]	{Microsoft.AspNetCore.Mvc.ModelBinding.BindersCollectionModelBinderProvider}
[13]	{Microsoft.AspNetCore.Mvc.ModelBinding.BindersComplexTypeModelBinderProvider}

Adding your provider to the end of the collection may result in a built-in model binder being called before your custom binder has a chance. In this example, the custom provider is added to the beginning of the collection to ensure it's used for `Author` action arguments.

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<AppDbContext>(options => options.UseInMemoryDatabase());

    services.AddMvc(options =>
    {
        // add custom binder to beginning of collection
        options.ModelBinderProviders.Insert(0, new AuthorEntityBinderProvider());
    });
}
```

## Recommendations and best practices

Custom model binders:

- Shouldn't attempt to set status codes or return results (for example, 404 Not Found). If model binding fails, an [action filter](#) or logic within the action method itself should handle the failure.
- Are most useful for eliminating repetitive code and cross-cutting concerns from action methods.
- Typically shouldn't be used to convert a string into a custom type, a [TypeConverter](#) is usually a better option.

# Build web APIs with ASP.NET Core

7/11/2018 • 4 minutes to read • [Edit Online](#)

By [Scott Addie](#)

[View or download sample code](#) ([how to download](#))

This document explains how to build a web API in ASP.NET Core and when it's most appropriate to use each feature.

## Derive class from ControllerBase

Inherit from the [ControllerBase](#) class in a controller that's intended to serve as a web API. For example:

```
[Produces("application/json")]
[Route("api/[controller]")]
public class PetsController : ControllerBase
{
    private readonly PetsRepository _repository;

    public PetsController(PetsRepository repository)
    {
        _repository = repository;
    }

    [HttpGet]
    public async Task<ActionResult<List<Pet>>> GetAllAsync()
    {
        return await _repository.GetPetsAsync();
    }

    [HttpGet("{id}")]
    [ProducesResponseType(404)]
    public async Task<ActionResult<Pet>> GetByIdAsync(int id)
    {
        var pet = await _repository.GetPetAsync(id);

        if (pet == null)
        {
            return NotFound();
        }

        return pet;
    }

    [HttpPost]
    [ProducesResponseType(400)]
    public async Task<ActionResult<Pet>> CreateAsync(Pet pet)
    {
        if (!ModelState.IsValid)
        {
            return BadRequest(ModelState);
        }

        await _repository.AddPetAsync(pet);

        return CreatedAtAction(nameof(GetByIdAsync),
            new { id = pet.Id }, pet);
    }
}
```

```

[Produces("application/json")]
[Route("api/[controller]")]
public class PetsController : ControllerBase
{
    private readonly PetsRepository _repository;

    public PetsController(PetsRepository repository)
    {
        _repository = repository;
    }

    [HttpGet]
    [ProducesResponseType(typeof(IEnumerable<Pet>), 200)]
    public async Task<IActionResult> GetAllAsync()
    {
        var pets = await _repository.GetPetsAsync();

        return Ok(pets);
    }

    [HttpGet("{id}")]
    [ProducesResponseType(typeof(Pet), 200)]
    [ProducesResponseType(404)]
    public async Task<IActionResult> GetByIdAsync(int id)
    {
        var pet = await _repository.GetPetAsync(id);

        if (pet == null)
        {
            return NotFound();
        }

        return Ok(pet);
    }

    [HttpPost]
    [ProducesResponseType(typeof(Pet), 201)]
    [ProducesResponseType(400)]
    public async Task<IActionResult> CreateAsync([FromBody] Pet pet)
    {
        if (!ModelState.IsValid)
        {
            return BadRequest(ModelState);
        }

        await _repository.AddPetAsync(pet);

        return CreatedAtAction(nameof(GetByIdAsync),
            new { id = pet.Id }, pet);
    }
}

```

The  `ControllerBase` class provides access to several properties and methods. In the preceding code, examples include `BadRequest` and `CreatedAtAction`. These methods are called within action methods to return HTTP 400 and 201 status codes, respectively. The  `ModelState` property, also provided by  `ControllerBase`, is accessed to handle request model validation.

## Annotate class with ApiControllerAttribute

ASP.NET Core 2.1 introduces the `[ApiController]` attribute to denote a web API controller class. For example:

```
[Route("api/[controller]")]
[ApiController]
public class ProductsController : ControllerBase
```

A compatibility version of 2.1 or later, set via [SetCompatibilityVersion](#), is required to use this attribute. For example, the highlighted code in `Startup.ConfigureServices` sets the 2.1 compatibility flag:

```
services.AddMvc()
    .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
```

The `[ApiController]` attribute is commonly coupled with `ControllerBase` to enable REST-specific behavior for controllers. `ControllerBase` provides access to methods such as [NotFound](#) and [File](#).

Another approach is to create a custom base controller class annotated with the `[ApiController]` attribute:

```
[ApiController]
public class MyBaseController
{
}
```

The following sections describe convenience features added by the attribute.

### Automatic HTTP 400 responses

Validation errors automatically trigger an HTTP 400 response. The following code becomes unnecessary in your actions:

```
[ProducesResponseType(typeof(Pet), 201)]
[ProducesResponseType(400)]
public async Task<IActionResult> CreateAsync([FromBody] Pet pet)
{
```

The default behavior is disabled when the [SuppressModelStateInvalidFilter](#) property is set to `true`. Add the following code in `Startup.ConfigureServices` after

```
services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1); :
```

```
services.Configure<ApiBehaviorOptions>(options =>
{
    options.SuppressConsumesConstraintForFormFileParameters = true;
    options.SuppressInferBindingSourcesForParameters = true;
    options.SuppressModelStateInvalidFilter = true;
});
```

### Binding source parameter inference

A binding source attribute defines the location at which an action parameter's value is found. The following binding source attributes exist:

ATTRIBUTE	BINDING SOURCE
<code>[FromBody]</code>	Request body
<code>[FromForm]</code>	Form data in the request body
<code>[FromHeader]</code>	Request header

ATTRIBUTE	BINDING SOURCE
[FromQuery]	Request query string parameter
[FromRoute]	Route data from the current request
[FromServices]	The request service injected as an action parameter

**WARNING**

Don't use `[FromRoute]` when values might contain `%2f` (that is `/`). `%2f` won't be unescaped to `/`. Use `[FromQuery]` if the value might contain `%2f`.

Without the `[ApiController]` attribute, binding source attributes are explicitly defined. In the following example, the `[FromQuery]` attribute indicates that the `discontinuedOnly` parameter value is provided in the request URL's query string:

```
[HttpGet]
public async Task<ActionResult<List<Product>>> GetAsync(
    [FromQuery] bool discontinuedOnly = false)
{
    List<Product> products = null;

    if (discontinuedOnly)
    {
        products = await _repository.GetDiscontinuedProductsAsync();
    }
    else
    {
        products = await _repository.GetProductsAsync();
    }

    return products;
}
```

Inference rules are applied for the default data sources of action parameters. These rules configure the binding sources you're otherwise likely to manually apply to the action parameters. The binding source attributes behave as follows:

- **[FromBody]** is inferred for complex type parameters. An exception to this rule is any complex, built-in type with a special meaning, such as `IFormCollection` and `CancellationToken`. The binding source inference code ignores those special types. When an action has more than one parameter explicitly specified (via `[FromBody]`) or inferred as bound from the request body, an exception is thrown. For example, the following action signatures cause an exception:

- **[FromForm]** is inferred for action parameters of type `IFormFile` and `IFormFileCollection`. It's not inferred for any simple or user-defined types.
- **[FromRoute]** is inferred for any action parameter name matching a parameter in the route template. When more than one route matches an action parameter, any route value is considered `[FromRoute]`.
- **[FromQuery]** is inferred for any other action parameters.

The default inference rules are disabled when the `SuppressInferBindingSourcesForParameters` property is set to `true`. Add the following code in `Startup.ConfigureServices` after

```
services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1); :
```

```
services.Configure<ApiBehaviorOptions>(options =>
{
    options.SuppressConsumesConstraintForFormFileParameters = true;
    options.SuppressInferBindingSourcesForParameters = true;
    options.SuppressModelStateInvalidFilter = true;
});
```

### Multipart/form-data request inference

When an action parameter is annotated with the `[FromForm]` attribute, the `multipart/form-data` request content type is inferred.

The default behavior is disabled when the `SuppressConsumesConstraintForFormFileParameters` property is set to `true`. Add the following code in `Startup.ConfigureServices` after

```
services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1); :
```

```
services.Configure<ApiBehaviorOptions>(options =>
{
    options.SuppressConsumesConstraintForFormFileParameters = true;
    options.SuppressInferBindingSourcesForParameters = true;
    options.SuppressModelStateInvalidFilter = true;
});
```

### Attribute routing requirement

Attribute routing becomes a requirement. For example:

```
[Route("api/[controller]")]
[ApiController]
public class ProductsController : ControllerBase
```

Actions are inaccessible via `conventional routes` defined in `UseMvc` or by `UseMvcWithDefaultRoute` in `Startup.Configure`.

## Additional resources

- [Controller action return types in ASP.NET Core Web API](#)
- [Custom formatters in ASP.NET Core Web API](#)
- [Format response data in ASP.NET Core Web API](#)
- [ASP.NET Core Web API help pages with Swagger / Open API](#)
- [Routing to controller actions in ASP.NET Core](#)

# Controller action return types in ASP.NET Core Web API

6/21/2018 • 4 minutes to read • [Edit Online](#)

By Scott Addie

[View or download sample code \(how to download\)](#)

ASP.NET Core offers the following options for Web API controller action return types:

- [Specific type](#)
- [IActionResult](#)
- [Specific type](#)
- [IActionResult](#)
- [ActionResult<T>](#)

This document explains when it's most appropriate to use each return type.

## Specific type

The simplest action returns a primitive or complex data type (for example, `string` or a custom object type).

Consider the following action, which returns a collection of custom `Product` objects:

```
[HttpGet]
public IEnumerable<Product> Get()
{
    return _repository.GetProducts();
}
```

Without known conditions to safeguard against during action execution, returning a specific type could suffice. The preceding action accepts no parameters, so parameter constraints validation isn't needed.

When known conditions need to be accounted for in an action, multiple return paths are introduced. In such a case, it's common to mix an [ActionResult](#) return type with the primitive or complex return type. Either [IActionResult](#) or [ActionResult<T>](#) are necessary to accommodate this type of action.

## IActionResult type

The [IActionResult](#) return type is appropriate when multiple [ActionResult](#) return types are possible in an action. The `ActionResult` types represent various HTTP status codes. Some common return types falling into this category are [BadRequestResult](#) (400), [NotFoundResult](#) (404), and [OkObjectResult](#) (200).

Because there are multiple return types and paths in the action, liberal use of the `[ProducesResponseType]` attribute is necessary. This attribute produces more descriptive response details for API help pages generated by tools like [Swagger](#). `[ProducesResponseType]` indicates the known types and HTTP status codes to be returned by the action.

### Synchronous action

Consider the following synchronous action in which there are two possible return types:

```
[HttpGet("{id}")]
[ProducesResponseType(200, Type = typeof(Product))]
[ProducesResponseType(404)]
public IActionResult GetById(int id)
{
    if (!_repository.TryGetProduct(id, out var product))
    {
        return NotFound();
    }

    return Ok(product);
}
```

In the preceding action, a 404 status code is returned when the product represented by `id` doesn't exist in the underlying data store. The `NotFound` helper method is invoked as a shortcut to `return new NotFoundResult();`. If the product does exist, a `Product` object representing the payload is returned with a 200 status code. The `Ok` helper method is invoked as the shorthand form of `return new OkObjectResult(product);`.

## Asynchronous action

Consider the following asynchronous action in which there are two possible return types:

```
[HttpPost]
[ProducesResponseType(201, Type = typeof(Product))]
[ProducesResponseType(400)]
public async Task<IActionResult> CreateAsync([FromBody] Product product)
{
    if (!ModelState.IsValid)
    {
        return BadRequest(ModelState);
    }

    await _repository.AddProductAsync(product);

    return CreatedAtAction(nameof(GetById), new { id = product.Id }, product);
}
```

In the preceding action, a 400 status code is returned when model validation fails and the `BadRequest` helper method is invoked. For example, the following model indicates that requests must provide the `Name` property and a value. Therefore, failure to provide a proper `Name` in the request causes model validation to fail.

```
public class Product
{
    public int Id { get; set; }

    [Required]
    public string Name { get; set; }

    public string Description { get; set; }
}
```

The preceding action's other known return code is a 201, which is generated by the `CreatedAtAction` helper method. In this path, the `Product` object is returned.

## ActionResult<T> type

ASP.NET Core 2.1 introduces the `ActionResult<T>` return type for Web API controller actions. It enables you to return a type deriving from `ActionResult` or return a `specific type`. `ActionResult<T>` offers the following benefits over the `IActionResult` type:

- The `[ProducesResponseType]` attribute's `Type` property can be excluded.
- **Implicit cast operators** support the conversion of both `T` and `ActionResult` to `ActionResult<T>`. `T` converts to `ObjectResult`, which means `return new ObjectResult(T);` is simplified to `return T;`.

Most actions have a specific return type. Unexpected conditions can occur during action execution, in which case the specific type isn't returned. For example, an action's input parameter may fail model validation. In such a case, it's common to return the appropriate `ActionResult` type instead of the specific type.

## Synchronous action

Consider a synchronous action in which there are two possible return types:

```
[HttpGet("{id}")]
[ProducesResponseType(200)]
[ProducesResponseType(404)]
public ActionResult<Product> GetById(int id)
{
    if (!_repository.TryGetProduct(id, out var product))
    {
        return NotFound();
    }

    return product;
}
```

In the preceding code, a 404 status code is returned when the product doesn't exist in the database. If the product does exist, the corresponding `Product` object is returned. Before ASP.NET Core 2.1, the `return product;` line would have been `return Ok(product);`.

### TIP

As of ASP.NET Core 2.1, action parameter binding source inference is enabled when a controller class is decorated with the `[ApiController]` attribute. A parameter name matching a name in the route template is automatically bound using the request route data. Consequently, the preceding action's `id` parameter isn't explicitly annotated with the `[FromRoute]` attribute.

## Asynchronous action

Consider an asynchronous action in which there are two possible return types:

```
[HttpPost]
[ProducesResponseType(201)]
[ProducesResponseType(400)]
public async Task<ActionResult<Product>> CreateAsync(Product product)
{
    if (!ModelState.IsValid)
    {
        return BadRequest(ModelState);
    }

    await _repository.AddProductAsync(product);

    return CreatedAtAction(nameof(GetById), new { id = product.Id }, product);
}
```

If model validation fails, the `BadRequest` method is invoked to return a 400 status code. The `ModelState` property containing the specific validation errors is passed to it. If model validation succeeds, the product is created in the database. A 201 status code is returned.

**TIP**

As of ASP.NET Core 2.1, action parameter binding source inference is enabled when a controller class is decorated with the `[ApiController]` attribute. Complex type parameters are automatically bound using the request body. Consequently, the preceding action's `product` parameter isn't explicitly annotated with the `[FromBody]` attribute.

## Additional resources

- [Controller actions](#)
- [Model validation](#)
- [Web API help pages using Swagger](#)

# Advanced topics for ASP.NET Core Web API

7/10/2018 • 2 minutes to read • [Edit Online](#)

- [Custom formatters](#)
- [Format response data](#)

# Custom formatters in ASP.NET Core Web API

6/21/2018 • 4 minutes to read • [Edit Online](#)

By [Tom Dykstra](#)

ASP.NET Core MVC has built-in support for data exchange in web APIs by using JSON, XML, or plain text formats. This article shows how to add support for additional formats by creating custom formatters.

[View or download sample code \(how to download\)](#)

## When to use custom formatters

Use a custom formatter when you want the [content negotiation](#) process to support a content type that isn't supported by the built-in formatters (JSON, XML, and plain text).

For example, if some of the clients for your web API can handle the [Protobuf](#) format, you might want to use Protobuf with those clients because it's more efficient. Or you might want your web API to send contact names and addresses in [vCard](#) format, a commonly used format for exchanging contact data. The sample app provided with this article implements a simple vCard formatter.

## Overview of how to use a custom formatter

Here are the steps to create and use a custom formatter:

- Create an output formatter class if you want to serialize data to send to the client.
- Create an input formatter class if you want to deserialize data received from the client.
- Add instances of your formatters to the `InputFormatters` and `OutputFormatters` collections in [MvcOptions](#).

The following sections provide guidance and code examples for each of these steps.

## How to create a custom formatter class

To create a formatter:

- Derive the class from the appropriate base class.
- Specify valid media types and encodings in the constructor.
- Override `CanReadType` / `CanWriteType` methods
- Override `ReadRequestBodyAsync` / `WriteResponseBodyAsync` methods

### Derive from the appropriate base class

For text media types (for example, vCard), derive from the [TextInputFormatter](#) or [TextOutputFormatter](#) base class.

```
public class VcardOutputFormatter : TextOutputFormatter
```

For binary types, derive from the [InputFormatter](#) or [OutputFormatter](#) base class.

### Specify valid media types and encodings

In the constructor, specify valid media types and encodings by adding to the `SupportedMediaTypes` and `SupportedEncodings` collections.

```
public VcardOutputFormatter()
{
    SupportedMediaTypes.Add(MediaTypeHeaderValue.Parse("text/vcard"));

    SupportedEncodings.Add(Encoding.UTF8);
    SupportedEncodings.Add(Encoding.Unicode);
}
```

#### NOTE

You can't do constructor dependency injection in a formatter class. For example, you can't get a logger by adding a logger parameter to the constructor. To access services, you have to use the context object that gets passed in to your methods. A code example [below](#) shows how to do this.

#### Override `CanReadType/CanWriteType`

Specify the type you can deserialize into or serialize from by overriding the `CanReadType` or `CanWriteType` methods. For example, you might only be able to create vCard text from a `Contact` type and vice versa.

```
protected override bool CanWriteType(Type type)
{
    if (typeof(Contact).IsAssignableFrom(type)
        || typeof(IEnumerable<Contact>).IsAssignableFrom(type))
    {
        return base.CanWriteType(type);
    }
    return false;
}
```

#### The `CanWriteResult` method

In some scenarios you have to override `CanWriteResult` instead of `CanWriteType`. Use `CanWriteResult` if the following conditions are true:

- Your action method returns a model class.
- There are derived classes which might be returned at runtime.
- You need to know at runtime which derived class was returned by the action.

For example, suppose your action method signature returns a `Person` type, but it may return a `Student` or `Instructor` type that derives from `Person`. If you want your formatter to handle only `Student` objects, check the type of `Object` in the context object provided to the `CanWriteResult` method. Note that it's not necessary to use `CanWriteResult` when the action method returns `IActionResult`; in that case, the `CanWriteType` method receives the runtime type.

#### Override `ReadRequestBodyAsync/WriteResponseBodyAsync`

You do the actual work of deserializing or serializing in `ReadRequestBodyAsync` or `WriteResponseBodyAsync`. The highlighted lines in the following example show how to get services from the dependency injection container (you can't get them from constructor parameters).

```

public override Task WriteResponseBodyAsync(OutputFormatterWriteContext context, Encoding selectedEncoding)
{
    IServiceProvider serviceProvider = context.HttpContext.RequestServices;
    var logger = serviceProvider.GetService(typeof(ILogger<VcardOutputFormatter>)) as ILogger;

    var response = context.HttpContext.Response;

    var buffer = new StringBuilder();
    if (context.Object is IEnumerable<Contact>)
    {
        foreach (Contact contact in context.Object as IEnumerable<Contact>)
        {
            FormatVcard(buffer, contact, logger);
        }
    }
    else
    {
        var contact = context.Object as Contact;
        FormatVcard(buffer, contact, logger);
    }
    return response.WriteAsync(buffer.ToString());
}

private static void FormatVcard(StringBuilder buffer, Contact contact, ILogger logger)
{
    buffer.AppendLine("BEGIN:VCARD");
    buffer.AppendLine("VERSION:2.1");
    buffer.AppendFormat($"N:{contact.LastName};{contact.FirstName}\r\n");
    buffer.AppendFormat($"FN:{contact.FirstName} {contact.LastName}\r\n");
    buffer.AppendFormat($"UID:{contact.ID}\r\n");
    buffer.AppendLine("END:VCARD");
    logger.LogInformation($"Writing {contact.FirstName} {contact.LastName}");
}

```

## How to configure MVC to use a custom formatter

To use a custom formatter, add an instance of the formatter class to the `InputFormatters` or `OutputFormatters` collection.

```

services.AddMvc(options =>
{
    options.InputFormatters.Insert(0, new VcardInputFormatter());
    options.OutputFormatters.Insert(0, new VcardOutputFormatter());
});

```

Formatters are evaluated in the order you insert them. The first one takes precedence.

## Next steps

See the [sample application](#), which implements simple vCard input and output formatters. The application reads and writes vCards that look like the following example:

```

BEGIN:VCARD
VERSION:2.1
N:Davolio;Nancy
FN:Nancy Davolio
UID:20293482-9240-4d68-b475-325df4a83728
END:VCARD

```

To see vCard output, run the application and send a Get request with Accept header "text/vcard" to

`http://localhost:63313/api/contacts/` (when running from Visual Studio) or `http://localhost:5000/api/contacts/` (when running from the command line).

To add a vCard to the in-memory collection of contacts, send a Post request to the same URL, with Content-Type header "text/vcard" and with vCard text in the body, formatted like the example above.

# Format response data in ASP.NET Core Web API

6/21/2018 • 8 minutes to read • [Edit Online](#)

By [Steve Smith](#)

ASP.NET Core MVC has built-in support for formatting response data, using fixed formats or in response to client specifications.

[View or download sample code \(how to download\)](#)

## Format-Specific Action Results

Some action result types are specific to a particular format, such as `JsonResult` and `ContentResult`. Actions can return specific results that are always formatted in a particular manner. For example, returning a `JsonResult` will return JSON-formatted data, regardless of client preferences. Likewise, returning a `ContentResult` will return plain-text-formatted string data (as will simply returning a string).

### NOTE

An action isn't required to return any particular type; MVC supports any object return value. If an action returns an `IActionResult` implementation and the controller inherits from `Controller`, developers have many helper methods corresponding to many of the choices. Results from actions that return objects that are not `IActionResult` types will be serialized using the appropriate `IOutputFormatter` implementation.

To return data in a specific format from a controller that inherits from the `Controller` base class, use the built-in helper method `Json` to return JSON and `Content` for plain text. Your action method should return either the specific result type (for instance, `JsonResult`) or `IActionResult`.

Returning JSON-formatted data:

```
// GET: api/authors
[HttpGet]
public JsonResult Get()
{
    return Json(_authorRepository.List());
}
```

Sample response from this action:

The screenshot shows the Microsoft Edge DevTools Network tab. A request for 'localhost:9664/api/authors' is selected. The response body contains the JSON array: [{"Name": "Steve Smith", "Twitter": "ardalis"}, {"Name": "Rick Anderson", "Twitter": "RickAndMSFT"}]. The 'Content type' field in the table is highlighted with a red box. In the 'Headers' section, 'Content-Type: application/json; charset=utf-8' is listed. The status code is 200 OK.

Name / Path	Protocol	Method	Result / Description	Content type
authors http://localhost:9664/api/	HTTP	GET	200 OK	application/json

Request URL: <http://localhost:9664/api/authors>  
Request Method: GET  
Status Code: 200 / OK

Request Headers:

- Accept: text/html, application/xhtml+xml, image/jxr, \*/\*
- Accept-Encoding: gzip, deflate
- Accept-Language: en-US, en; q=0.5
- Connection: Keep-Alive
- Host: localhost:9664
- User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64)...

Response Headers:

- Content-Length: 93
- Content-Type: application/json; charset=utf-8
- Date: Sun, 01 May 2016 23:33:19 GMT
- Server: Kestrel
- X-Powered-By: ASP.NET
- X-SourceFiles: =?UTF-8?B?QzpcZGV2XGdpdGh1Ybh3B...

0 errors | 1 request | 93 B transferred | 4.76 ms taken (DOMContentLoaded: 26 ms, load: 43 ms)

Note that the content type of the response is `application/json`, shown both in the list of network requests and in the Response Headers section. Also note the list of options presented by the browser (in this case, Microsoft Edge) in the Accept header in the Request Headers section. The current technique is ignoring this header; obeying it is discussed below.

To return plain text formatted data, use `ContentResult` and the `Content` helper:

```
// GET api/authors/about
[HttpGet("About")]
public ContentResult About()
{
    return Content("An API listing authors of docs.asp.net.");
}
```

A response from this action:

An API listing authors of docs.asp.net.

Name / Path	Protocol	Method	Result / Description	Content type	Re
about http://localhost:9664/api/authors/	HTTP	GET	200 OK	text/plain	15

Request URL: <http://localhost:9664/api/authors/about>  
Request Method: GET  
Status Code: 200 / OK

Request Headers:

- Accept: text/html, application/xhtml+xml, image/jxr, \*/\*
- Accept-Encoding: gzip, deflate
- Accept-Language: en-US, en; q=0.5
- Connection: Keep-Alive
- Host: localhost:9664
- User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64...

Response Headers:

- Content-Encoding: gzip
- Content-Length: 152
- Content-Type: text/plain; charset=utf-8
- Date: Sun, 01 May 2016 23:40:02 GMT
- Server: Kestrel
- Vary: Accept-Encoding

0 errors | 1 request | 152 B transferred | 1.19 s taken (DOMContentLoaded: 1.21 s, load: 1.22 s)

Note in this case the `Content-Type` returned is `text/plain`. You can also achieve this same behavior using just a string response type:

```
// GET api/authors/version
[HttpGet("version")]
public string Version()
{
    return "Version 1.0.0";
}
```

#### TIP

For non-trivial actions with multiple return types or options (for example, different HTTP status codes based on the result of operations performed), prefer `IActionResult` as the return type.

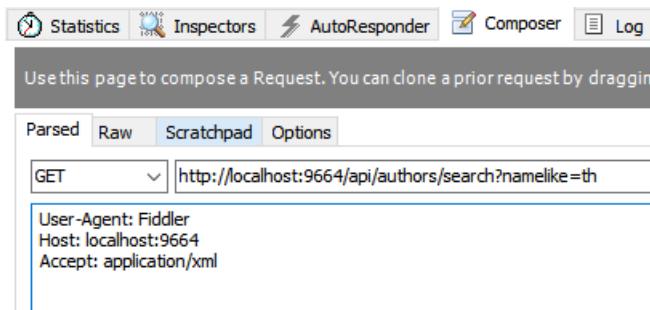
## Content Negotiation

Content negotiation (*conneg* for short) occurs when the client specifies an [Accept header](#). The default format used by ASP.NET Core MVC is JSON. Content negotiation is implemented by `ObjectResult`. It's also built into the status code specific action results returned from the helper methods (which are all based on `ObjectResult`). You can also return a model type (a class you've defined as your data transfer type) and the framework will automatically wrap it in an `ObjectResult` for you.

The following action method uses the `Ok` and `NotFound` helper methods:

```
// GET: api/authors/search?namelike=th
[HttpGet("Search")]
public IActionResult Search(string namelike)
{
    var result = _authorRepository.GetByNameSubstring(namelike);
    if (!result.Any())
    {
        return NotFound(namelike);
    }
    return Ok(result);
}
```

A JSON-formatted response will be returned unless another format was requested and the server can return the requested format. You can use a tool like [Fiddler](#) to create a request that includes an `Accept` header and specify another format. In that case, if the server has a *formatter* that can produce a response in the requested format, the result will be returned in the client-preferred format.



In the above screenshot, the Fiddler Composer has been used to generate a request, specifying `Accept: application/xml`. By default, ASP.NET Core MVC only supports JSON, so even when another format is specified, the result returned is still JSON-formatted. You'll see how to add additional formatters in the next section.

Controller actions can return POCOs (Plain Old CLR Objects), in which case ASP.NET Core MVC automatically creates an `ObjectResult` for you that wraps the object. The client will get the formatted serialized object (JSON format is the default; you can configure XML or other formats). If the object being returned is `null`, then the framework will return a `204 No Content` response.

Returning an object type:

```
// GET api/authors/ardalis
[HttpGet("{alias}")]
public Author Get(string alias)
{
    return _authorRepository.GetByAlias(alias);
}
```

In the sample, a request for a valid author alias will receive a 200 OK response with the author's data. A request for an invalid alias will receive a 204 No Content response. Screenshots showing the response in XML and JSON formats are shown below.

### Content Negotiation Process

Content *negotiation* only takes place if an `Accept` header appears in the request. When a request contains an `accept` header, the framework will enumerate the media types in the `accept` header in preference order and will try to find a formatter that can produce a response in one of the formats specified by the `accept` header. In case no formatter is found that can satisfy the client's request, the framework will try to find the first formatter that can produce a response (unless the developer has configured the option on `MvcOptions` to return 406 Not Acceptable instead). If the request specifies XML, but the XML formatter has not been configured, then the JSON formatter

will be used. More generally, if no formatter is configured that can provide the requested format, then the first formatter that can format the object is used. If no header is given, the first formatter that can handle the object to be returned will be used to serialize the response. In this case, there isn't any negotiation taking place - the server is determining what format it will use.

#### NOTE

If the Accept header contains `/*`, the Header will be ignored unless `RespectBrowserAcceptHeader` is set to true on `MvcOptions`.

## Browsers and Content Negotiation

Unlike typical API clients, web browsers tend to supply `Accept` headers that include a wide array of formats, including wildcards. By default, when the framework detects that the request is coming from a browser, it will ignore the `Accept` header and instead return the content in the application's configured default format (JSON unless otherwise configured). This provides a more consistent experience when using different browsers to consume APIs.

If you would prefer your application honor browser accept headers, you can configure this as part of MVC's configuration by setting `RespectBrowserAcceptHeader` to `true` in the `ConfigureServices` method in `Startup.cs`.

```
services.AddMvc(options =>
{
    options.RespectBrowserAcceptHeader = true; // false by default
});
```

## Configuring Formatters

If your application needs to support additional formats beyond the default of JSON, you can add NuGet packages and configure MVC to support them. There are separate formatters for input and output. Input formatters are used by [Model Binding](#); output formatters are used to format responses. You can also configure [Custom Formatters](#).

### Adding XML Format Support

To add support for XML formatting, install the `Microsoft.AspNetCore.Mvc.Formatters.Xml` NuGet package.

Add the `XmlSerializerFormatters` to MVC's configuration in `Startup.cs`:

```
services.AddMvc()
    .AddXmlSerializerFormatters();
```

Alternately, you can add just the output formatter:

```
services.AddMvc(options =>
{
    options.OutputFormatters.Add(new XmlSerializerOutputFormatter());
});
```

These two approaches will serialize results using `System.Xml.Serialization.XmlSerializer`. If you prefer, you can use the `System.Runtime.Serialization.DataContractSerializer` by adding its associated formatter:

```

services.AddMvc(options =>
{
    options.OutputFormatters.Add(new XmlDataContractSerializerOutputFormatter());
});

```

Once you've added support for XML formatting, your controller methods should return the appropriate format based on the request's `Accept` header, as this Fiddler example demonstrates:

The screenshot shows the Fiddler interface with the following details:

- Request Headers:** GET <http://localhost:9664/api/authors/ardalis> HTTP/1.1, User-Agent: Fiddler, Host: localhost:9664, Accept: application/xml.
- Response Headers:** HTTP/1.1 200 OK, Content-Type: application/xml; charset=utf-8, Server: Kestrel, X-SourceFiles: =?UTF-8?B?QzpcZGV2XHNzbW10aFxnaXRodWIuY29tXGFzcG51dC1kb2NzXGFzcG51dFxtdmNb9kZWxZXGZvcm1hdHRpbmdcc2FtcGx1XHNY1ixSZNwb25ZZUZvcm1hdHRpbmdTYW1wbGVcYXBpXGF1dGhvcnNcYXJkYWxpcw==?=, X-Powered-By: ASP.NET, Date: Wed, 01 Jun 2016 13:34:40 GMT, Content-Length: 166.
- Response Body:** XML representation of an Author object: <Author xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema"><Name>Steve Smith</Name><Twitter>ardalis</Twitter></Author>

You can see in the Inspectors tab that the Raw GET request was made with an `Accept: application/xml` header set. The response pane shows the `Content-Type: application/xml` header, and the `Author` object has been serialized to XML.

Use the Composer tab to modify the request to specify `application/json` in the `Accept` header. Execute the request, and the response will be formatted as JSON:

The screenshot shows the Fiddler interface with the following details:

- Request Headers:** GET <http://localhost:9664/api/authors/ardalis> HTTP/1.1, User-Agent: Fiddler, Host: localhost:9664, Accept: application/json.
- Response Headers:** HTTP/1.1 200 OK, Transfer-Encoding: chunked, Content-Type: application/json; charset=utf-8, Server: Kestrel, X-SourceFiles: =?UTF-8?B?QzpcZGV2XHNzbW10aFxnaXRodWIuY29tXGFzcG51dC1kb2NzXGFzcG51dFxtdmNb9kZWxZXGZvcm1hdHRpbmdcc2FtcGx1XHNY1ixSZNwb25ZZUZvcm1hdHRpbmdTYW1wbGVcYXBpXGF1dGhvcnNcYXJkYWxpcw==?=, X-Powered-By: ASP.NET, Date: Wed, 01 Jun 2016 13:40:03 GMT.
- Response Body:** JSON representation of an Author object: [{"Name": "Steve Smith", "Twitter": "ardalis"}]

In this screenshot, you can see the request sets a header of `Accept: application/json` and the response specifies the same as its `Content-Type`. The `Author` object is shown in the body of the response, in JSON format.

### Forcing a Particular Format

If you would like to restrict the response formats for a specific action you can, you can apply the `[Produces]` filter. The `[Produces]` filter specifies the response formats for a specific action (or controller). Like most `Filters`, this can be applied at the action, controller, or global scope.

```
[Produces("application/json")]
public class AuthorsController
```

The `[Produces]` filter will force all actions within the `AuthorsController` to return JSON-formatted responses, even if other formatters were configured for the application and the client provided an `Accept` header requesting a different, available format. See [Filters](#) to learn more, including how to apply filters globally.

## Special Case Formatters

Some special cases are implemented using built-in formatters. By default, `string` return types will be formatted as `text/plain` (`text/html` if requested via `Accept` header). This behavior can be removed by removing the `TextOutputFormatter`. You remove formatters in the `Configure` method in `Startup.cs` (shown below). Actions that have a model object return type will return a 204 No Content response when returning `null`. This behavior can be removed by removing the `HttpNoContentOutputFormatter`. The following code removes the `TextOutputFormatter` and `HttpNoContentOutputFormatter`.

```
services.AddMvc(options =>
{
    options.OutputFormatters.RemoveType<TextOutputFormatter>();
    options.OutputFormatters.RemoveType<HttpNoContentOutputFormatter>();
});
```

Without the `TextOutputFormatter`, `string` return types return 406 Not Acceptable, for example. Note that if an XML formatter exists, it will format `string` return types if the `TextOutputFormatter` is removed.

Without the `HttpNoContentOutputFormatter`, null objects are formatted using the configured formatter. For example, the JSON formatter will simply return a response with a body of `null`, while the XML formatter will return an empty XML element with the attribute `xsi:nil="true"` set.

## Response Format URL Mappings

Clients can request a particular format as part of the URL, such as in the query string or part of the path, or by using a format-specific file extension such as `.xml` or `.json`. The mapping from request path should be specified in the route the API is using. For example:

```
[FormatFilter]
public class ProductsController
{
    [Route("[controller]/[action]/[id].{format?}")]
    public Product GetById(int id)
```

This route would allow the requested format to be specified as an optional file extension. The `[FormatFilter]` attribute checks for the existence of the format value in the `RouteData` and will map the response format to the appropriate formatter when the response is created.

ROUTE	FORMATTER
<code>/products/GetById/5</code>	The default output formatter
<code>/products/GetById/5.json</code>	The JSON formatter (if configured)
<code>/products/GetById/5.xml</code>	The XML formatter (if configured)

# Test, debug, and troubleshoot in ASP.NET Core

7/3/2018 • 2 minutes to read • [Edit Online](#)

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Understand and troubleshoot warnings and errors with ASP.NET Core projects.

# Integration tests in ASP.NET Core

7/6/2018 • 15 minutes to read • [Edit Online](#)

By [Luke Latham](#) and [Steve Smith](#)

Integration tests ensure that an app's components function correctly at a level that includes the app's supporting infrastructure, such as the database, file system, and network. ASP.NET Core supports integration tests using a unit test framework with a test web host and an in-memory test server.

This topic assumes a basic understanding of unit tests. If unfamiliar with test concepts, see the [Unit Testing in .NET Core and .NET Standard](#) topic and its linked content.

[View or download sample code \(how to download\)](#)

The sample app is a Razor Pages app and assumes a basic understanding of Razor Pages. If unfamiliar with Razor Pages, see the following topics:

- [Introduction to Razor Pages](#)
- [Get started with Razor Pages](#)
- [Razor Pages unit tests](#)

## Introduction to integration tests

Integration tests evaluate an app's components on a broader level than [unit tests](#). Unit tests are used to test isolated software components, such as individual class methods. Integration tests confirm that two or more app components work together to produce an expected result, possibly including every component required to fully process a request.

These broader tests are used to test the app's infrastructure and whole framework, often including the following components:

- Database
- File system
- Network appliances
- Request-response pipeline

Unit tests use fabricated components, known as *fakes* or *mock objects*, in place of infrastructure components.

In contrast to unit tests, integration tests:

- Use the actual components that the app uses in production.
- Require more code and data processing.
- Take longer to run.

Therefore, limit the use of integration tests to the most important infrastructure scenarios. If a behavior can be tested using either a unit test or an integration test, choose the unit test.

**TIP**

Don't write integration tests for every possible permutation of data and file access with databases and file systems. Regardless of how many places across an app interact with databases and file systems, a focused set of read, write, update, and delete integration tests are usually capable of adequately testing database and file system components. Use unit tests for routine tests of method logic that interact with these components. In unit tests, the use of infrastructure fakes/mocks result in faster test execution.

**NOTE**

In discussions of integration tests, the tested project is frequently called the *system under test*, or "SUT" for short.

## ASP.NET Core integration tests

Integration tests in ASP.NET Core require the following:

- A test project is used to contain and execute the tests. The test project has a reference to the tested ASP.NET Core project, called the *system under test* (SUT). "SUT" is used throughout this topic to refer to the tested app.
- The test project creates a test web host for the SUT and uses a test server client to handle requests and responses to the SUT.
- A test runner is used to execute the tests and report the test results.

Integration tests follow a sequence of events that include the usual *Arrange*, *Act*, and *Assert* test steps:

1. The SUT's web host is configured.
2. A test server client is created to submit requests to the app.
3. The *Arrange* test step is executed: The test app prepares a request.
4. The *Act* test step is executed: The client submits the request and receives the response.
5. The *Assert* test step is executed: The *actual* response is validated as a *pass* or *fail* based on an *expected* response.
6. The process continues until all of the tests are executed.
7. The test results are reported.

Usually, the test web host is configured differently than the app's normal web host for the test runs. For example, a different database or different app settings might be used for the tests.

Infrastructure components, such as the test web host and in-memory test server ([TestServer](#)), are provided or managed by the [Microsoft.AspNetCore.Mvc.Testing](#) package. Use of this package streamlines test creation and execution.

The `Microsoft.AspNetCore.Mvc.Testing` package handles the following tasks:

- Copies the dependencies file (\*.deps) from the SUT into the test project's *bin* folder.
- Sets the content root to the SUT's project root so that static files and pages/views are found when the tests are executed.
- Provides the [WebApplicationFactory](#) class to streamline bootstrapping the SUT with `TestServer`.

The [unit tests](#) documentation describes how to set up a test project and test runner, along with detailed instructions on how to run tests and recommendations for how to name tests and test classes.

#### NOTE

When creating a test project for an app, separate the unit tests from the integration tests into different projects. This helps ensure that infrastructure testing components aren't accidentally included in the unit tests. Separation of unit and integration tests also allows control over which set of tests are run.

There's virtually no difference between the configuration for tests of Razor Pages apps and MVC apps. The only difference is in how the tests are named. In a Razor Pages app, tests of page endpoints are usually named after the page model class (for example, `IndexPageTests` to test component integration for the Index page). In an MVC app, tests are usually organized by controller classes and named after the controllers they test (for example, `HomeControllerTests` to test component integration for the Home controller).

## Test app prerequisites

The test project must:

- Reference the following packages:
  - `Microsoft.AspNetCore.App`
  - `Microsoft.AspNetCore.Mvc.Testing`
- Specify the Web SDK in the project file (`<Project Sdk="Microsoft.NET.Sdk.Web">`). The Web SDK is required when referencing the [Microsoft.AspNetCore.App metapackage](#).

These prerequisites can be seen in the [sample app](#). Inspect the `tests/RazorPagesProject.Tests/RazorPagesProject.Tests.csproj` file. The sample app uses the [xUnit](#) test framework and the [AngleSharp](#) parser library, so the sample app also references:

- `xunit`
- `xunit.runner.visualstudio`
- `AngleSharp`

## Basic tests with the default `WebApplicationFactory`

`WebApplicationFactory<TEEntryPoint>` is used to create a `TestServer` for the integration tests. `TEEntryPoint` is the entry point class of the SUT, usually the `Startup` class.

Test classes implement a *class fixture* interface (`IClassFixture`) to indicate the class contains tests and provide shared object instances across the tests in the class.

### Basic test of app endpoints

The following test class, `BasicTests`, uses the `WebApplicationFactory` to bootstrap the SUT and provide an `HttpClient` to a test method, `Get_EndpointsReturnSuccessAndCorrectContentType`. The method checks if the response status code is successful (status codes in the range 200-299) and the `Content-Type` header is `text/html; charset=utf-8` for several app pages.

`CreateClient` creates an instance of `HttpClient` that automatically follows redirects and handles cookies.

```

public class BasicTests
    : IClassFixture<WebApplicationFactory<RazorPagesProject.Startup>>
{
    private readonly WebApplicationFactory<RazorPagesProject.Startup> _factory;

    public BasicTests(WebApplicationFactory<RazorPagesProject.Startup> factory)
    {
        _factory = factory;
    }

    [Theory]
    [InlineData("/")]
    [InlineData("/Index")]
    [InlineData("/About")]
    [InlineData("/Privacy")]
    [InlineData("/Contact")]
    public async Task Get_EndpointsReturnSuccessAndCorrectContentType(string url)
    {
        // Arrange
        var client = _factory.CreateClient();

        // Act
        var response = await client.GetAsync(url);

        // Assert
        response.EnsureSuccessStatusCode(); // Status Code 200-299
        Assert.Equal("text/html; charset=utf-8",
            response.Content.Headers.ContentType.ToString());
    }
}

```

## Test a secure endpoint

Another test in the `BasicTests` class checks that a secure endpoint redirects an unauthenticated user to the app's Login page.

In the SUT, the `/SecurePage` page uses an `AuthorizePage` convention to apply an `AuthorizeFilter` to the page. For more information, see [Razor Pages authorization conventions](#).

```

services.AddMvc()
    .SetCompatibilityVersion(CompatibilityVersion.Version_2_1)
    .AddRazorPagesOptions(options =>
    {
        options.Conventions.AuthorizePage("/SecurePage");
    });

```

In the `Get_SecurePageRequiresAnAuthenticatedUser` test, a `WebApplicationFactoryClientOptions` is set to disallow redirects by setting `AllowAutoRedirect` to `false`:

```

[Fact]
public async Task Get_SecurePageRequiresAnAuthenticatedUser()
{
    // Arrange
    var client = _factory.CreateClient(
        new WebApplicationFactoryClientOptions
    {
        AllowAutoRedirect = false
    });

    // Act
    var response = await client.GetAsync("/SecurePage");

    // Assert
    Assert.Equal(HttpStatusCode.Redirect, response.StatusCode);
    Assert.StartsWith("http://localhost/Identity/Account/Login",
        response.Headers.Location.OriginalString);
}

```

By disallowing the client to follow the redirect, the following checks can be made:

- The status code returned by the SUT can be checked against the expected `(HttpStatusCode.Redirect)` result, not the final status code after the redirect to the Login page, which would be `(HttpStatusCode.OK)`.
- The `Location` header value in the response headers is checked to confirm that it starts with `http://localhost/Identity/Account/Login`, not the final Login page response, where the `Location` header wouldn't be present.

For more information on `WebApplicationFactoryClientOptions`, see the [Client options](#) section.

## Customize WebApplicationFactory

Web host configuration can be created independently of the test classes by inheriting from `WebApplicationFactory` to create one or more custom factories:

1. Inherit from `WebApplicationFactory` and override `ConfigureWebHost`. The `IWebHostBuilder` allows the configuration of the service collection with `ConfigureServices`:

```

public class CustomWebApplicationFactory<TStartup>
    : WebApplicationFactory<RazorPagesProject.Startup>
{
    protected override void ConfigureWebHost(IWebHostBuilder builder)
    {
        builder.ConfigureServices(services =>
        {
            // Create a new service provider.
            var serviceProvider = new ServiceCollection()
                .AddEntityFrameworkInMemoryDatabase()
                .BuildServiceProvider();

            // Add a database context (ApplicationContext) using an in-memory
            // database for testing.
            services.AddDbContext<ApplicationContext>(options =>
            {
                options.UseInMemoryDatabase("InMemoryDbForTesting");
                options.UseInternalServiceProvider(serviceProvider);
            });

            // Build the service provider.
            var sp = services.BuildServiceProvider();

            // Create a scope to obtain a reference to the database
            // context (ApplicationContext).
            using (var scope = sp.CreateScope())
            {
                var scopedServices = scope.ServiceProvider;
                var db = scopedServices.GetRequiredService<ApplicationContext>();
                var logger = scopedServices
                    .GetRequiredService<ILogger<CustomWebApplicationFactory<TStartup>>>();

                // Ensure the database is created.
                db.Database.EnsureCreated();

                try
                {
                    // Seed the database with test data.
                    Utilities.InitializeDbForTests(db);
                }
                catch (Exception ex)
                {
                    logger.LogError(ex, $"An error occurred seeding the " +
                        "database with test messages. Error: {ex.Message}");
                }
            }
        });
    }
}

```

Database seeding in the [sample app](#) is performed by the `InitializeDbForTests` method. The method is described in the [Integration tests sample: Test app organization](#) section.

2. Use the custom `CustomWebApplicationFactory` in test classes. The following example uses the factory in the `IndexPageTests` class:

```

public class IndexPageTests : IClassFixture<CustomWebApplicationFactory<RazorPagesProject.Startup>>
{
    private readonly HttpClient _client;
    private readonly CustomWebApplicationFactory<RazorPagesProject.Startup> _factory;

    public IndexPageTests(
        CustomWebApplicationFactory<RazorPagesProject.Startup> factory)
    {
        _client = factory.CreateClient(new WebApplicationFactoryClientOptions
        {
            AllowAutoRedirect = false
        });
        _factory = factory;
    }
}

```

The sample app's client is configured to prevent the `HttpClient` from following redirects. As explained in the [Test a secure endpoint](#) section, this permits tests to check the result of the app's first response. The first response is a redirect in many of these tests with a `Location` header.

3. A typical test uses the `HttpClient` and helper methods to process the request and the response:

```

[Fact]
public async Task Post_DeleteAllMessagesHandler_ReturnsRedirectToRoot()
{
    // Arrange
    var defaultPage = await _client.GetAsync("/");
    var content = await HtmlHelpers.GetDocumentAsync(defaultPage);

    //Act
    var response = await _client.SendAsync(
        (IHtmlFormElement)content.QuerySelector("form[id='messages']"),
        (IHtmlButtonElement)content.QuerySelector("button[id='deleteAllBtn']"));

    // Assert
    Assert.Equal(HttpStatusCode.OK, defaultPage.StatusCode);
    Assert.Equal(HttpStatusCode.Redirect, response.StatusCode);
    Assert.Equal("/", response.Headers.Location.OriginalString);
}

```

Any POST request to the SUT must satisfy the antiforgery check that's automatically made by the app's [data protection antiforgery system](#). In order to arrange for a test's POST request, the test app must:

1. Make a request for the page.
2. Parse the antiforgery cookie and request validation token from the response.
3. Make the POST request with the antiforgery cookie and request validation token in place.

The `SendAsync` helper extension methods (`Helpers/HttpClientExtensions.cs`) and the `GetDocumentAsync` helper method (`Helpers/HtmlHelpers.cs`) in the [sample app](#) use the [AngleSharp](#) parser to handle the antiforgery check with the following methods:

- `GetDocumentAsync` – Receives the `HttpResponseMessage` and returns an `IHtmlDocument`. `GetDocumentAsync` uses a factory that prepares a *virtual response* based on the original `HttpResponseMessage`. For more information, see the [AngleSharp documentation](#).
- `SendAsync` extension methods for the `HttpClient` compose an `HttpRequestMessage` and call `SendAsync(HttpRequestMessage)` to submit requests to the SUT. Overloads for `SendAsync` accept the HTML form (`IHtmlFormElement`) and the following:
  - Submit button of the form (`IHtmlElement`)
  - Form values collection (`IEnumerable<KeyValuePair<string, string>>`)

- o Submit button (`IHtmlElement`) and form values (`IEnumerable<KeyValuePair<string, string>>`)

#### NOTE

[AngleSharp](#) is a third-party parsing library used for demonstration purposes in this topic and the sample app. AngleSharp isn't supported or required for integration testing of ASP.NET Core apps. Other parsers can be used, such as the [Html Agility Pack \(HAP\)](#). Another approach is to write code to handle the antiforgery system's request verification token and antiforgery cookie directly.

## Customize the client with WithWebHostBuilder

When additional configuration is required within a test method, `WithWebHostBuilder` creates a new `WebApplicationFactory` with an `IWebHostBuilder` that is further customized by configuration.

The `Post_DeleteMessageHandler_ReturnsRedirectToRoot` test method of the [sample app](#) demonstrates the use of `WithWebHostBuilder`. This test performs a record delete in the database by triggering a form submission in the SUT.

Because another test in the `IndexPageTests` class performs an operation that deletes all of the records in the database and may run before the `Post_DeleteMessageHandler_ReturnsRedirectToRoot` method, the database is seeded in this test method to ensure that a record is present for the SUT to delete. Selecting the `deleteBtn1` button of the `messages` form in the SUT is simulated in the request to the SUT:

```

[Fact]
public async Task Post_DeleteMessageHandler_ReturnsRedirectToRoot()
{
    // Arrange
    var client = _factory.WithWebHostBuilder(builder =>
    {
        builder.ConfigureServices(services =>
        {
            var serviceProvider = services.BuildServiceProvider();

            using (var scope = serviceProvider.CreateScope())
            {
                var scopedServices = scope.ServiceProvider;
                var db = scopedServices
                    .GetRequiredService<ApplicationContext>();
                var logger = scopedServices
                    .GetRequiredService<ILogger<IndexPageTests>>();

                try
                {
                    Utilities.InitializeDbForTests(db);
                }
                catch (Exception ex)
                {
                    logger.LogError(ex, "An error occurred seeding " +
                        "the database with test messages. Error: " +
                        ex.Message);
                }
            }
        });
    })
    .CreateClient(new WebApplicationFactoryClientOptions
    {
        AllowAutoRedirect = false
    });
    var defaultPage = await client.GetAsync("/");
    var content = await HtmlHelpers.GetDocumentAsync(defaultPage);

    //Act
    var response = await client.SendAsync(
        (IHtmlFormElement)content.QuerySelector("form[id='messages']"),
        (IHtmlButtonElement)content.QuerySelector("button[id='deleteBtn1']"));

    // Assert
    Assert.Equal(HttpStatusCode.OK, defaultPage.StatusCode);
    Assert.Equal(HttpStatusCode.Redirect, response.StatusCode);
    Assert.Equal("/", response.Headers.Location.OriginalString);
}

```

## Client options

The following table shows the default [WebApplicationFactoryClientOptions](#) available when creating `HttpClient` instances.

OPTION	DESCRIPTION	DEFAULT
<a href="#">AllowAutoRedirect</a>	Gets or sets whether or not <code>HttpClient</code> instances should automatically follow redirect responses.	<code>true</code>
<a href="#">BaseAddress</a>	Gets or sets the base address of <code>HttpClient</code> instances.	<code>http://localhost</code>

OPTION	DESCRIPTION	DEFAULT
HandleCookies	Gets or sets whether <code>HttpClient</code> instances should handle cookies.	<code>true</code>
MaxAutomaticRedirections	Gets or sets the maximum number of redirect responses that <code>HttpClient</code> instances should follow.	7

Create the `WebApplicationFactoryClientOptions` class and pass it to the `CreateClient` method (default values are shown in the code example):

```
// Default client option values are shown
var clientOptions = new WebApplicationFactoryClientOptions();
clientOptions.AllowAutoRedirect = true;
clientOptions.BaseAddress = new Uri("http://localhost");
clientOptions.HandleCookies = true;
clientOptions.MaxAutomaticRedirections = 7;

_client = _factory.CreateClient(clientOptions);
```

## How the test infrastructure infers the app content root path

The `WebApplicationFactory` constructor infers the app content root path by searching for a `WebApplicationFactoryContentRootAttribute` on the assembly containing the integration tests with a key equal to the `TEntryPoint` assembly `System.Reflection.Assembly.FullName`. In case an attribute with the correct key isn't found, `WebApplicationFactory` falls back to searching for a solution file (`*.sln`) and appends the `TEntryPoint` assembly name to the solution directory. The app root directory (the content root path) is used to discover views and content files.

In most cases, it isn't necessary to explicitly set the app content root, as the search logic usually finds the correct content root at runtime. In special scenarios where the content root isn't found using the built-in search algorithm, the app content root can be specified explicitly or by using custom logic. To set the app content root in those scenarios, call the `useSolutionRelativeContentRoot` extension method from the `Microsoft.AspNetCore.TestHost` package. Supply the solution's relative path and optional solution file name or glob pattern (default = `*.sln`).

Call the `UseSolutionRelativeContentRoot` extension method using *ONE* of the following approaches:

- When configuring test classes with `WebApplicationFactory`, provide a custom configuration with the `IWebHostBuilder`:

```
public IndexPageTests(
    WebApplicationFactory<RazorPagesProject.Startup> factory)
{
    var _factory = factory.WithWebHostBuilder(builder =>
    {
        builder.UseSolutionRelativeContentRoot("<SOLUTION-RELATIVE-PATH>");

        ...
    });
}
```

- When configuring test classes with a custom `WebApplicationFactory`, inherit from `WebApplicationFactory` and override `ConfigureWebHost`:

```

public class CustomWebApplicationFactory<TStartup>
    : WebApplicationFactory<RazorPagesProject.Startup>
{
    protected override void ConfigureWebHost(IWebHostBuilder builder)
    {
        builder.ConfigureServices(services =>
        {
            builder.UseSolutionRelativeContentRoot("<SOLUTION-RELATIVE-PATH>");

            ...
        });
    }
}

```

## Disable shadow copying

Shadow copying causes the tests to execute in a different folder than the output folder. For tests to work properly, shadow copying must be disabled. The [sample app](#) uses xUnit and disables shadow copying for xUnit by including an `xunit.runner.json` file with the correct configuration setting. For more information, see [Configuring xUnit.net with JSON](#).

Add the `xunit.runner.json` file to root of the test project with the following content:

```
{
  "shadowCopy": false
}
```

## Integration tests sample

The [sample app](#) is composed of two apps:

APP	PROJECT FOLDER	DESCRIPTION
Message app (the SUT)	<code>src/RazorPagesProject</code>	Allows a user to add, delete one, delete all, and analyze messages.
Test app	<code>tests/RazorPagesProject.Tests</code>	Used to integration test the SUT.

The tests can be run using the built-in test features of an IDE, such as [Visual Studio](#). If using [Visual Studio Code](#) or the command line, execute the following command at a command prompt in the `tests/RazorPagesProject.Tests` folder:

```
dotnet test
```

### Message app (SUT) organization

The SUT is a Razor Pages message system with the following characteristics:

- The Index page of the app (`Pages/Index.cshtml` and `Pages/Index.cshtml.cs`) provides a UI and page model methods to control the addition, deletion, and analysis of messages (average words per message).
- A message is described by the `Message` class (`Data/Message.cs`) with two properties: `Id` (key) and `Text` (message). The `Text` property is required and limited to 200 characters.
- Messages are stored using [Entity Framework's in-memory database](#)<sup>†</sup>.
- The app contains a data access layer (DAL) in its database context class, `AppDbContext` (`Data/AppDbContext.cs`).

- If the database is empty on app startup, the message store is initialized with three messages.
- The app includes a `/SecurePage` that can only be accessed by an authenticated user.

<sup>†</sup>The EF topic, [Test with InMemory](#), explains how to use an in-memory database for tests with MSTest. This topic uses the [xUnit](#) test framework. Test concepts and test implementations across different test frameworks are similar but not identical.

Although the app doesn't use the [repository pattern](#) and isn't an effective example of the [Unit of Work \(UoW\) pattern](#), Razor Pages supports these patterns of development. For more information, see [Designing the infrastructure persistence layer](#), [Implementing the Repository and Unit of Work Patterns in an ASP.NET MVC Application](#), and [Test controller logic](#) (the sample implements the repository pattern).

## Test app organization

The test app is a console app inside the `tests/RazorPagesProject.Tests` folder.

TEST APP FOLDER	DESCRIPTION
<code>BasicTests</code>	<code>BasicTests.cs</code> contains test methods for routing, accessing a secure page by an unauthenticated user, and obtaining a GitHub user profile and checking the profile's user login.
<code>IntegrationTests</code>	<code>IndexPageTests.cs</code> contains the integration tests for the Index page using custom <code>WebApplicationFactory</code> class.
<code>Helpers/Utilities</code>	<ul style="list-style-type: none"> <li>• <code>Utilities.cs</code> contains the <code>InitializeDbForTests</code> method used to seed the database with test data.</li> <li>• <code>HtmlHelpers.cs</code> provides a method to return an AngleSharp <code>IHtmlDocument</code> for use by the test methods.</li> <li>• <code>HttpClientExtensions.cs</code> provide overloads for <code>SendAsync</code> to submit requests to the SUT.</li> </ul>

The test framework is [xUnit](#). Integration tests are conducted using the [Microsoft.AspNetCore.TestHost](#), which includes the [TestServer](#). Because the [Microsoft.AspNetCore.Mvc.Testing](#) package is used to configure the test host and test server, the `TestHost` and `TestServer` packages don't require direct package references in the test app's project file or developer configuration in the test app.

## Seeding the database for testing

Integration tests usually require a small dataset in the database prior to the test execution. For example, a delete test calls for a database record deletion, so the database must have at least one record for the delete request to succeed.

The sample app seeds the database with three messages in `Utilities.cs` that tests can use when they execute:

```
public static void InitializeDbForTests(ApplicationDbContext db)
{
    db.Messages.AddRange(GetSeedingMessages());
    db.SaveChanges();
}

public static List<Message> GetSeedingMessages()
{
    return new List<Message>()
    {
        new Message(){ Text = "TEST RECORD: You're standing on my scarf." },
        new Message(){ Text = "TEST RECORD: Would you like a jelly baby?" },
        new Message(){ Text = "TEST RECORD: To the rational mind, " +
            "nothing is inexplicable; only unexplained." }
    };
}
```

## Additional resources

- [Unit tests](#)
- [Razor Pages unit tests](#)
- [Middleware](#)
- [Test controllers](#)

# Razor Pages unit tests in ASP.NET Core

6/21/2018 • 9 minutes to read • [Edit Online](#)

By [Luke Latham](#)

ASP.NET Core supports unit tests of Razor Pages apps. Tests of the data access layer (DAL) and page models help ensure:

- Parts of a Razor Pages app work independently and together as a unit during app construction.
- Classes and methods have limited scopes of responsibility.
- Additional documentation exists on how the app should behave.
- Regressions, which are errors brought about by updates to the code, are found during automated building and deployment.

This topic assumes that you have a basic understanding of Razor Pages apps and unit tests. If you're unfamiliar with Razor Pages apps or test concepts, see the following topics:

- [Introduction to Razor Pages](#)
- [Get started with Razor Pages](#)
- [Unit testing C# in .NET Core using dotnet test and xUnit](#)

[View or download sample code \(how to download\)](#)

The sample project is composed of two apps:

APP	PROJECT FOLDER	DESCRIPTION
Message app	<i>src/RazorPagesTestSample</i>	Allows a user to add, delete one, delete all, and analyze messages.
Test app	<i>tests/RazorPagesTestSample.Tests</i>	Used to unit test the message app: Data access layer (DAL) and Index page model.

The tests can be run using the built-in test features of an IDE, such as [Visual Studio](#). If using [Visual Studio Code](#) or the command line, execute the following command at a command prompt in the *tests/RazorPagesTestSample.Tests* folder:

```
dotnet test
```

## Message app organization

The message app is a simple Razor Pages message system with the following characteristics:

- The Index page of the app (*Pages/Index.cshtml* and *Pages/Index.cshtml.cs*) provides a UI and page model methods to control the addition, deletion, and analysis of messages (average words per message).
- A message is described by the `Message` class (*Data/Message.cs*) with two properties: `Id` (key) and `Text` (message). The `Text` property is required and limited to 200 characters.
- Messages are stored using [Entity Framework's in-memory database](#)<sup>†</sup>.
- The app contains a data access layer (DAL) in its database context class, `AppDbContext`

(`Data/AppDbContext.cs`). The DAL methods are marked `virtual`, which allows mocking the methods for use in the tests.

- If the database is empty on app startup, the message store is initialized with three messages. These *seeded messages* are also used in tests.

<sup>†</sup>The EF topic, [Test with InMemory](#), explains how to use an in-memory database for tests with MSTest. This topic uses the [xUnit](#) test framework. Test concepts and test implementations across different test frameworks are similar but not identical.

Although the app doesn't use the [repository pattern](#) and isn't an effective example of the [Unit of Work \(UoW\) pattern](#), Razor Pages supports these patterns of development. For more information, see [Designing the infrastructure persistence layer, Implementing the Repository and Unit of Work Patterns in an ASP.NET MVC Application](#), and [Test controller logic](#) (the sample implements the repository pattern).

## Test app organization

The test app is a console app inside the `tests/RazorPagesTestSample.Tests` folder.

TEST APP FOLDER	DESCRIPTION
<code>UnitTests</code>	<ul style="list-style-type: none"><li>• <code>DataAccessLayerTest.cs</code> contains the unit tests for the DAL.</li><li>• <code>IndexPageTests.cs</code> contains the unit tests for the Index page model.</li></ul>
<code>Utilities</code>	Contains the <code>TestingDbContextOptions</code> method used to create new database context options for each DAL unit test so that the database is reset to its baseline condition for each test.

The test framework is [xUnit](#). The object mocking framework is [Moq](#).

## Unit tests of the data access layer (DAL)

The message app has a DAL with four methods contained in the `AppDbContext` class (`src/RazorPagesTestSample/Data/AppDbContext.cs`). Each method has one or two unit tests in the test app.

DAL METHOD	FUNCTION
<code>GetMessagesAsync</code>	Obtains a <code>List&lt;Message&gt;</code> from the database sorted by the <code>Text</code> property.
<code>AddMessageAsync</code>	Adds a <code>Message</code> to the database.
<code>DeleteAllMessagesAsync</code>	Deletes all <code>Message</code> entries from the database.
<code>DeleteMessageAsync</code>	Deletes a single <code>Message</code> from the database by <code>Id</code> .

Unit tests of the DAL require [DbContextOptions](#) when creating a new `AppDbContext` for each test. One approach to creating the `DbContextOptions` for each test is to use a [DbContextOptionsBuilder](#):

```

var optionsBuilder = new DbContextOptionsBuilder<AppDbContext>()
    .UseInMemoryDatabase("InMemoryDb");

using (var db = new AppDbContext(optionsBuilder.Options))
{
    // Use the db here in the unit test.
}

```

The problem with this approach is that each test receives the database in whatever state the previous test left it. This can be problematic when trying to write atomic unit tests that don't interfere with each other. To force the `AppDbContext` to use a new database context for each test, supply a `DbContextOptions` instance that's based on a new service provider. The test app shows how to do this using its `Utilities` class method `TestingDbContextOptions` (`tests/RazorPagesTestSample.Tests/Utilities/Utilities.cs`):

```

public static DbContextOptions<AppDbContext> TestDbContextOptions()
{
    // Create a new service provider to create a new in-memory database.
    var serviceProvider = new ServiceCollection()
        .AddEntityFrameworkInMemoryDatabase()
        .BuildServiceProvider();

    // Create a new options instance using an in-memory database and
    // IServiceProvider that the context should resolve all of its
    // services from.
    var builder = new DbContextOptionsBuilder<AppDbContext>()
        .UseInMemoryDatabase("InMemoryDb")
        .UseInternalServiceProvider(serviceProvider);

    return builder.Options;
}

```

Using the `DbContextOptions` in the DAL unit tests allows each test to run atomically with a fresh database instance:

```

using (var db = new AppDbContext(Utilities.TestingDbContextOptions()))
{
    // Use the db here in the unit test.
}

```

Each test method in the `DataAccessLayerTest` class (`UnitTests/DataAccessLayerTest.cs`) follows a similar Arrange-Act-Assert pattern:

1. Arrange: The database is configured for the test and/or the expected outcome is defined.
2. Act: The test is executed.
3. Assert: Assertions are made to determine if the test result is a success.

For example, the `DeleteMessageAsync` method is responsible for removing a single message identified by its `Id` (`src/RazorPagesTestSample/Data/AppDbContext.cs`):

```

public async virtual Task DeleteMessageAsync(int id)
{
    var message = await Messages.FindAsync(id);

    if (message != null)
    {
        Messages.Remove(message);
        await SaveChangesAsync();
    }
}

```

There are two tests for this method. One test checks that the method deletes a message when the message is present in the database. The other method tests that the database doesn't change if the message `Id` for deletion doesn't exist. The `DeleteMessageAsync_MessageIsDeleted_WhenMessageIsFound` method is shown below:

```

[Fact]
public async Task DeleteMessageAsync_MessageIsDeleted_WhenMessageIsFound()
{
    using (var db = new AppDbContext(Utilities.TestDbContextOptions()))
    {
        // Arrange
        var seedMessages = AppDbContext.GetSeedingMessages();
        await db.AddRangeAsync(seedMessages);
        await db.SaveChangesAsync();
        var recId = 1;
        var expectedMessages =
            seedMessages.Where(message => message.Id != recId).ToList();

        // Act
        await db.DeleteMessageAsync(recId);

        // Assert
        var actualMessages = await db.Messages.AsNoTracking().ToListAsync();
        Assert.Equal(
            expectedMessages.OrderBy(x => x.Id),
            actualMessages.OrderBy(x => x.Id),
            new Utilities.MessageComparer());
    }
}

```

First, the method performs the Arrange step, where preparation for the Act step takes place. The seeding messages are obtained and held in `seedMessages`. The seeding messages are saved into the database. The message with an `Id` of `1` is set for deletion. When the `DeleteMessageAsync` method is executed, the expected messages should have all of the messages except for the one with an `Id` of `1`. The `expectedMessages` variable represents this expected outcome.

```

// Arrange
var seedMessages = AppDbContext.GetSeedingMessages();
await db.AddRangeAsync(seedMessages);
await db.SaveChangesAsync();
var recId = 1;
var expectedMessages =
    seedMessages.Where(message => message.Id != recId).ToList();

```

The method acts: The `DeleteMessageAsync` method is executed passing in the `recId` of `1`:

```

// Act
await db.DeleteMessageAsync(recId);

```

Finally, the method obtains the `Messages` from the context and compares it to the `expectedMessages` asserting that the two are equal:

```
// Assert
var actualMessages = await db.Messages.AsNoTracking().ToListAsync();
Assert.Equal(
    expectedMessages.OrderBy(m => m.Id).Select(m => m.Text),
    actualMessages.OrderBy(m => m.Id).Select(m => m.Text));
```

In order to compare that the two `List<Message>` are the same:

- The messages are ordered by `Id`.
- Message pairs are compared on the `Text` property.

A similar test method, `DeleteMessageAsync_NoMessageIsDeleted_WhenMessageIsNotFound` checks the result of attempting to delete a message that doesn't exist. In this case, the expected messages in the database should be equal to the actual messages after the `DeleteMessageAsync` method is executed. There should be no change to the database's content:

```
[Fact]
public async Task DeleteMessageAsync_NoMessageIsDeleted_WhenMessageIsNotFound()
{
    using (var db = new AppDbContext(Utilities.TestDbContextOptions()))
    {
        // Arrange
        var expectedMessages = AppDbContext.GetSeedingMessages();
        await db.AddRangeAsync(expectedMessages);
        await db.SaveChangesAsync();
        var recId = 4;

        // Act
        await db.DeleteMessageAsync(recId);

        // Assert
        var actualMessages = await db.Messages.AsNoTracking().ToListAsync();
        Assert.Equal(
            expectedMessages.OrderBy(m => m.Id).Select(m => m.Text),
            actualMessages.OrderBy(m => m.Id).Select(m => m.Text));
    }
}
```

## Unit tests of the page model methods

Another set of unit tests is responsible for tests of page model methods. In the message app, the Index page models are found in the `IndexModel` class in `src/RazorPagesTestSample/Pages/Index.cshtml.cs`.

PAGE MODEL METHOD	FUNCTION
<code>OnGetAsync</code>	Obtains the messages from the DAL for the UI using the <code>GetMessagesAsync</code> method.
<code>OnPostAddMessageAsync</code>	If the <code>ModelState</code> is valid, calls <code>AddMessageAsync</code> to add a message to the database.
<code>OnPostDeleteAllMessagesAsync</code>	Calls <code>DeleteAllMessagesAsync</code> to delete all of the messages in the database.

PAGE MODEL METHOD	FUNCTION
OnPostDeleteMessageAsync	Executes <code>DeleteMessageAsync</code> to delete a message with the <code>Id</code> specified.
OnPostAnalyzeMessagesAsync	If one or more messages are in the database, calculates the average number of words per message.

The page model methods are tested using seven tests in the `IndexPageTests` class (*tests/RazorPagesTestSample.Tests/UnitTests/IndexPageTests.cs*). The tests use the familiar Arrange-Assert-Act pattern. These tests focus on:

- Determining if the methods follow the correct behavior when the `ModelState` is invalid.
- Confirming the methods produce the correct `IActionResult`.
- Checking that property value assignments are made correctly.

This group of tests often mock the methods of the DAL to produce expected data for the Act step where a page model method is executed. For example, the `GetMessagesAsync` method of the `AppDbContext` is mocked to produce output. When a page model method executes this method, the mock returns the result. The data doesn't come from the database. This creates predictable, reliable test conditions for using the DAL in the page model tests.

The `OnGetAsync_PopulatesThePageModel_WithAListOfMessages` test shows how the `GetMessagesAsync` method is mocked for the page model:

```
var mockAppDbContext = new Mock<AppDbContext>(optionsBuilder.Options);
var expectedMessages = AppDbContext.GetSeedingMessages();
mockAppDbContext.Setup(
    db => db.GetMessagesAsync().Returns(Task.FromResult(expectedMessages)));
var pageModel = new IndexModel(mockAppDbContext.Object);
```

When the `OnGetAsync` method is executed in the Act step, it calls the page model's `GetMessagesAsync` method.

Unit test Act step (*tests/RazorPagesTestSample.Tests/UnitTests/IndexPageTests.cs*):

```
// Act
await pageModel.OnGetAsync();
```

`IndexPage` page model's `OnGetAsync` method (*src/RazorPagesTestSample/Pages/Index.cshtml.cs*):

```
public async Task OnGetAsync()
{
    Messages = await _db.GetMessagesAsync();
}
```

The `GetMessagesAsync` method in the DAL doesn't return the result for this method call. The mocked version of the method returns the result.

In the `Assert` step, the actual messages (`actualMessages`) are assigned from the `Messages` property of the page model. A type check is also performed when the messages are assigned. The expected and actual messages are compared by their `Text` properties. The test asserts that the two `List<Message>` instances contain the same messages.

```
// Assert
var actualMessages = Assert.IsAssignableFrom<List<Message>>(pageModel.Messages);
Assert.Equal(
    expectedMessages.OrderBy(m => m.Id).Select(m => m.Text),
    actualMessages.OrderBy(m => m.Id).Select(m => m.Text));
```

Other tests in this group create page model objects that include the `DefaultHttpContext`, the `ModelStateDictionary`, an `ActionContext` to establish the `PageContext`, a `ViewDataDictionary`, and a `PageContext`. These are useful in conducting tests. For example, the message app establishes a `ModelState` error with `AddModelError` to check that a valid `PageResult` is returned when `OnPostAddMessageAsync` is executed:

```
[Fact]
public async Task OnPostAddMessageAsync_ReturnsAPageResult_WhenModelStateIsInvalid()
{
    // Arrange
    var optionsBuilder = new DbContextOptionsBuilder<AppDbContext>()
        .UseInMemoryDatabase("InMemoryDb");
    var mockAppDbContext = new Mock<AppDbContext>(optionsBuilder.Options);
    var expectedMessages = AppDbContext.GetSeedingMessages();
    mockAppDbContext.Setup(db => db.GetMessagesAsync()).Returns(Task.FromResult(expectedMessages));
    var httpContext = new DefaultHttpContext();
    var ModelState = new ModelStateDictionary();
    var actionContext = new ActionContext(httpContext, new RouteData(), new PageActionDescriptor(),
    ModelState);
    var modelMetadataProvider = new EmptyModelMetadataProvider();
    var ViewData = new ViewDataDictionary(modelMetadataProvider, ModelState);
    var TempData = new TempDataDictionary(httpContext, Mock.Of<ITempDataProvider>());
    var pageContext = new PageContext(actionContext)
    {
        PageContext = pageContext,
        TempData = TempData,
        Url = new UrlHelper(actionContext)
    };
    pageModel.ModelState.AddModelError("Message.Text", "The Text field is required.");

    // Act
    var result = await pageModel.OnPostAddMessageAsync();

    // Assert
    Assert.IsType<PageResult>(result);
}
```

## Additional resources

- [Unit testing C# in .NET Core using dotnet test and xUnit](#)
- [Test controllers](#)
- [Unit Test Your Code \(Visual Studio\)](#)
- [Integration tests](#)
- [xUnit.net](#)
- [Getting started with xUnit.net \(.NET Core/ASP.NET Core\)](#)
- [Moq](#)
- [Moq Quickstart](#)

# Test controller logic in ASP.NET Core

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By [Steve Smith](#)

Controllers in ASP.NET MVC apps should be small and focused on user-interface concerns. Large controllers that deal with non-UI concerns are more difficult to test and maintain.

[View or download sample from GitHub](#)

## Testing controllers

Controllers are a central part of any ASP.NET Core MVC application. As such, you should have confidence they behave as intended for your app. Automated tests can provide you with this confidence and can detect errors before they reach production. It's important to avoid placing unnecessary responsibilities within your controllers and ensure your tests focus only on controller responsibilities.

Controller logic should be minimal and not be focused on business logic or infrastructure concerns (for example, data access). Test controller logic, not the framework. Test how the controller *behaves* based on valid or invalid inputs. Test controller responses based on the result of the business operation it performs.

Typical controller responsibilities:

- Verify `ModelState.IsValid`.
- Return an error response if `ModelState` is invalid.
- Retrieve a business entity from persistence.
- Perform an action on the business entity.
- Save the business entity to persistence.
- Return an appropriate `IActionResult`.

## Unit testing

[Unit testing](#) involves testing a part of an app in isolation from its infrastructure and dependencies. When unit testing controller logic, only the contents of a single action is tested, not the behavior of its dependencies or of the framework itself. As you unit test your controller actions, make sure you focus only on its behavior. A controller unit test avoids things like [filters](#), [routing](#), or [model binding](#). By focusing on testing just one thing, unit tests are generally simple to write and quick to run. A well-written set of unit tests can be run frequently without much overhead. However, unit tests don't detect issues in the interaction between components, which is the purpose of [integration tests](#).

If you're writing custom filters, routes, etc, you should unit test them, but not as part of your tests on a particular controller action. They should be tested in isolation.

### TIP

[Create and run unit tests with Visual Studio.](#)

To demonstrate unit testing, review the following controller. It displays a list of brainstorming sessions and allows new brainstorming sessions to be created with a POST:

```

using System;
using System.ComponentModel.DataAnnotations;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using TestingControllersSample.Core.Interfaces;
using TestingControllersSample.Core.Model;
using TestingControllersSample.ViewModels;

namespace TestingControllersSample.Controllers
{
    public class HomeController : Controller
    {
        private readonly IBrainstormSessionRepository _sessionRepository;

        public HomeController(IBrainstormSessionRepository sessionRepository)
        {
            _sessionRepository = sessionRepository;
        }

        public async Task<IActionResult> Index()
        {
            var sessionList = await _sessionRepository.ListAsync();

            var model = sessionList.Select(session => new StormSessionViewModel()
            {
                Id = session.Id,
                DateCreated = session.DateCreated,
                Name = session.Name,
                IdeaCount = session.Ideas.Count
            });

            return View(model);
        }

        public class NewSessionModel
        {
            [Required]
            public string SessionName { get; set; }
        }

        [HttpPost]
        public async Task<IActionResult> Index(NewSessionModel model)
        {
            if (!ModelState.IsValid)
            {
                return BadRequest(ModelState);
            }
            else
            {
                await _sessionRepository.AddAsync(new BrainstormSession()
                {
                    DateCreated = DateTimeOffset.Now,
                    Name = model.SessionName
                });
            }

            return RedirectToAction(actionName: nameof(Index));
        }
    }
}

```

The controller is following the [explicit dependencies principle](#), expecting dependency injection to provide it with an instance of `IBrainstormSessionRepository`. This makes it fairly easy to test using a mock object framework, like [Moq](#). The `HTTP GET Index` method has no looping or branching and only calls one method. To test this `Index`

method, we need to verify that a `ViewResult` is returned, with a `ViewModel` from the repository's `List` method.

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Moq;
using TestingControllersSample.Controllers;
using TestingControllersSample.Core.Interfaces;
using TestingControllersSample.Core.Model;
using TestingControllersSample.ViewModels;
using Xunit;

namespace TestingControllersSample.Tests.UnitTests
{
    public class HomeControllerTests
    {
        [Fact]
        public async Task Index_ReturnsAViewResult_WithAListOfBrainstormSessions()
        {
            // Arrange
            var mockRepo = new Mock<IBrainstormSessionRepository>();
            mockRepo.Setup(repo => repo.ListAsync()).Returns(Task.FromResult(GetTestSessions()));
            var controller = new HomeController(mockRepo.Object);

            // Act
            var result = await controller.Index();

            // Assert
            var viewResult = Assert.IsType<ViewResult>(result);
            var model = Assert.IsAssignableFrom<IEnumerable<StormSessionViewModel>>(
                viewResult.ViewData.Model);
            Assert.Equal(2, model.Count());
        }

        private List<BrainstormSession> GetTestSessions()
        {
            var sessions = new List<BrainstormSession>();
            sessions.Add(new BrainstormSession()
            {
                DateCreated = new DateTime(2016, 7, 2),
                Id = 1,
                Name = "Test One"
            });
            sessions.Add(new BrainstormSession()
            {
                DateCreated = new DateTime(2016, 7, 1),
                Id = 2,
                Name = "Test Two"
            });
            return sessions;
        }
    }
}
```

The `HomeController` `HTTP POST Index` method (shown above) should verify:

- The action method returns a Bad Request `ViewResult` with the appropriate data when `ModelState.IsValid` is `false`
- The `Add` method on the repository is called and a `RedirectToActionResult` is returned with the correct arguments when `ModelState.IsValid` is true.

Invalid model state can be tested by adding errors using `AddModelError` as shown in the first test below.

```

[Fact]
public async Task IndexPost_ReturnsBadRequestResult_WhenModelStateIsInvalid()
{
    // Arrange
    var mockRepo = new Mock<IBrainstormSessionRepository>();
    mockRepo.Setup(repo => repo.ListAsync()).Returns(Task.FromResult(GetTestSessions()));
    var controller = new HomeController(mockRepo.Object);
    controller.ModelState.AddModelError("SessionName", "Required");
    var newSession = new HomeController.NewSessionModel();

    // Act
    var result = await controller.Index(newSession);

    // Assert
    var badRequestResult = Assert.IsType<BadRequestObjectResult>(result);
    Assert.IsType<SerializableError>(badRequestResult.Value);
}

[Fact]
public async Task IndexPost_ReturnsARedirectAndAddsSession_WhenModelStateIsValid()
{
    // Arrange
    var mockRepo = new Mock<IBrainstormSessionRepository>();
    mockRepo.Setup(repo => repo.AddAsync(It.IsAny<BrainstormSession>()))
        .Returns(Task.CompletedTask)
        .Verifiable();
    var controller = new HomeController(mockRepo.Object);
    var newSession = new HomeController.NewSessionModel()
    {
        SessionName = "Test Name"
    };

    // Act
    var result = await controller.Index(newSession);

    // Assert
    var redirectToActionResult = Assert.IsType<RedirectToActionResult>(result);
    Assert.Null(redirectToActionResult.ControllerName);
    Assert.Equal("Index", redirectToActionResult.ActionName);
    mockRepo.Verify();
}

```

The first test confirms when `ModelState` isn't valid, the same `ViewResult` is returned as for a `GET` request. Note that the test doesn't attempt to pass in an invalid model. That wouldn't work anyway since model binding isn't running (though an [integration test](#) would use exercise model binding). In this case, model binding isn't being tested. These unit tests are only testing what the code in the action method does.

The second test verifies that when `ModelState` is valid, a new `BrainstormSession` is added (via the repository), and the method returns a `RedirectToActionResult` with the expected properties. Mocked calls that aren't called are normally ignored, but calling `Verifiable` at the end of the setup call allows it to be verified in the test. This is done with the call to `mockRepo.Verify()`, which will fail the test if the expected method wasn't called.

#### NOTE

The Moq library used in this sample makes it easy to mix verifiable, or "strict", mocks with non-verifiable mocks (also called "loose" mocks or stubs). Learn more about [customizing Mock behavior with Moq](#).

Another controller in the app displays information related to a particular brainstorming session. It includes some logic to deal with invalid id values:

```

using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using TestingControllersSample.Core.Interfaces;
using TestingControllersSample.ViewModels;

namespace TestingControllersSample.Controllers
{
    public class SessionController : Controller
    {
        private readonly IBrainstormSessionRepository _sessionRepository;

        public SessionController(IBrainstormSessionRepository sessionRepository)
        {
            _sessionRepository = sessionRepository;
        }

        public async Task<IActionResult> Index(int? id)
        {
            if (!id.HasValue)
            {
                return RedirectToAction(actionName: nameof(Index), controllerName: "Home");
            }

            var session = await _sessionRepository.GetByIdAsync(id.Value);
            if (session == null)
            {
                return Content("Session not found.");
            }

            var viewModel = new StormSessionViewModel()
            {
                DateCreated = session.DateCreated,
                Name = session.Name,
                Id = session.Id
            };

            return View(viewModel);
        }
    }
}

```

The controller action has three cases to test, one for each `return` statement:

```

using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Moq;
using TestingControllersSample.Controllers;
using TestingControllersSample.Core.Interfaces;
using TestingControllersSample.Core.Model;
using TestingControllersSample.ViewModels;
using Xunit;

namespace TestingControllersSample.Tests.UnitTests
{
    public class SessionControllerTests
    {
        [Fact]
        public async Task IndexReturnsARedirectToIndexHomeWhenIdIsNull()
        {
            // Arrange
            var controller = new SessionController(sessionRepository: null);

            // Act

```

```

        var result = await controller.Index(id: null);

        // Assert
        var redirectToActionResult = Assert.IsType<RedirectToActionResult>(result);
        Assert.Equal("Home", redirectToActionResult.ControllerName);
        Assert.Equal("Index", redirectToActionResult.ActionName);
    }

    [Fact]
    public async Task IndexReturnsContentWithSessionNotFoundWhenSessionNotFound()
    {
        // Arrange
        int testSessionId = 1;
        var mockRepo = new Mock<IBrainstormSessionRepository>();
        mockRepo.Setup(repo => repo.GetByIdAsync(testSessionId))
            .Returns(Task.FromResult((BrainstormSession)null));
        var controller = new SessionController(mockRepo.Object);

        // Act
        var result = await controller.Index(testSessionId);

        // Assert
        var contentResult = Assert.IsType<ContentResult>(result);
        Assert.Equal("Session not found.", contentResult.Content);
    }

    [Fact]
    public async Task IndexReturnsViewResultWithStormSessionViewModel()
    {
        // Arrange
        int testSessionId = 1;
        var mockRepo = new Mock<IBrainstormSessionRepository>();
        mockRepo.Setup(repo => repo.GetByIdAsync(testSessionId))
            .Returns(Task.FromResult(GetTestSessions().FirstOrDefault(s => s.Id == testSessionId)));
        var controller = new SessionController(mockRepo.Object);

        // Act
        var result = await controller.Index(testSessionId);

        // Assert
        var viewResult = Assert.IsType<ViewResult>(result);
        var model = Assert.IsType<StormSessionViewModel>(viewResult.ViewData.Model);
        Assert.Equal("Test One", model.Name);
        Assert.Equal(2, model.DateCreated.Day);
        Assert.Equal(testSessionId, model.Id);
    }

    private List<BrainstormSession> GetTestSessions()
    {
        var sessions = new List<BrainstormSession>();
        sessions.Add(new BrainstormSession()
        {
            DateCreated = new DateTime(2016, 7, 2),
            Id = 1,
            Name = "Test One"
        });
        sessions.Add(new BrainstormSession()
        {
            DateCreated = new DateTime(2016, 7, 1),
            Id = 2,
            Name = "Test Two"
        });
        return sessions;
    }
}

```

The app exposes functionality as a web API (a list of ideas associated with a brainstorming session and a method for adding new ideas to a session):

```
using System;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using TestingControllersSample.ClientModels;
using TestingControllersSample.Core.Interfaces;
using TestingControllersSample.Core.Model;

namespace TestingControllersSample.Api
{
    [Route("api/ideas")]
    public class IdeasController : Controller
    {
        private readonly IBrainstormSessionRepository _sessionRepository;

        public IdeasController(IBrainstormSessionRepository sessionRepository)
        {
            _sessionRepository = sessionRepository;
        }

        [HttpGet("forSession/{sessionId}")]
        public async Task<IActionResult> ForSession(int sessionId)
        {
            var session = await _sessionRepository.GetByIdAsync(sessionId);
            if (session == null)
            {
                return NotFound(sessionId);
            }

            var result = session.Ideas.Select(idea => new IdeaDTO()
            {
                Id = idea.Id,
                Name = idea.Name,
                Description = idea.Description,
                DateCreated = idea.DateCreated
            }).ToList();

            return Ok(result);
        }

        [HttpPost("create")]
        public async Task<IActionResult> Create([FromBody]NewIdeaModel model)
        {
            if (!ModelState.IsValid)
            {
                return BadRequest(ModelState);
            }

            var session = await _sessionRepository.GetByIdAsync(model.SessionId);
            if (session == null)
            {
                return NotFound(model.SessionId);
            }

            var idea = new Idea()
            {
                DateCreated = DateTimeOffset.Now,
                Description = model.Description,
                Name = model.Name
            };
            session.AddIdea(idea);

            await _sessionRepository.UpdateAsync(session);
        }
    }
}
```

```
        return OK(session);  
    }  
}
```

The `ForSession` method returns a list of `IdeaDTO` types. Avoid returning your business domain entities directly via API calls, since frequently they include more data than the API client requires, and they unnecessarily couple your app's internal domain model with the API you expose externally. Mapping between domain entities and the types you will return over the wire can be done manually (using a LINQ `Select` as shown here) or using a library like [AutoMapper](#)

The unit tests for the `Create` and `ForSession` API methods:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;
using Moq;
using TestingControllersSample.Api;
using TestingControllersSample.ClientModels;
using TestingControllersSample.Core.Interfaces;
using TestingControllersSample.Core.Model;
using Xunit;

namespace TestingControllersSample.Tests.UnitTests
{
    public class ApiIdeasControllerTests
    {
        [Fact]
        public async Task Create_ReturnsBadRequest_GivenInvalidModel()
        {
            // Arrange & Act
            var mockRepo = new Mock<IBrainstormSessionRepository>();
            var controller = new IdeasController(mockRepo.Object);
            controller.ModelState.AddModelError("error", "some error");

            // Act
            var result = await controller.Create(model: null);

            // Assert
            Assert.IsType<BadRequestObjectResult>(result);
        }

        [Fact]
        public async Task Create_ReturnsHttpNotFound_ForInvalidSession()
        {
            // Arrange
            int testSessionId = 123;
            var mockRepo = new Mock<IBrainstormSessionRepository>();
            mockRepo.Setup(repo => repo.GetByIdAsync(testSessionId))
                .Returns(Task.FromResult((BrainstormSession)null));
            var controller = new IdeasController(mockRepo.Object);

            // Act
            var result = await controller.Create(new NewIdeaModel());

            // Assert
            Assert.IsType<NotFoundObjectResult>(result);
        }

        [Fact]
        public async Task Create_ReturnsNewlyCreatedIdeaForSession()
        {
            // Arrange
            int testSessionId = 123;
```

```

        string testName = "test name";
        string testDescription = "test description";
        var testSession = GetTestSession();
        var mockRepo = new Mock<IBrainstormSessionRepository>();
        mockRepo.Setup(repo => repo.GetByIdAsync(testSessionId))
            .Returns(Task.FromResult(testSession));
        var controller = new IdeasController(mockRepo.Object);

        var newIdea = new NewIdeaModel()
        {
            Description = testDescription,
            Name = testName,
            SessionId = testSessionId
        };
        mockRepo.Setup(repo => repo.UpdateAsync(testSession))
            .Returns(Task.CompletedTask)
            .Verifiable();

        // Act
        var result = await controller.Create(newIdea);

        // Assert
        var okResult = Assert.IsType<OkObjectResult>(result);
        var returnSession = Assert.IsType<BrainstormSession>(okResult.Value);
        mockRepo.Verify();
        Assert.Equal(2, returnSession.Ideas.Count());
        Assert.Equal(testName, returnSession.Ideas.LastOrDefault().Name);
        Assert.Equal(testDescription, returnSession.Ideas.LastOrDefault().Description);
    }

    private BrainstormSession GetTestSession()
    {
        var session = new BrainstormSession()
        {
            DateCreated = new DateTime(2016, 7, 2),
            Id = 1,
            Name = "Test One"
        };

        var idea = new Idea() { Name = "One" };
        session.AddIdea(idea);
        return session;
    }
}
}

```

As stated previously, to test the behavior of the method when `ModelState` is invalid, add a model error to the controller as part of the test. Don't try to test model validation or model binding in your unit tests - just test your action method's behavior when confronted with a particular `ModelState` value.

The second test depends on the repository returning null, so the mock repository is configured to return null. There's no need to create a test database (in memory or otherwise) and construct a query that will return this result - it can be done in a single statement as shown.

The last test verifies that the repository's `Update` method is called. As we did previously, the mock is called with `Verifiable` and then the mocked repository's `Verify` method is called to confirm the verifiable method was executed. It's not a unit test responsibility to ensure that the `Update` method saved the data; that can be done with an integration test.

## Integration testing

[Integration tests](#) is done to ensure separate modules within your app work correctly together. Generally, anything you can test with a unit test, you can also test with an integration test, but the reverse isn't true. However,

integration tests tend to be much slower than unit tests. Thus, it's best to test whatever you can with unit tests, and use integration tests for scenarios that involve multiple collaborators.

Although they may still be useful, mock objects are rarely used in integration tests. In unit testing, mock objects are an effective way to control how collaborators outside of the unit being tested should behave for the purposes of the test. In an integration test, real collaborators are used to confirm the whole subsystem works together correctly.

## Application state

One important consideration when performing integration testing is how to set your app's state. Tests need to run independent of one another, and so each test should start with the app in a known state. If your app doesn't use a database or have any persistence, this may not be an issue. However, most real-world apps persist their state to some kind of data store, so any modifications made by one test could impact another test unless the data store is reset. Using the built-in `TestServer`, it's very straightforward to host ASP.NET Core apps within our integration tests, but that doesn't necessarily grant access to the data it will use. If you're using an actual database, one approach is to have the app connect to a test database, which your tests can access and ensure is reset to a known state before each test executes.

In this sample application, I'm using Entity Framework Core's `InMemoryDatabase` support, so I can't just connect to it from my test project. Instead, I expose an `InitializeDatabase` method from the app's `Startup` class, which I call when the app starts up if it's in the `Development` environment. My integration tests automatically benefit from this as long as they set the environment to `Development`. I don't have to worry about resetting the database, since the `InMemoryDatabase` is reset each time the app restarts.

The `Startup` class:

```
using System;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;
using TestingControllersSample.Core.Interfaces;
using TestingControllersSample.Core.Model;
using TestingControllersSample.Infrastructure;

namespace TestingControllersSample
{
    public class Startup
    {
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<AppDbContext>(
                optionsBuilder => optionsBuilder.UseInMemoryDatabase("InMemoryDb"));

            services.AddMvc();

            services.AddScoped<IBrainstormSessionRepository,
                EFStormSessionRepository>();
        }

        public void Configure(IApplicationBuilder app,
            IHostingEnvironment env,
            ILoggerFactory loggerFactory)
        {
            if (env.IsDevelopment())
            {
                var repository = app.ApplicationServices.GetService<IBrainstormSessionRepository>();
                InitializeDatabaseAsync(repository).Wait();
            }
        }
    }
}
```

```

        app.UseStaticFiles();

        app.UseMvcWithDefaultRoute();
    }

    public async Task InitializeDatabaseAsync(IBrainstormSessionRepository repo)
    {
        var sessionList = await repo.ListAsync();
        if (!sessionList.Any())
        {
            await repo.AddAsync(GetTestSession());
        }
    }

    public static BrainstormSession GetTestSession()
    {
        var session = new BrainstormSession()
        {
            Name = "Test Session 1",
            DateCreated = new DateTime(2016, 8, 1)
        };
        var idea = new Idea()
        {
            DateCreated = new DateTime(2016, 8, 1),
            Description = "Totally awesome idea",
            Name = "Awesome idea"
        };
        session.AddIdea(idea);
        return session;
    }
}
}

```

You'll see the `GetTestSession` method used frequently in the integration tests below.

## Accessing views

Each integration test class configures the `TestServer` that will run the ASP.NET Core app. By default, `TestServer` hosts the web app in the folder where it's running - in this case, the test project folder. Thus, when you attempt to test controller actions that return `ViewResult`, you may see this error:

```
The view 'Index' wasn't found. The following locations were searched:
(list of locations)
```

To correct this issue, you need to configure the server's content root, so it can locate the views for the project being tested. This is done by a call to `UseContentRoot` in the `TestFixture` class, shown below:

```

using System;
using System.IO;
using System.Net.Http;
using System.Reflection;
using Microsoft.AspNetCore.Hosting;
using Microsoft.AspNetCore.Mvc.ApplicationParts;
using Microsoft.AspNetCore.Mvc.Controllers;
using Microsoft.AspNetCore.Mvc.ViewComponents;
using Microsoft.AspNetCore.TestHost;
using Microsoft.Extensions.DependencyInjection;

namespace TestingControllersSample.Tests.IntegrationTests
{
    /// <summary>
    /// A test fixture which hosts the target project (project we wish to test) in an in-memory server.
    /// </summary>
    /// <typeparam name="TStartup">The target project's startup type</typeparam>

```

```

/// <summary>
/// Gets the full path to the target project that we wish to test
/// </summary>
/// <param name="projectRelativePath">
/// The parent directory of the target project.
/// e.g. src, samples, test, or test/Websites
/// </param>
/// <param name="startupAssembly">The target project's assembly.</param>
/// <returns>The full path to the target project.</returns>
private static string GetProjectPath(string projectRelativePath, Assembly startupAssembly)
{
    // Get name of the target project which we want to test
    var projectName = startupAssembly.GetName().Name;

    // Get currently executing test project path
    var applicationBasePath = System.AppContext.BaseDirectory;

    // Find the path to the target project
    var directoryInfo = new DirectoryInfo(applicationBasePath);
    do
    {
        if (directoryInfo.Parent != null)
            directoryInfo = directoryInfo.Parent;
    }
    while (directoryInfo.Name != projectName);
    return Path.Combine(directoryInfo.FullName, projectRelativePath);
}

protected virtual void InitializeServices(IServiceCollection services)
{
    var startupAssembly = typeof(TStartup).GetTypeInfo().Assembly;

    // Inject a custom application part manager.
    // Overrides AddMvcCore() because it uses TryAdd().
    var manager = new ApplicationPartManager();
    manager.ApplicationParts.Add(new AssemblyPart(startupAssembly));
    manager.FeatureProviders.Add(new ControllerFeatureProvider());
    manager.FeatureProviders.Add(new ViewComponentFeatureProvider());

    services.AddSingleton(manager);
}

```

```
        {
            directoryInfo = directoryInfo.Parent;

            var project DirectoryInfo = new DirectoryInfo(Path.Combine(directoryInfo.FullName,
projectRelativePath));
            if (projectDirectoryInfo.Exists)
            {
                var project FileInfo = new FileInfo(Path.Combine(projectDirectoryInfo.FullName,
 projectName, $"{projectName}.csproj"));
                if (projectFileInfo.Exists)
                {
                    return Path.Combine(projectDirectoryInfo.FullName, projectName);
                }
            }
        }
        while (directoryInfo.Parent != null);

        throw new Exception($"Project root could not be located using the application root
{applicationBasePath}.");
    }
}
}
```

The `TestFixture` class is responsible for configuring and creating the `TestServer`, setting up an `HttpClient` to communicate with the `TestServer`. Each of the integration tests uses the `client` property to connect to the test server and make a request.

```

using System;
using System.Collections.Generic;
using System.Net;
using System.Net.Http;
using System.Threading.Tasks;
using Xunit;

namespace TestingControllersSample.Tests.IntegrationTests
{
    public class HomeControllerTests : IClassFixture<TestFixture<TestingControllersSample.Startup>>
    {
        private readonly HttpClient _client;

        public HomeControllerTests(TestFixture<TestingControllersSample.Startup> fixture)
        {
            _client = fixture.Client;
        }

        [Fact]
        public async Task ReturnsInitialListOfBrainstormSessions()
        {
            // Arrange - get a session known to exist
            var testSession = Startup.GetTestSession();

            // Act
            var response = await _client.GetAsync("/");

            // Assert
            response.EnsureSuccessStatusCode();
            var responseString = await response.Content.ReadAsStringAsync();
            Assert.Contains(testSession.Name, responseString);
        }

        [Fact]
        public async Task PostAddsNewBrainstormSession()
        {
            // Arrange
            string testSessionName = Guid.NewGuid().ToString();
            var data = new Dictionary<string, string>();
            data.Add("SessionName", testSessionName);
            var content = new FormUrlEncodedContent(data);

            // Act
            var response = await _client.PostAsync("/", content);

            // Assert
            Assert.Equal(HttpStatusCode.Redirect, response.StatusCode);
            Assert.Equal("/", response.Headers.Location.ToString());
        }
    }
}

```

In the first test above, the `responseString` holds the actual rendered HTML from the View, which can be inspected to confirm it contains expected results.

The second test constructs a form POST with a unique session name and POSTs it to the app, then verifies that the expected redirect is returned.

## API methods

If your app exposes web APIs, it's a good idea to have automated tests confirm they execute as expected. The built-in `TestServer` makes it easy to test web APIs. If your API methods are using model binding, you should always check `ModelState.IsValid`, and integration tests are the right place to confirm that your model validation is working properly.

The following set of tests target the `Create` method in the `IdeasController` class shown above:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Net;
using System.Net.Http;
using System.Threading.Tasks;
using Newtonsoft.Json;
using TestingControllersSample.ClientModels;
using TestingControllersSample.Core.Model;
using Xunit;

namespace TestingControllersSample.Tests.IntegrationTests
{
    public class ApiIdeasControllerTests : IClassFixture<TestFixture<TestingControllersSample.Startup>>
    {
        internal class NewIdeaDto
        {
            public NewIdeaDto(string name, string description, int sessionId)
            {
                Name = name;
                Description = description;
                SessionId = sessionId;
            }

            public string Name { get; set; }
            public string Description { get; set; }
            public int SessionId { get; set; }
        }

        private readonly HttpClient _client;

        public ApiIdeasControllerTests(TestFixture<TestingControllersSample.Startup> fixture)
        {
            _client = fixture.Client;
        }

        [Fact]
        public async Task CreatePostReturnsBadRequestForMissingNameValue()
        {
            // Arrange
            var newIdea = new NewIdeaDto("", "Description", 1);

            // Act
            var response = await _client.PostAsJsonAsync("/api/ideas/create", newIdea);

            // Assert
            Assert.Equal(HttpStatusCode.BadRequest, response.StatusCode);
        }

        [Fact]
        public async Task CreatePostReturnsBadRequestForMissingDescriptionValue()
        {
            // Arrange
            var newIdea = new NewIdeaDto("Name", "", 1);

            // Act
            var response = await _client.PostAsJsonAsync("/api/ideas/create", newIdea);

            // Assert
            Assert.Equal(HttpStatusCode.BadRequest, response.StatusCode);
        }

        [Fact]
        public async Task CreatePostReturnsBadRequestForSessionIdValueTooSmall()
        {
            // Arrange
        }
    }
}
```

```

    // ...
    var newIdea = new NewIdeaDto("Name", "Description", 0);

    // Act
    var response = await _client.PostAsJsonAsync("/api/ideas/create", newIdea);

    // Assert
    Assert.Equal(HttpStatusCode.BadRequest, response.StatusCode);
}

[Fact]
public async Task CreatePostReturnsBadRequestForSessionIdValueTooLarge()
{
    // Arrange
    var newIdea = new NewIdeaDto("Name", "Description", 1000001);

    // Act
    var response = await _client.PostAsJsonAsync("/api/ideas/create", newIdea);

    // Assert
    Assert.Equal(HttpStatusCode.BadRequest, response.StatusCode);
}

[Fact]
public async Task CreatePostReturnsNotFoundForInvalidSession()
{
    // Arrange
    var newIdea = new NewIdeaDto("Name", "Description", 123);

    // Act
    var response = await _client.PostAsJsonAsync("/api/ideas/create", newIdea);

    // Assert
    Assert.Equal(HttpStatusCode.NotFound, response.StatusCode);
}

[Fact]
public async Task CreatePostReturnsCreatedIdeaWithCorrectInputs()
{
    // Arrange
    var testIdeaName = Guid.NewGuid().ToString();
    var newIdea = new NewIdeaDto(testIdeaName, "Description", 1);

    // Act
    var response = await _client.PostAsJsonAsync("/api/ideas/create", newIdea);

    // Assert
    response.EnsureSuccessStatusCode();
    var returnedSession = await response.Content.ReadAsJsonAsync<BrainstormSession>();
    Assert.Equal(2, returnedSession.Ideas.Count);
    Assert.Contains(testIdeaName, returnedSession.Ideas.Select(i => i.Name).ToList());
}

[Fact]
public async Task ForSessionReturnsNotFoundForBadSessionId()
{
    // Arrange & Act
    var response = await _client.GetAsync("/api/ideas/forsession/500");

    // Assert
    Assert.Equal(HttpStatusCode.NotFound, response.StatusCode);
}

[Fact]
public async Task ForSessionReturnsIdeasForValidSessionId()
{
    // Arrange
    var testSession = Startup.GetTestSession();

    // Act

```

```
// Act
var response = await _client.GetAsync("/api/ideas/forsession/1");

// Assert
response.EnsureSuccessStatusCode();
var ideaList = JsonConvert.DeserializeObject<List<IdeaDTO>>(
    await response.Content.ReadAsStringAsync());
var firstIdea = ideaList.First();
Assert.Equal(testSession.Ideas.First().Name, firstIdea.Name);
}

}
}
```

Unlike integration tests of actions that returns HTML views, web API methods that return results can usually be deserialized as strongly typed objects, as the last test above shows. In this case, the test deserializes the result to a `BrainstormSession` instance, and confirms that the idea was correctly added to its collection of ideas.

You'll find additional examples of integration tests in this article's [sample project](#).

# Troubleshoot ASP.NET Core projects

7/10/2018 • 2 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

The following links provide troubleshooting guidance:

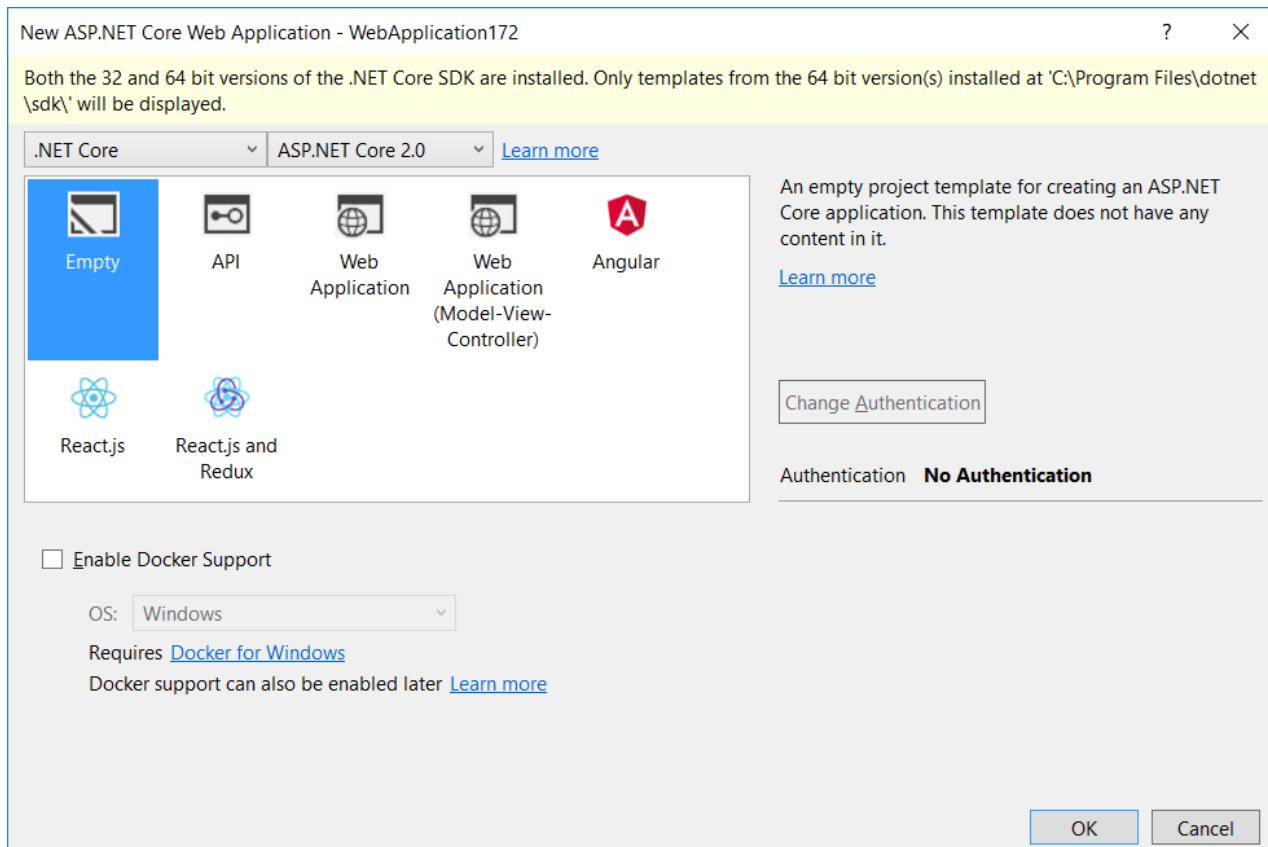
- [Troubleshoot ASP.NET Core on Azure App Service](#)
- [Troubleshoot ASP.NET Core on IIS](#)
- [Common errors reference for Azure App Service and IIS with ASP.NET Core](#)
- [NDC Conference \(London, 2018\): Diagnosing issues in ASP.NET Core Applications](#)
- [ASP.NET Blog: Troubleshooting ASP.NET Core Performance Problems](#)

## .NET Core SDK warnings

### Both the 32 bit and 64 bit versions of the .NET Core SDK are installed

In the **New Project** dialog for ASP.NET Core, you may see the following warning:

Both 32 and 64 bit versions of the .NET Core SDK are installed. Only templates from the 64 bit version(s) installed at 'C:\Program Files\dotnet\sdk\' will be displayed.



This warning appears when both 32-bit (x86) and 64-bit (x64) versions of the [.NET Core SDK](#) are installed.

Common reasons both versions may be installed include:

- You originally downloaded the .NET Core SDK installer using a 32-bit machine but then copied it across and installed it on a 64-bit machine.
- The 32-bit .NET Core SDK was installed by another application.

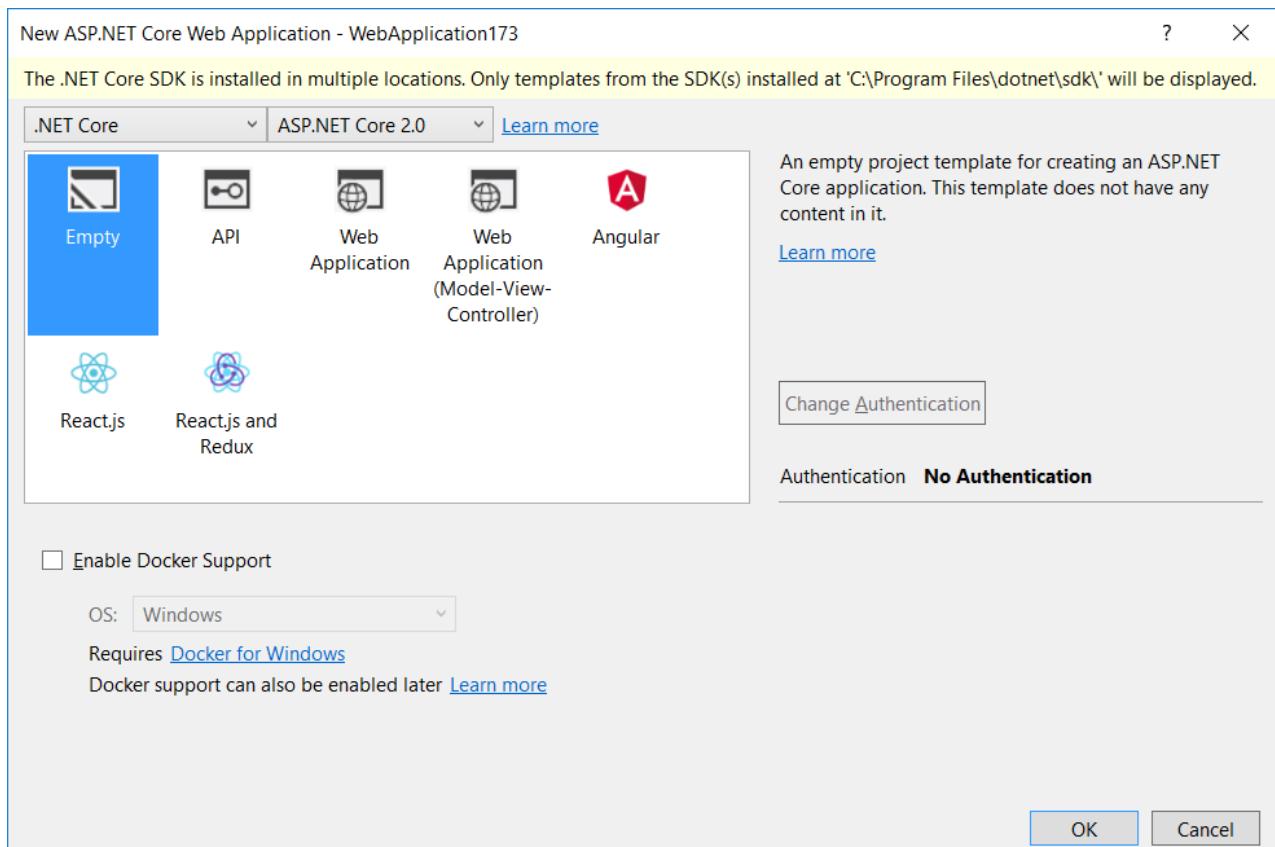
- The wrong version was downloaded and installed.

Uninstall the 32-bit .NET Core SDK to prevent this warning. Uninstall from **Control Panel > Programs and Features > Uninstall or change a program**. If you understand why the warning occurs and its implications, you can ignore the warning.

### The .NET Core SDK is installed in multiple locations

In the **New Project** dialog for ASP.NET Core, you may see the following warning:

The .NET Core SDK is installed in multiple locations. Only templates from the SDK(s) installed at 'C:\Program Files\dotnet\sdk\' will be displayed.



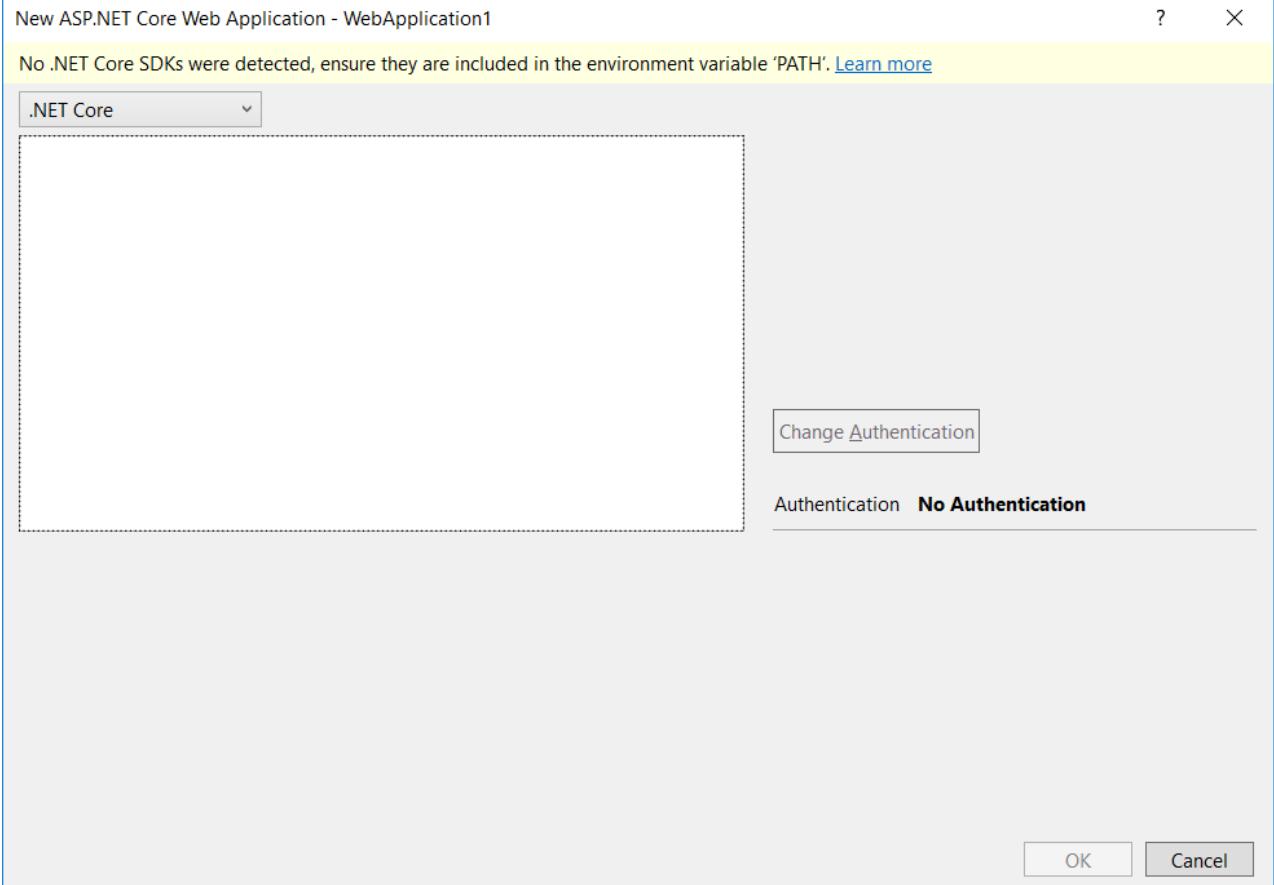
You see this message when you have at least one installation of the .NET Core SDK in a directory outside of C:\Program Files\dotnet\sdk\. Usually this happens when the .NET Core SDK has been deployed on a machine using copy/paste instead of the MSI installer.

Uninstall the 32-bit .NET Core SDK to prevent this warning. Uninstall from **Control Panel > Programs and Features > Uninstall or change a program**. If you understand why the warning occurs and its implications, you can ignore the warning.

### No .NET Core SDKs were detected

In the **New Project** dialog for ASP.NET Core, you may see the following warning:

No .NET Core SDKs were detected, ensure they are included in the environment variable 'PATH'.



This warning appears when the environment variable `PATH` doesn't point to any .NET Core SDKs on the machine.  
To resolve this problem:

- Install or verify the .NET Core SDK is installed.
- Verify that the `PATH` environment variable points to the location in which the SDK is installed. The installer normally sets the `PATH`.

# Work with data in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

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# Razor Pages with Entity Framework Core in ASP.NET Core - Tutorial 1 of 8

7/10/2018 • 15 minutes to read • [Edit Online](#)

The ASP.NET Core 2.0 version of this tutorial can be found in [this PDF file](#).

The ASP.NET Core 2.1 version of this tutorial has many improvements over the 2.0 version.

By [Tom Dykstra](#) and [Rick Anderson](#)

The Contoso University sample web app demonstrates how to create an ASP.NET Core Razor Pages app using Entity Framework (EF) Core.

The sample app is a web site for a fictional Contoso University. It includes functionality such as student admission, course creation, and instructor assignments. This page is the first in a series of tutorials that explain how to build the Contoso University sample app.

[Download or view the completed app.](#) [Download instructions.](#)

## Prerequisites

- [Visual Studio](#)
- [.NET Core CLI](#)

[Visual Studio 2017 version 15.7.3 or later](#) with the following workloads:

- **ASP.NET and web development**
- **.NET Core cross-platform development**

[.NET Core 2.1 SDK or later](#)

Familiarity with [Razor Pages](#). New programmers should complete [Get started with Razor Pages](#) before starting this series.

## Troubleshooting

If you run into a problem you can't resolve, you can generally find the solution by comparing your code to the [completed project](#). A good way to get help is by posting a question to [StackOverflow.com](#) for [ASP.NET Core](#) or [EF Core](#).

## The Contoso University web app

The app built in these tutorials is a basic university web site.

Users can view and update student, course, and instructor information. Here are a few of the screens created in the tutorial.

The screenshot shows a web browser window titled "Index - Contoso University". The address bar displays "localhost:1234/Students". The main content area is titled "Contoso University" and features a large heading "Index". Below it is a link "Create New". A search bar with the placeholder "Find by name:" and a "Search" button is present. A horizontal table header row includes columns for "Last Name", "First Name", and "Enrollment Date". Three student records are listed:

Last Name	First Name	Enrollment Date	
Smith	Joe	2017-10-31	Edit   Details   Delete
Alexander	Carson	2010-09-01	Edit   Details   Delete
Alonso	Meredith	2012-09-01	Edit   Details   Delete

Below the table are navigation buttons "Previous" and "Next". At the bottom of the page is a copyright notice: "© 2017 - Contoso University".

The screenshot shows a web browser window titled "Edit - Contoso University". The address bar displays "localhost:1234/Students/Edit/1". The main content area is titled "Contoso University" and features a large heading "Edit". Below it is a sub-heading "Student". The page contains three form fields with labels: "Last Name" (with value "Alexander"), "First Name" (with value "Carson"), and "Enrollment Date" (with value "09/01/2010"). A "Save" button is located at the bottom left. A "Back to List" link is at the bottom center. At the bottom of the page is a copyright notice: "© 2017 - Contoso University".

The UI style of this site is close to what's generated by the built-in templates. The tutorial focus is on EF

Core with Razor Pages, not the UI.

## Create the ContosoUniversity Razor Pages web app

- [Visual Studio](#)
  - [.NET Core CLI](#)
- From the Visual Studio **File** menu, select **New > Project**.
  - Create a new ASP.NET Core Web Application. Name the project **ContosoUniversity**. It's important to name the project *ContosoUniversity* so the namespaces match when code is copy/pasted.
  - Select **ASP.NET Core 2.1** in the dropdown, and then select **Web Application**.

For images of the preceding steps, see [Create a Razor web app](#). Run the app.

## Set up the site style

A few changes set up the site menu, layout, and home page. Update *Pages/Shared/\_Layout.cshtml* with the following changes:

- Change each occurrence of "ContosoUniversity" to "Contoso University". There are three occurrences.
- Add menu entries for **Students**, **Courses**, **Instructors**, and **Departments**, and delete the **Contact** menu entry.

The changes are highlighted. (All the markup is *not* displayed.)

```

<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>@ViewData["Title"] : Contoso University</title>

    <environment include="Development">
        <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />
        <link rel="stylesheet" href("~/css/site.css" />
    </environment>
    <environment exclude="Development">
        <link rel="stylesheet"
            href="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/css/bootstrap.min.css"
            asp-fallback-href="~/lib/bootstrap/dist/css/bootstrap.min.css"
            asp-fallback-test-class="sr-only" asp-fallback-test-property="position" asp-fallback-
            test-value="absolute" />
        <link rel="stylesheet" href "~/css/site.min.css" asp-append-version="true" />
    </environment>
</head>
<body>
    <nav class="navbar navbar-inverse navbar-fixed-top">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-
target=".navbar-collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a asp-page="/Index" class="navbar-brand">Contoso University</a>
            </div>
            <div class="navbar-collapse collapse">
                <ul class="nav navbar-nav">
                    <li><a asp-page="/Index">Home</a></li>
                    <li><a asp-page="/About">About</a></li>
                    <li><a asp-page="/Students/Index">Students</a></li>
                    <li><a asp-page="/Courses/Index">Courses</a></li>
                    <li><a asp-page="/Instructors/Index">Instructors</a></li>
                    <li><a asp-page="/Departments/Index">Departments</a></li>
                </ul>
            </div>
        </div>
    </nav>

    <partial name="_CookieConsentPartial" />

    <div class="container body-content">
        @RenderBody()
        <hr />
        <footer>
            <p>&copy; 2018 : Contoso University</p>
        </footer>
    </div>

```

@\*Remaining markup not shown for brevity.\*@

In *Pages/Index.cshtml*, replace the contents of the file with the following code to replace the text about ASP.NET and MVC with text about this app:

```

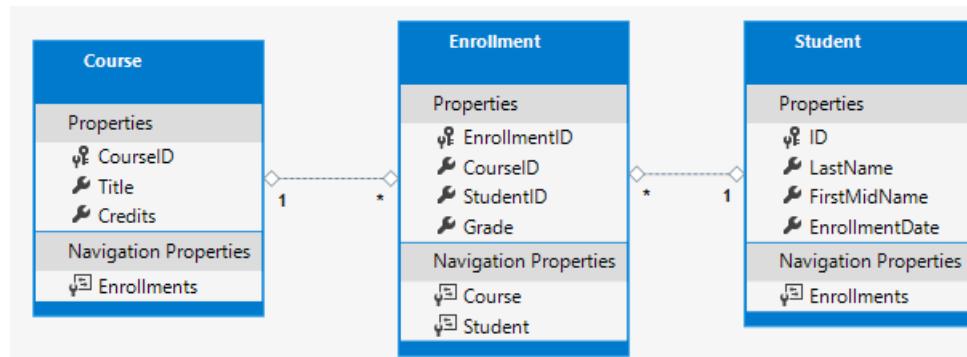
@page
@model IndexModel
 @{
     ViewData["Title"] = "Home page";
 }

<div class="jumbotron">
    <h1>Contoso University</h1>
</div>
<div class="row">
    <div class="col-md-4">
        <h2>Welcome to Contoso University</h2>
        <p>
            Contoso University is a sample application that
            demonstrates how to use Entity Framework Core in an
            ASP.NET Core Razor Pages web app.
        </p>
    </div>
    <div class="col-md-4">
        <h2>Build it from scratch</h2>
        <p>You can build the application by following the steps in a series of tutorials.</p>
        <p>
            <a class="btn btn-default"
                href="https://docs.microsoft.com/aspnet/core/data/ef-rp/intro">
                See the tutorial &raquo;
            </a>
        </p>
    </div>
    <div class="col-md-4">
        <h2>Download it</h2>
        <p>You can download the completed project from GitHub.</p>
        <p>
            <a class="btn btn-default"
                href="https://github.com/aspnet/Docs/tree/master/aspnetcore/data/ef-rp/intro/samples/cu-final">
                See project source code &raquo;
            </a>
        </p>
    </div>
</div>

```

## Create the data model

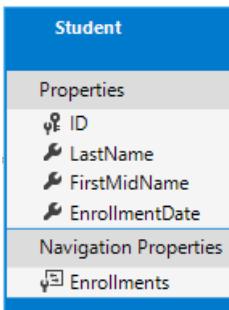
Create entity classes for the Contoso University app. Start with the following three entities:



There's a one-to-many relationship between `Student` and `Enrollment` entities. There's a one-to-many relationship between `Course` and `Enrollment` entities. A student can enroll in any number of courses. A course can have any number of students enrolled in it.

In the following sections, a class for each one of these entities is created.

### The Student entity



Create a *Models* folder. In the *Models* folder, create a class file named *Student.cs* with the following code:

```
using System;
using System.Collections.Generic;

namespace ContosoUniversity.Models
{
    public class Student
    {
        public int ID { get; set; }
        public string LastName { get; set; }
        public string FirstMidName { get; set; }
        public DateTime EnrollmentDate { get; set; }

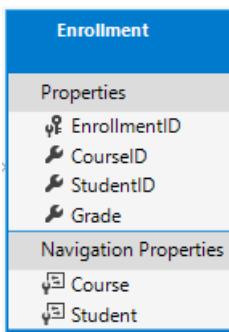
        public ICollection<Enrollment> Enrollments { get; set; }
    }
}
```

The `ID` property becomes the primary key column of the database (DB) table that corresponds to this class. By default, EF Core interprets a property that's named `ID` or `classnameID` as the primary key. In `classnameID`, `classname` is the name of the class. The alternative automatically recognized primary key is `StudentID` in the preceding example.

The `Enrollments` property is a navigation property. Navigation properties link to other entities that are related to this entity. In this case, the `Enrollments` property of a `Student` entity holds all of the `Enrollment` entities that are related to that `Student`. For example, if a `Student` row in the DB has two related `Enrollment` rows, the `Enrollments` navigation property contains those two `Enrollment` entities. A related `Enrollment` row is a row that contains that student's primary key value in the `studentID` column. For example, suppose the student with `ID=1` has two rows in the `Enrollment` table. The `Enrollment` table has two rows with `studentID = 1`. `StudentID` is a foreign key in the `Enrollment` table that specifies the student in the `Student` table.

If a navigation property can hold multiple entities, the navigation property must be a list type, such as `ICollection<T>`. `ICollection<T>` can be specified, or a type such as `List<T>` or `HashSet<T>`. When `ICollection<T>` is used, EF Core creates a `HashSet<T>` collection by default. Navigation properties that hold multiple entities come from many-to-many and one-to-many relationships.

### The Enrollment entity



In the *Models* folder, create *Enrollment.cs* with the following code:

```
namespace ContosoUniversity.Models
{
    public enum Grade
    {
        A, B, C, D, F
    }

    public class Enrollment
    {
        public int EnrollmentID { get; set; }
        public int CourseID { get; set; }
        public int StudentID { get; set; }
        public Grade? Grade { get; set; }

        public Course Course { get; set; }
        public Student Student { get; set; }
    }
}
```

The `EnrollmentID` property is the primary key. This entity uses the `classnameID` pattern instead of `ID` like the `Student` entity. Typically developers choose one pattern and use it throughout the data model. In a later tutorial, using ID without classname is shown to make it easier to implement inheritance in the data model.

The `Grade` property is an `enum`. The question mark after the `Grade` type declaration indicates that the `Grade` property is nullable. A grade that's null is different from a zero grade -- null means a grade isn't known or hasn't been assigned yet.

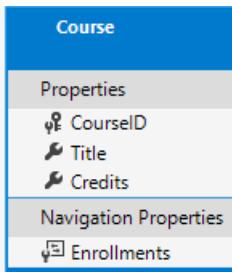
The `StudentID` property is a foreign key, and the corresponding navigation property is `Student`. An `Enrollment` entity is associated with one `Student` entity, so the property contains a single `Student` entity. The `Student` entity differs from the `Student.Enrollments` navigation property, which contains multiple `Enrollment` entities.

The `CourseID` property is a foreign key, and the corresponding navigation property is `course`. An `Enrollment` entity is associated with one `Course` entity.

EF Core interprets a property as a foreign key if it's named

`<navigation property name><primary key property name>`. For example, `StudentID` for the `Student` navigation property, since the `Student` entity's primary key is `ID`. Foreign key properties can also be named `<primary key property name>`. For example, `CourseID` since the `Course` entity's primary key is `CourseID`.

## The Course entity



In the *Models* folder, create *Course.cs* with the following code:

```

using System.Collections.Generic;
using System.ComponentModel.DataAnnotations.Schema;

namespace ContosoUniversity.Models
{
    public class Course
    {
        [DatabaseGenerated(DatabaseGeneratedOption.None)]
        public int CourseID { get; set; }
        public string Title { get; set; }
        public int Credits { get; set; }

        public ICollection<Enrollment> Enrollments { get; set; }
    }
}

```

The `Enrollments` property is a navigation property. A `Course` entity can be related to any number of `Enrollment` entities.

The `DatabaseGenerated` attribute allows the app to specify the primary key rather than having the DB generate it.

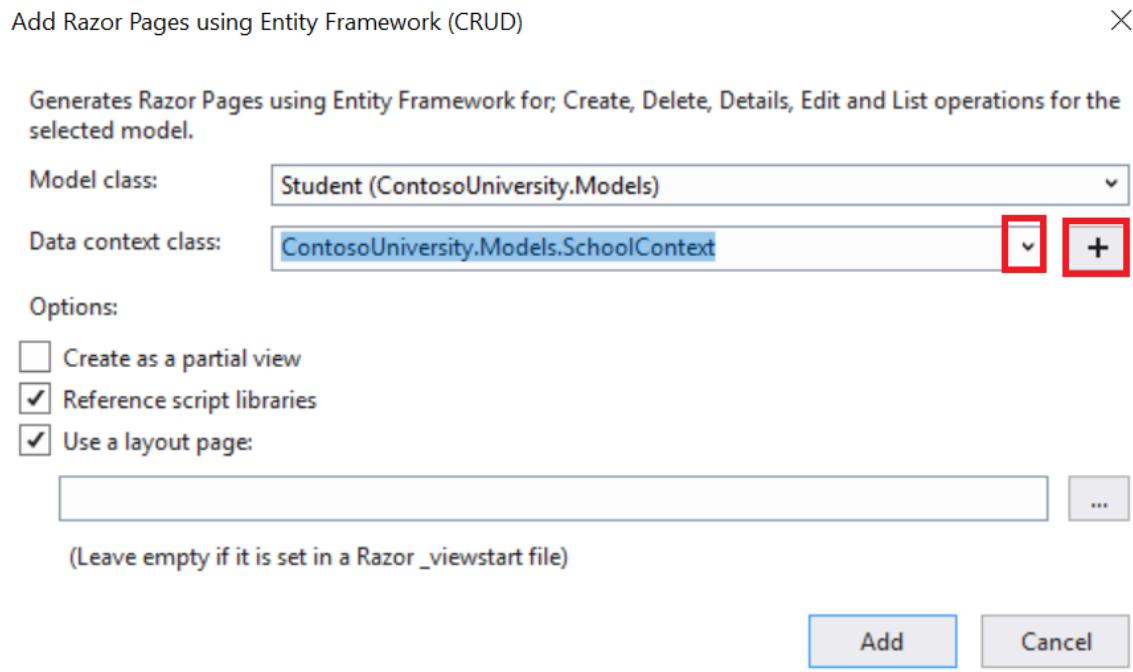
## Scaffold the student model

In this section, the student model is scaffolded. That is, the scaffolding tool produces pages for Create, Read, Update, and Delete (CRUD) operations for the student model.

- Build the project.
- Create the *Pages/Students* folder.
- [Visual Studio](#)
- [.NET Core CLI](#)
- In **Solution Explorer**, right click on the *Pages/Students* folder > **Add** > **New Scaffolded Item**.
- In the **Add Scaffold** dialog, select **Razor Pages using Entity Framework (CRUD)** > **ADD**.

Complete the **Add Razor Pages using Entity Framework (CRUD)** dialog:

- In the **Model class** drop-down, select **Student (ContosoUniversity.Models)**.
- In the **Data context class** row, select the + (plus) sign and change the generated name to **ContosoUniversity.Models.SchoolContext**.
- In the **Data context class** drop-down, select **ContosoUniversity.Models.SchoolContext**
- Select **Add**.



See [Scaffold the movie model](#) if you have a problem with the preceding step.

The scaffold process created and changed the following files:

#### Files created

- *Pages/Students* Create, Delete, Details, Edit, Index.
- *Data/ContosoUniversityContext.cs*

#### Files updates

- *Startup.cs* : Changes to this file are detailed in the next section.
- *appsettings.json* : The connection string used to connect to a local database is added.

## Examine the context registered with dependency injection

ASP.NET Core is built with [dependency injection](#). Services (such as the EF Core DB context) are registered with dependency injection during application startup. Components that require these services (such as Razor Pages) are provided these services via constructor parameters. The constructor code that gets a db context instance is shown later in the tutorial.

The scaffolding tool automatically created a DB Context and registered it with the dependency injection container.

Examine the `ConfigureServices` method in *Startup.cs*. The highlighted line was added by the scaffolder:

```
public void ConfigureServices(IServiceCollection services)
{
    services.Configure<CookiePolicyOptions>(options =>
    {
        // This lambda determines whether user consent for
        // non-essential cookies is needed for a given request.
        options.CheckConsentNeeded = context => true;
        options.MinimumSameSitePolicy = SameSiteMode.None;
    });

    services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1);

    services.AddDbContext<SchoolContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("SchoolContext")));
}
```

The name of the connection string is passed in to the context by calling a method on a [DbContextOptions](#) object. For local development, the [ASP.NET Core configuration system](#) reads the connection string from the *appsettings.json* file.

## Update main

In *Program.cs*, modify the `Main` method to do the following:

- Get a DB context instance from the dependency injection container.
- Call the [EnsureCreated](#).
- Dispose the context when the `EnsureCreated` method completes.

The following code shows the updated *Program.cs* file.

```

using ContosoUniversity.Models; // SchoolContext
using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.DependencyInjection; // CreateScope
using Microsoft.Extensions.Logging;
using System;

namespace ContosoUniversity
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = CreateWebHostBuilder(args).Build();

            using (var scope = host.Services.CreateScope())
            {
                var services = scope.ServiceProvider;

                try
                {
                    var context = services.GetRequiredService<SchoolContext>();
                    context.Database.EnsureCreated();
                }
                catch (Exception ex)
                {
                    var logger = services.GetRequiredService<ILogger<Program>>();
                    logger.LogError(ex, "An error occurred creating the DB.");
                }
            }

            host.Run();
        }

        public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>();
    }
}

```

`EnsureCreated` ensures that the database for the context exists. If it exists, no action is taken. If it does not exist, then the database and all its schema are created. `EnsureCreated` does not use migrations to create the database. A database that is created with `EnsureCreated` cannot be later updated using migrations.

`EnsureCreated` is called on app start, which allows the following work flow:

- Delete the DB.
- Change the DB schema (for example, add an `EmailAddress` field).
- Run the app.
- `EnsureCreated` creates a DB with the `EmailAddress` column.

`EnsureCreated` is convenient early in development when the schema is rapidly evolving. Later in the tutorial the DB is deleted and migrations are used.

## Test the app

Run the app and accept the cookie policy. This app doesn't keep personal information. You can read about the cookie policy at [EU General Data Protection Regulation \(GDPR\) support](#).

- Select the **Students** link and then **Create New**.
- Test the Edit, Details, and Delete links.

## Examine the SchoolContext DB context

The main class that coordinates EF Core functionality for a given data model is the DB context class. The data context is derived from [Microsoft.EntityFrameworkCore.DbContext](#). The data context specifies which entities are included in the data model. In this project, the class is named `SchoolContext`.

Update `SchoolContext.cs` with the following code:

```
using Microsoft.EntityFrameworkCore;

namespace ContosoUniversity.Models
{
    public class SchoolContext : DbContext
    {
        public SchoolContext(DbContextOptions<SchoolContext> options)
            : base(options)
        {
        }

        public DbSet<Student> Student { get; set; }
        public DbSet<Enrollment> Enrollment { get; set; }
        public DbSet<Course> Course { get; set; }
    }
}
```

The highlighted code creates a `DbSet< TEntity >` property for each entity set. In EF Core terminology:

- An entity set typically corresponds to a DB table.
- An entity corresponds to a row in the table.

`DbSet<Enrollment>` and `DbSet<Course>` could be omitted. EF Core includes them implicitly because the `Student` entity references the `Enrollment` entity, and the `Enrollment` entity references the `Course` entity. For this tutorial, keep `DbSet<Enrollment>` and `DbSet<Course>` in the `SchoolContext`.

### SQL Server Express LocalDB

The connection string specifies [SQL Server LocalDB](#). LocalDB is a lightweight version of the SQL Server Express Database Engine and is intended for app development, not production use. LocalDB starts on demand and runs in user mode, so there's no complex configuration. By default, LocalDB creates `.mdf` DB files in the `c:/Users/<user>` directory.

## Add code to initialize the DB with test data

EF Core creates an empty DB. In this section, an `Initialize` method is written to populate it with test data.

In the `Data` folder, create a new class file named `DbInitializer.cs` and add the following code:

```
using ContosoUniversity.Models;
using System;
using System.Linq;

namespace ContosoUniversity.Data
{
    public static class DbInitializer
    {
        public static void Initialize(SchoolContext context)
        {
            // context.Database.EnsureCreated();

            // Look for any students.
        }
    }
}
```

```

        if (context.Student.Any())
        {
            return; // DB has been seeded
        }

        var students = new Student[]
        {
            new
            Student{FirstMidName="Carson",LastName="Alexander",EnrollmentDate=DateTime.Parse("2005-09-01")},
            new
            Student{FirstMidName="Meredith",LastName="Alonso",EnrollmentDate=DateTime.Parse("2002-09-01")},
            new Student{FirstMidName="Arturo",LastName="Anand",EnrollmentDate=DateTime.Parse("2003-09-01")},
            new
            Student{FirstMidName="Gytis",LastName="Barzdukas",EnrollmentDate=DateTime.Parse("2002-09-01")},
            new Student{FirstMidName="Yan",LastName="Li",EnrollmentDate=DateTime.Parse("2002-09-01")},
            new Student{FirstMidName="Peggy",LastName="Justice",EnrollmentDate=DateTime.Parse("2001-09-01")},
            new Student{FirstMidName="Laura",LastName="Norman",EnrollmentDate=DateTime.Parse("2003-09-01")},
            new Student{FirstMidName="Nino",LastName="Olivetto",EnrollmentDate=DateTime.Parse("2005-09-01")}
        };
        foreach (Student s in students)
        {
            context.Student.Add(s);
        }
        context.SaveChanges();

        var courses = new Course[]
        {
            new Course{CourseID=1050,Title="Chemistry",Credits=3},
            new Course{CourseID=4022,Title="Microeconomics",Credits=3},
            new Course{CourseID=4041,Title="Macroeconomics",Credits=3},
            new Course{CourseID=1045,Title="Calculus",Credits=4},
            new Course{CourseID=3141,Title="Trigonometry",Credits=4},
            new Course{CourseID=2021,Title="Composition",Credits=3},
            new Course{CourseID=2042,Title="Literature",Credits=4}
        };
        foreach (Course c in courses)
        {
            context.Course.Add(c);
        }
        context.SaveChanges();

        var enrollments = new Enrollment[]
        {
            new Enrollment{StudentID=1,CourseID=1050,Grade=Grade.A},
            new Enrollment{StudentID=1,CourseID=4022,Grade=Grade.C},
            new Enrollment{StudentID=1,CourseID=4041,Grade=Grade.B},
            new Enrollment{StudentID=2,CourseID=1045,Grade=Grade.B},
            new Enrollment{StudentID=2,CourseID=3141,Grade=Grade.F},
            new Enrollment{StudentID=2,CourseID=2021,Grade=Grade.F},
            new Enrollment{StudentID=3,CourseID=1050},
            new Enrollment{StudentID=4,CourseID=1050},
            new Enrollment{StudentID=4,CourseID=4022,Grade=Grade.F},
            new Enrollment{StudentID=5,CourseID=4041,Grade=Grade.C},
            new Enrollment{StudentID=6,CourseID=1045},
            new Enrollment{StudentID=7,CourseID=3141,Grade=Grade.A},
        };
        foreach (Enrollment e in enrollments)
        {
            context.Enrollment.Add(e);
        }
        context.SaveChanges();
    }
}

```

The code checks if there are any students in the DB. If there are no students in the DB, the DB is initialized with test data. It loads test data into arrays rather than `List<T>` collections to optimize performance.

The `EnsureCreated` method automatically creates the DB for the DB context. If the DB exists, `EnsureCreated` returns without modifying the DB.

In `Program.cs`, modify the `Main` method to call `Initialize`:

```
public class Program
{
    public static void Main(string[] args)
    {
        var host = CreateWebHostBuilder(args).Build();

        using (var scope = host.Services.CreateScope())
        {
            var services = scope.ServiceProvider;

            try
            {
                var context = services.GetRequiredService<SchoolContext>();
                // using ContosoUniversity.Data;
                DbInitializer.Initialize(context);
            }
            catch (Exception ex)
            {
                var logger = services.GetRequiredService<ILogger<Program>>();
                logger.LogError(ex, "An error occurred creating the DB.");
            }
        }

        host.Run();
    }

    public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
        WebHost.CreateDefaultBuilder(args)
            .UseStartup<Startup>();
}
```

Delete any student records and restart the app. If the DB is not initialized, set a break point in `Initialize` to diagnose the problem.

## View the DB

Open **SQL Server Object Explorer** (SSOX) from the **View** menu in Visual Studio. In SSOX, click **(localdb)\MSSQLLocalDB > Databases > ContosoUniversity1**.

Expand the **Tables** node.

Right-click the **Student** table and click **View Data** to see the columns created and the rows inserted into the table.

## Asynchronous code

Asynchronous programming is the default mode for ASP.NET Core and EF Core.

A web server has a limited number of threads available, and in high load situations all of the available threads might be in use. When that happens, the server can't process new requests until the threads are freed up. With synchronous code, many threads may be tied up while they aren't actually doing any work

because they're waiting for I/O to complete. With asynchronous code, when a process is waiting for I/O to complete, its thread is freed up for the server to use for processing other requests. As a result, asynchronous code enables server resources to be used more efficiently, and the server is enabled to handle more traffic without delays.

Asynchronous code does introduce a small amount of overhead at run time. For low traffic situations, the performance hit is negligible, while for high traffic situations, the potential performance improvement is substantial.

In the following code, the `async` keyword, `Task<T>` return value, `await` keyword, and `ToListAsync` method make the code execute asynchronously.

```
public async Task OnGetAsync()
{
    Student = await _context.Student.ToListAsync();
}
```

- The `async` keyword tells the compiler to:
  - Generate callbacks for parts of the method body.
  - Automatically create the `Task` object that's returned. For more information, see [Task Return Type](#).
  - The implicit return type `Task` represents ongoing work.
  - The `await` keyword causes the compiler to split the method into two parts. The first part ends with the operation that's started asynchronously. The second part is put into a callback method that's called when the operation completes.
  - `ToListAsync` is the asynchronous version of the `ToList` extension method.

Some things to be aware of when writing asynchronous code that uses EF Core:

- Only statements that cause queries or commands to be sent to the DB are executed asynchronously. That includes, `ToListAsync`, `SingleOrDefaultAsync`, `FirstOrDefaultAsync`, and `SaveChangesAsync`. It doesn't include statements that just change an `IQueryable`, such as

```
var students = context.Students.Where(s => s.LastName == "Davolio") .
```
- An EF Core context isn't thread safe: don't try to do multiple operations in parallel.
- To take advantage of the performance benefits of `async` code, verify that library packages (such as for paging) use `async` if they call EF Core methods that send queries to the DB.

For more information about asynchronous programming in .NET, see [Async Overview](#) and [Asynchronous programming with `async` and `await`](#).

In the next tutorial, basic CRUD (create, read, update, delete) operations are examined.

NEXT

# ASP.NET Core MVC with EF Core - tutorial series

6/21/2018 • 2 minutes to read • [Edit Online](#)

This tutorial teaches ASP.NET Core MVC and Entity Framework Core with controllers and views. Razor Pages is a new alternative in ASP.NET Core 2.0, a page-based programming model that makes building web UI easier and more productive. We recommend the [Razor Pages](#) tutorial over the MVC version. The Razor Pages tutorial:

- Is easier to follow.
- Provides more EF Core best practices.
- Uses more efficient queries.
- Is more current with the latest API.
- Covers more features.
- Is the preferred approach for new application development.

If you choose this tutorial over the [Razor Pages](#) version, let us know why in [this GitHub issue](#).

1. [Get started](#)
2. [Create, Read, Update, and Delete operations](#)
3. [Sorting, filtering, paging, and grouping](#)
4. [Migrations](#)
5. [Create a complex data model](#)
6. [Reading related data](#)
7. [Updating related data](#)
8. [Handle concurrency conflicts](#)
9. [Inheritance](#)
10. [Advanced topics](#)

# Get Started with ASP.NET Core and Entity Framework 6

6/21/2018 • 3 minutes to read • [Edit Online](#)

By Paweł Grudzień, Damien Pontifex, and Tom Dykstra

This article shows how to use Entity Framework 6 in an ASP.NET Core application.

## Overview

To use Entity Framework 6, your project has to compile against .NET Framework, as Entity Framework 6 doesn't support .NET Core. If you need cross-platform features you will need to upgrade to [Entity Framework Core](#).

The recommended way to use Entity Framework 6 in an ASP.NET Core application is to put the EF6 context and model classes in a class library project that targets the full framework. Add a reference to the class library from the ASP.NET Core project. See the sample [Visual Studio solution with EF6 and ASP.NET Core projects](#).

You can't put an EF6 context in an ASP.NET Core project because .NET Core projects don't support all of the functionality that EF6 commands such as *Enable-Migrations* require.

Regardless of project type in which you locate your EF6 context, only EF6 command-line tools work with an EF6 context. For example, `Scaffold-DbContext` is only available in Entity Framework Core. If you need to do reverse engineering of a database into an EF6 model, see [Code First to an Existing Database](#).

## Reference full framework and EF6 in the ASP.NET Core project

Your ASP.NET Core project needs to reference .NET framework and EF6. For example, the `.csproj` file of your ASP.NET Core project will look similar to the following example (only relevant parts of the file are shown).

```
<PropertyGroup>
  <TargetFramework>net452</TargetFramework>
  <PreserveCompilationContext>true</PreserveCompilationContext>
  <AssemblyName>MVCCore</AssemblyName>
  <OutputType>Exe</OutputType>
  <PackageId>MVCCore</PackageId>
</PropertyGroup>
```

When creating a new project, use the **ASP.NET Core Web Application (.NET Framework)** template.

## Handle connection strings

The EF6 command-line tools that you'll use in the EF6 class library project require a default constructor so they can instantiate the context. But you'll probably want to specify the connection string to use in the ASP.NET Core project, in which case your context constructor must have a parameter that lets you pass in the connection string. Here's an example.

```
public class SchoolContext : DbContext
{
    public SchoolContext(string connString) : base(connString)
    {
    }
```

Since your EF6 context doesn't have a parameterless constructor, your EF6 project has to provide an implementation of [IDbContextFactory](#). The EF6 command-line tools will find and use that implementation so they can instantiate the context. Here's an example.

```
public class SchoolContextFactory : IDbContextFactory<SchoolContext>
{
    public SchoolContext Create()
    {
        return new EF6.SchoolContext("Server=
(localdb)\\mssqllocaldb;Database=EF6MVCCore;Trusted_Connection=True;MultipleActiveResultSets=true");
    }
}
```

In this sample code, the `IDbContextFactory` implementation passes in a hard-coded connection string. This is the connection string that the command-line tools will use. You'll want to implement a strategy to ensure that the class library uses the same connection string that the calling application uses. For example, you could get the value from an environment variable in both projects.

## Set up dependency injection in the ASP.NET Core project

In the Core project's `Startup.cs` file, set up the EF6 context for dependency injection (DI) in `ConfigureServices`. EF context objects should be scoped for a per-request lifetime.

```
public void ConfigureServices(IServiceCollection services)
{
    // Add framework services.
    services.AddMvc();
    services.AddScoped<SchoolContext>(_ => new
    SchoolContext(Configuration.GetConnectionString("DefaultConnection")));
}
```

You can then get an instance of the context in your controllers by using DI. The code is similar to what you'd write for an EF Core context:

```
public class StudentsController : Controller
{
    private readonly SchoolContext _context;

    public StudentsController(SchoolContext context)
    {
        _context = context;
    }
}
```

## Sample application

For a working sample application, see the [sample Visual Studio solution](#) that accompanies this article.

This sample can be created from scratch by the following steps in Visual Studio:

- Create a solution.
- **Add New Project > Web > ASP.NET Core Web Application (.NET Framework)**
- **Add New Project > Windows Classic Desktop > Class Library (.NET Framework)**
- In **Package Manager Console** (PMC) for both projects, run the command  
`Install-Package Entityframework`.

- In the class library project, create data model classes and a context class, and an implementation of `IDbContextFactory`.
- In PMC for the class library project, run the commands `Enable-Migrations` and `Add-Migration Initial`. If you have set the ASP.NET Core project as the startup project, add `-StartupProjectName EF6` to these commands.
- In the Core project, add a project reference to the class library project.
- In the Core project, in `Startup.cs`, register the context for DI.
- In the Core project, in `appsettings.json`, add the connection string.
- In the Core project, add a controller and view(s) to verify that you can read and write data. (Note that ASP.NET Core MVC scaffolding won't work with the EF6 context referenced from the class library.)

## Summary

This article has provided basic guidance for using Entity Framework 6 in an ASP.NET Core application.

## Additional resources

- [Entity Framework - Code-Based Configuration](#)

# Azure Storage in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

- [Adding Azure Storage by using Visual Studio Connected Services](#)
- [Get Started with Blob storage and Visual Studio Connected Services](#)
- [Get Started with Queue Storage and Visual Studio Connected Services](#)
- [Get Started with Table Storage and Visual Studio Connected Services](#)

# Client-side development in ASP.NET Core

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# Use Gulp in ASP.NET Core

6/21/2018 • 9 minutes to read • [Edit Online](#)

By [Erik Reitan](#), [Scott Addie](#), [Daniel Roth](#), and [Shayne Boyer](#)

In a typical modern web app, the build process might:

- Bundle and minify JavaScript and CSS files.
- Run tools to call the bundling and minification tasks before each build.
- Compile LESS or SASS files to CSS.
- Compile CoffeeScript or TypeScript files to JavaScript.

A *task runner* is a tool which automates these routine development tasks and more. Visual Studio provides built-in support for two popular JavaScript-based task runners: [Gulp](#) and [Grunt](#).

## Gulp

Gulp is a JavaScript-based streaming build toolkit for client-side code. It's commonly used to stream client-side files through a series of processes when a specific event is triggered in a build environment. For instance, Gulp can be used to automate [bundling and minification](#) or the cleansing of a development environment before a new build.

A set of Gulp tasks is defined in *gulpfile.js*. The following JavaScript includes Gulp modules and specifies file paths to be referenced within the forthcoming tasks:

```
/// <binding Clean='clean' />
"use strict";

var gulp = require("gulp"),
    rimraf = require("rimraf"),
    concat = require("gulp-concat"),
    cssmin = require("gulp-cssmin"),
    uglify = require("gulp-uglify");

var paths = {
    webroot: "./wwwroot/"
};

paths.js = paths.webroot + "js/**/*.js";
paths.minJs = paths.webroot + "js/**/*.min.js";
paths.css = paths.webroot + "css/**/*.css";
paths.minCss = paths.webroot + "css/**/*.min.css";
paths.concatJsDest = paths.webroot + "js/site.min.js";
paths.concatCssDest = paths.webroot + "css/site.min.css";
```

The above code specifies which Node modules are required. The `require` function imports each module so that the dependent tasks can utilize their features. Each of the imported modules is assigned to a variable. The modules can be located either by name or path. In this example, the modules named `gulp`, `rimraf`, `gulp-concat`, `gulp-cssmin`, and `gulp-uglify` are retrieved by name. Additionally, a series of paths are created so that the locations of CSS and JavaScript files can be reused and referenced within the tasks. The following table provides descriptions of the modules included in *gulpfile.js*.

MODULE NAME	DESCRIPTION
gulp	The Gulp streaming build system. For more information, see <a href="#">gulp</a> .
rimraf	A Node deletion module. For more information, see <a href="#">rimraf</a> .
gulp-concat	A module that concatenates files based on the operating system's newline character. For more information, see <a href="#">gulp-concat</a> .
gulp-cssmin	A module that minifies CSS files. For more information, see <a href="#">gulp-cssmin</a> .
gulp-uglify	A module that minifies <code>.js</code> files. For more information, see <a href="#">gulp-uglify</a> .

Once the requisite modules are imported, the tasks can be specified. Here there are six tasks registered, represented by the following code:

```
gulp.task("clean:js", function (cb) {
  rimraf(paths.concatJsDest, cb);
});

gulp.task("clean:css", function (cb) {
  rimraf(paths.concatCssDest, cb);
});

gulp.task("clean", ["clean:js", "clean:css"]);

gulp.task("min:js", function () {
  return gulp.src([paths.js, "!" + paths.minJs], { base: "." })
    .pipe(concat(paths.concatJsDest))
    .pipe(uglify())
    .pipe(gulp.dest("."));
});

gulp.task("min:css", function () {
  return gulp.src([paths.css, "!" + paths.minCss])
    .pipe(concat(paths.concatCssDest))
    .pipe(cssmin())
    .pipe(gulp.dest("."));
});

gulp.task("min", ["min:js", "min:css"]);
```

The following table provides an explanation of the tasks specified in the code above:

TASK NAME	DESCRIPTION
clean:js	A task that uses the rimraf Node deletion module to remove the minified version of the site.js file.
clean:css	A task that uses the rimraf Node deletion module to remove the minified version of the site.css file.
clean	A task that calls the <code>clean:js</code> task, followed by the <code>clean:css</code> task.

TASK NAME	DESCRIPTION
min:js	A task that minifies and concatenates all .js files within the js folder. The .min.js files are excluded.
min:css	A task that minifies and concatenates all .css files within the css folder. The .min.css files are excluded.
min	A task that calls the <code>min:js</code> task, followed by the <code>min:css</code> task.

## Running default tasks

If you haven't already created a new Web app, create a new ASP.NET Web Application project in Visual Studio.

1. Add a new JavaScript file to your project and name it `gulpfile.js`, then copy the following code.

```

/// <binding Clean='clean' />
"use strict";

var gulp = require("gulp"),
    rimraf = require("rimraf"),
    concat = require("gulp-concat"),
    cssmin = require("gulp-cssmin"),
    uglify = require("gulp-uglify");

var paths = {
    webroot: "./wwwroot/"
};

paths.js = paths.webroot + "js/**/*.js";
paths.minJs = paths.webroot + "js/**/*.min.js";
paths.css = paths.webroot + "css/**/*.css";
paths.minCss = paths.webroot + "css/**/*.min.css";
paths.concatJsDest = paths.webroot + "js/site.min.js";
paths.concatCssDest = paths.webroot + "css/site.min.css";

gulp.task("clean:js", function (cb) {
    rimraf(paths.concatJsDest, cb);
});

gulp.task("clean:css", function (cb) {
    rimraf(paths.concatCssDest, cb);
});

gulp.task("clean", ["clean:js", "clean:css"]);

gulp.task("min:js", function () {
    return gulp.src([paths.js, "!" + paths.minJs], { base: "." })
        .pipe(concat(paths.concatJsDest))
        .pipe(uglify())
        .pipe(gulp.dest("."));
});

gulp.task("min:css", function () {
    return gulp.src([paths.css, "!" + paths.minCss])
        .pipe(concat(paths.concatCssDest))
        .pipe(cssmin())
        .pipe(gulp.dest("."));
});

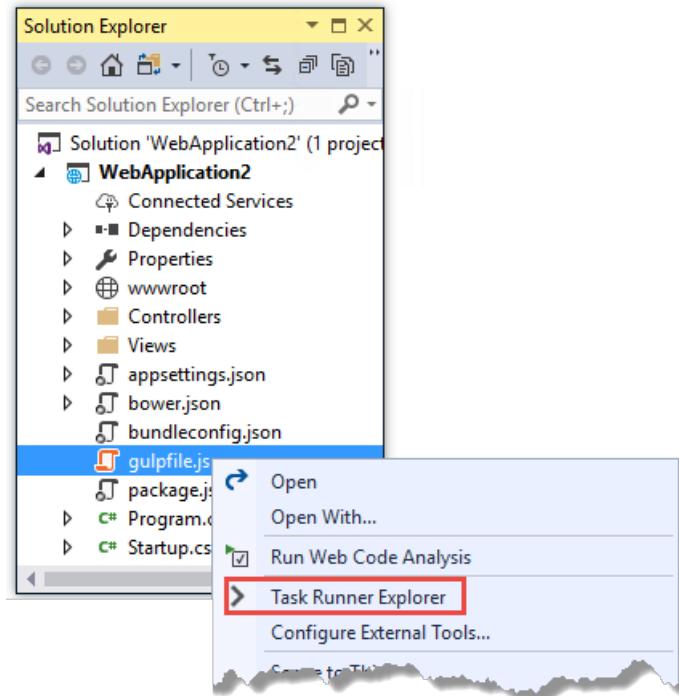
gulp.task("min", ["min:js", "min:css"]);

```

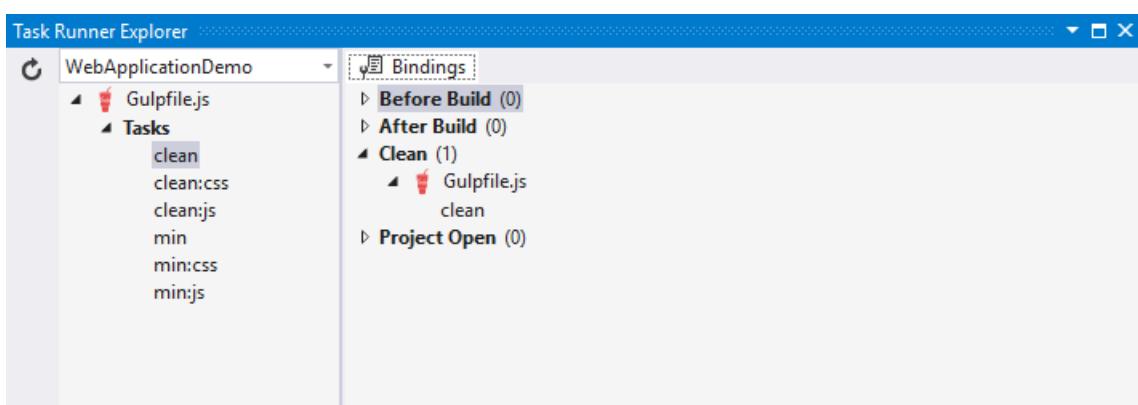
2. Open the `package.json` file (add if not there) and add the following.

```
{  
  "devDependencies": {  
    "gulp": "3.9.1",  
    "gulp-concat": "2.6.1",  
    "gulp-cssmin": "0.1.7",  
    "gulp-uglify": "2.0.1",  
    "rimraf": "2.6.1"  
  }  
}
```

3. In **Solution Explorer**, right-click `gulpfile.js`, and select **Task Runner Explorer**.



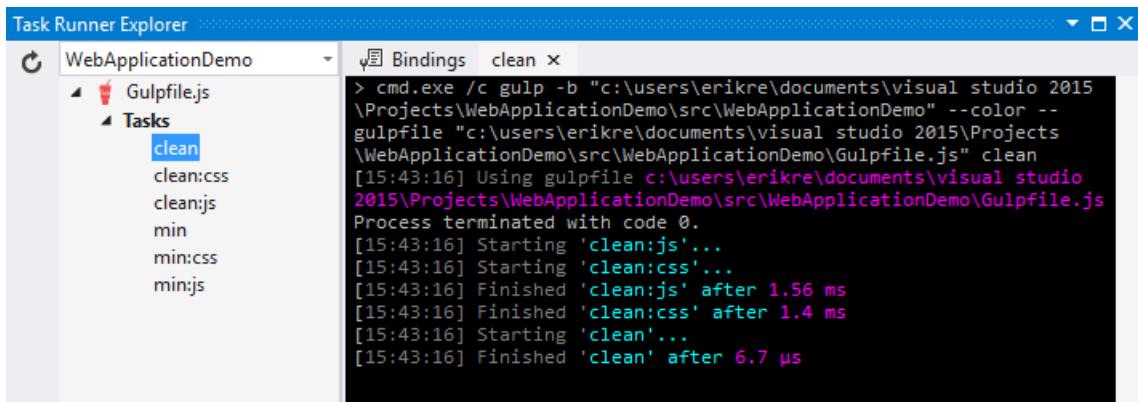
**Task Runner Explorer** shows the list of Gulp tasks. (You might have to click the **Refresh** button that appears to the left of the project name.)



#### IMPORTANT

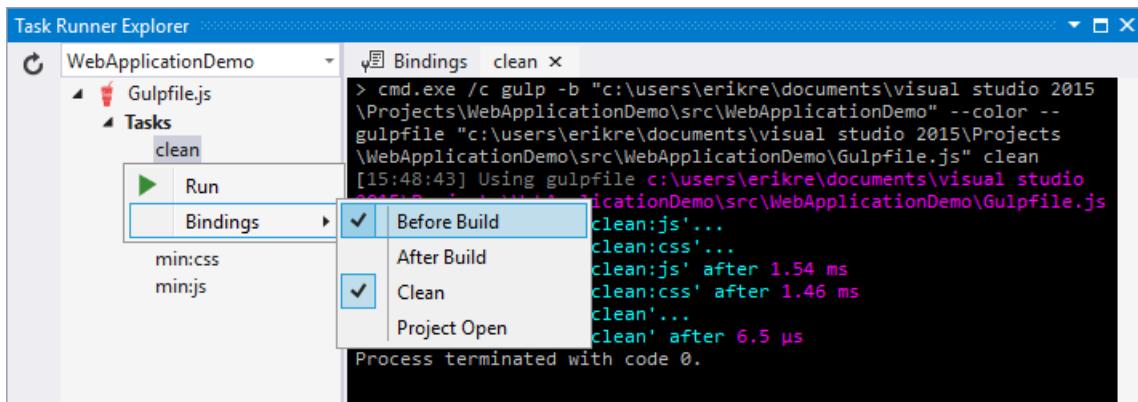
The **Task Runner Explorer** context menu item appears only if `gulpfile.js` is in the root project directory.

4. Underneath **Tasks** in **Task Runner Explorer**, right-click **clean**, and select **Run** from the pop-up menu.



**Task Runner Explorer** will create a new tab named **clean** and execute the clean task as it's defined in *gulpfile.js*.

5. Right-click the **clean** task, then select **Bindings > Before Build**.



The **Before Build** binding configures the clean task to run automatically before each build of the project.

The bindings you set up with **Task Runner Explorer** are stored in the form of a comment at the top of your *gulpfile.js* and are effective only in Visual Studio. An alternative that doesn't require Visual Studio is to configure automatic execution of gulp tasks in your *.csproj* file. For example, put this in your *.csproj* file:

```
<Target Name="MyPreCompileTarget" BeforeTargets="Build">
  <Exec Command="gulp clean" />
</Target>
```

Now the clean task is executed when you run the project in Visual Studio or from a command prompt using the `dotnet run` command (run `npm install` first).

## Defining and running a new task

To define a new Gulp task, modify *gulpfile.js*.

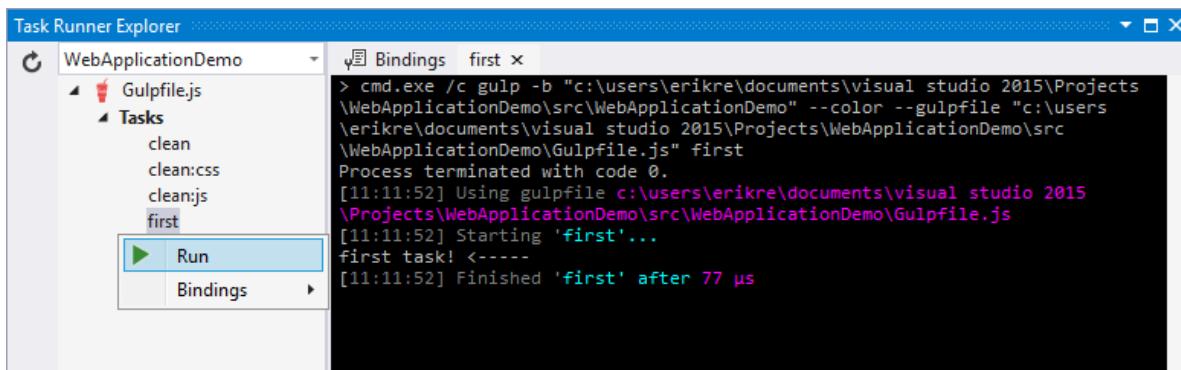
1. Add the following JavaScript to the end of *gulpfile.js*:

```
gulp.task("first", function () {
  console.log('first task! -----');
});
```

This task is named `first`, and it simply displays a string.

2. Save *gulpfile.js*.
3. In **Solution Explorer**, right-click *gulpfile.js*, and select *Task Runner Explorer*.

4. In **Task Runner Explorer**, right-click **first**, and select **Run**.



The output text is displayed. To see examples based on common scenarios, see [Gulp Recipes](#).

## Defining and running tasks in a series

When you run multiple tasks, the tasks run concurrently by default. However, if you need to run tasks in a specific order, you must specify when each task is complete, as well as which tasks depend on the completion of another task.

1. To define a series of tasks to run in order, replace the `first` task that you added above in `gulpfile.js` with the following:

```

gulp.task("series:first", function () {
  console.log('first task! <-----');
});

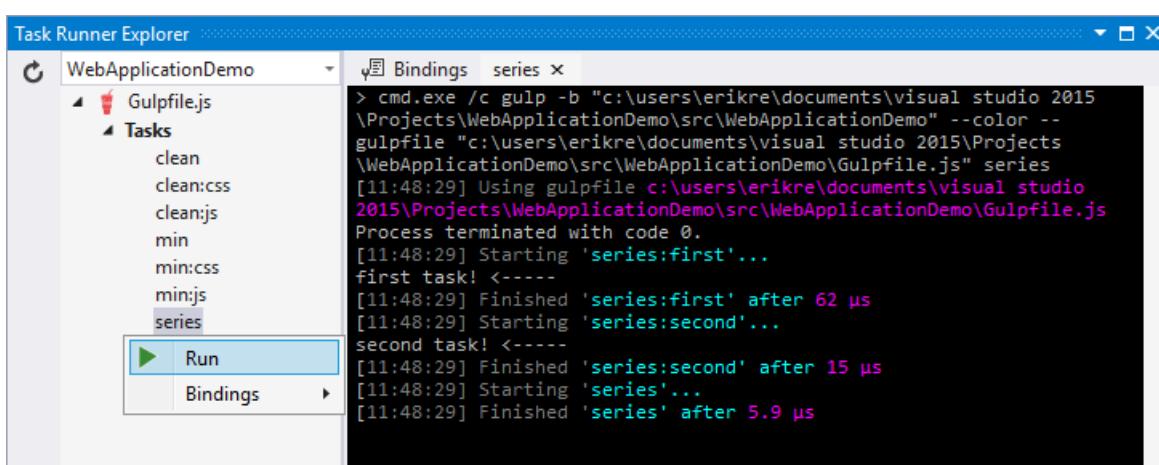
gulp.task("series:second", ["series:first"], function () {
  console.log('second task! <-----');
});

gulp.task("series", ["series:first", "series:second"], function () {});

```

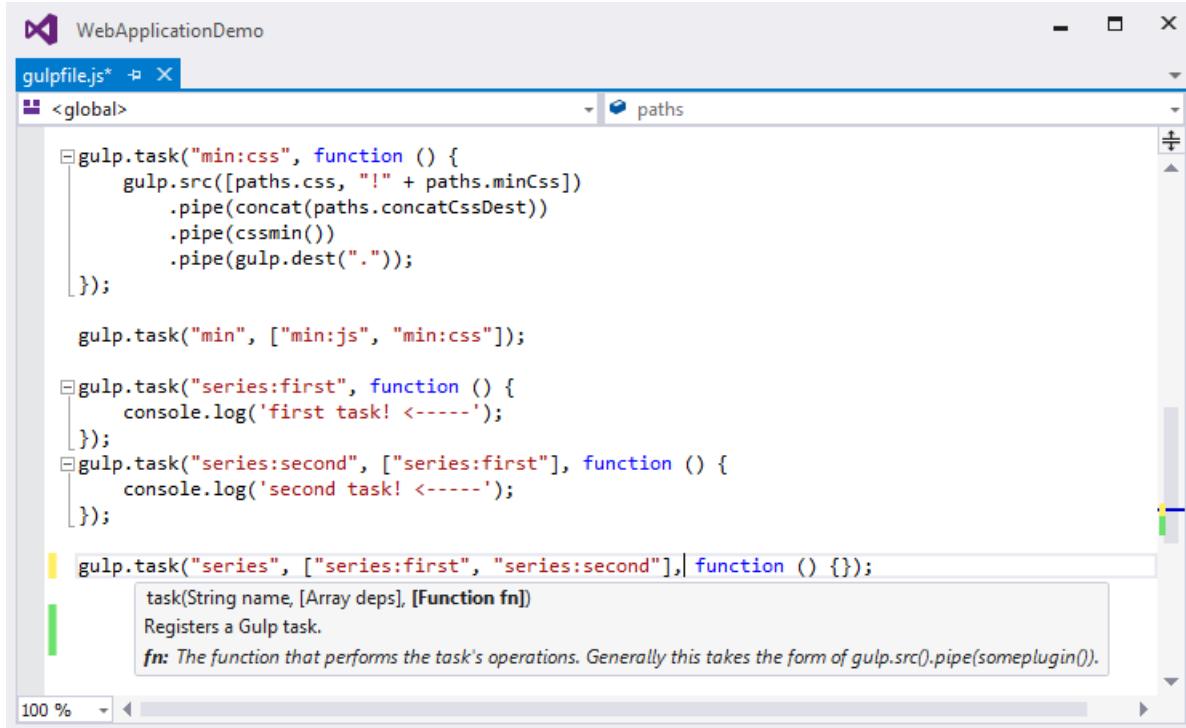
You now have three tasks: `series:first`, `series:second`, and `series`. The `series:second` task includes a second parameter which specifies an array of tasks to be run and completed before the `series:second` task will run. As specified in the code above, only the `series:first` task must be completed before the `series:second` task will run.

2. Save `gulpfile.js`.
3. In **Solution Explorer**, right-click `gulpfile.js` and select **Task Runner Explorer** if it isn't already open.
4. In **Task Runner Explorer**, right-click `series` and select **Run**.



## IntelliSense

IntelliSense provides code completion, parameter descriptions, and other features to boost productivity and to decrease errors. Gulp tasks are written in JavaScript; therefore, IntelliSense can provide assistance while developing. As you work with JavaScript, IntelliSense lists the objects, functions, properties, and parameters that are available based on your current context. Select a coding option from the pop-up list provided by IntelliSense to complete the code.



For more information about IntelliSense, see [JavaScript IntelliSense](#).

## Development, staging, and production environments

When Gulp is used to optimize client-side files for staging and production, the processed files are saved to a local staging and production location. The `_Layout.cshtml` file uses the **environment** tag helper to provide two different versions of CSS files. One version of CSS files is for development and the other version is optimized for both staging and production. In Visual Studio 2017, when you change the **ASPNETCORE\_ENVIRONMENT** environment variable to `Production`, Visual Studio will build the Web app and link to the minimized CSS files. The following markup shows the **environment** tag helpers containing link tags to the `Development` CSS files and the minified `Staging, Production` CSS files.

```

<environment names="Development">
  <script src="~/lib/jquery/dist/jquery.js"></script>
  <script src="~/lib/bootstrap/dist/js/bootstrap.js"></script>
  <script src("~/js/site.js" asp-append-version="true")></script>
</environment>
<environment names="Staging,Production">
  <script src="https://ajax.aspnetcdn.com/ajax/jquery/jquery-2.2.0.min.js"
    asp-fallback-src="~/lib/jquery/dist/jquery.min.js"
    asp-fallback-test="window.jQuery"
    crossorigin="anonymous"
    integrity="sha384-K+ctZQ+LL8q6tP7I94W+qzQsfRV2a+AfhI9k8z8l9ggpc8X+Ytst4yBo/hH+8Fk">
  </script>
  <script src="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/bootstrap.min.js"
    asp-fallback-src="~/lib/bootstrap/dist/js/bootstrap.min.js"
    asp-fallback-test="window.jQuery && window.jQuery.fn && window.jQuery.fn.modal"
    crossorigin="anonymous"
    integrity="sha384-Tc5IQib027qvjSMfHjOMaLkfUWVxZxUPnCJA7l2mCWNIPG9mGCD8wGNICPD7Txa">
  </script>
  <script src "~/js/site.min.js" asp-append-version="true"></script>
</environment>

```

## Switching between environments

To switch between compiling for different environments, modify the **ASPNETCORE\_ENVIRONMENT** environment variable's value.

1. In **Task Runner Explorer**, verify that the **min** task has been set to run **Before Build**.

2. In **Solution Explorer**, right-click the project name and select **Properties**.

The property sheet for the Web app is displayed.

3. Click the **Debug** tab.

4. Set the value of the **Hosting:Environment** environment variable to **Production**.

5. Press **F5** to run the application in a browser.

6. In the browser window, right-click the page and select **View Source** to view the HTML for the page.

Notice that the stylesheet links point to the minified CSS files.

7. Close the browser to stop the Web app.

8. In Visual Studio, return to the property sheet for the Web app and change the **Hosting:Environment** environment variable back to **Development**.

9. Press **F5** to run the application in a browser again.

10. In the browser window, right-click the page and select **View Source** to see the HTML for the page.

Notice that the stylesheet links point to the unminified versions of the CSS files.

For more information related to environments in ASP.NET Core, see [Use multiple environments](#).

## Task and module details

A Gulp task is registered with a function name. You can specify dependencies if other tasks must run before the current task. Additional functions allow you to run and watch the Gulp tasks, as well as set the source (*src*) and destination (*dest*) of the files being modified. The following are the primary Gulp API functions:

GULP FUNCTION	SYNTAX	DESCRIPTION
task	<code>gulp.task(name[, deps], fn) { }</code>	The <code>task</code> function creates a task. The <code>name</code> parameter defines the name of the task. The <code>deps</code> parameter contains an array of tasks to be completed before this task runs. The <code>fn</code> parameter represents a callback function which performs the operations of the task.
watch	<code>gulp.watch(glob [, opts], tasks)</code> <code>{ }</code>	The <code>watch</code> function monitors files and runs tasks when a file change occurs. The <code>glob</code> parameter is a <code>string</code> or <code>array</code> that determines which files to watch. The <code>opts</code> parameter provides additional file watching options.
src	<code>gulp.src(globs[, options]) { }</code>	The <code>src</code> function provides files that match the glob value(s). The <code>glob</code> parameter is a <code>string</code> or <code>array</code> that determines which files to read. The <code>options</code> parameter provides additional file options.
dest	<code>gulp.dest(path[, options]) { }</code>	The <code>dest</code> function defines a location to which files can be written. The <code>path</code> parameter is a string or function that determines the destination folder. The <code>options</code> parameter is an object that specifies output folder options.

For additional Gulp API reference information, see [Gulp Docs API](#).

## Gulp recipes

The Gulp community provides Gulp [Recipes](#). These recipes consist of Gulp tasks to address common scenarios.

## Additional resources

- [Gulp documentation](#)
- [Bundling and minification in ASP.NET Core](#)
- [Use Grunt in ASP.NET Core](#)

# Use Grunt in ASP.NET Core

6/21/2018 • 8 minutes to read • [Edit Online](#)

By [Noel Rice](#)

Grunt is a JavaScript task runner that automates script minification, TypeScript compilation, code quality "lint" tools, CSS pre-processors, and just about any repetitive chore that needs doing to support client development. Grunt is fully supported in Visual Studio, though the ASP.NET project templates use Gulp by default (see [Use Gulp](#)).

This example uses an empty ASP.NET Core project as its starting point, to show how to automate the client build process from scratch.

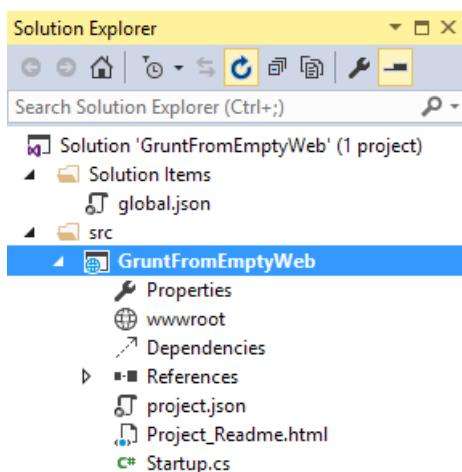
The finished example cleans the target deployment directory, combines JavaScript files, checks code quality, condenses JavaScript file content and deploys to the root of your web application. We will use the following packages:

- **grunt**: The Grunt task runner package.
- **grunt-contrib-clean**: A plugin that removes files or directories.
- **grunt-contrib-jshint**: A plugin that reviews JavaScript code quality.
- **grunt-contrib-concat**: A plugin that joins files into a single file.
- **grunt-contrib-uglify**: A plugin that minifies JavaScript to reduce size.
- **grunt-contrib-watch**: A plugin that watches file activity.

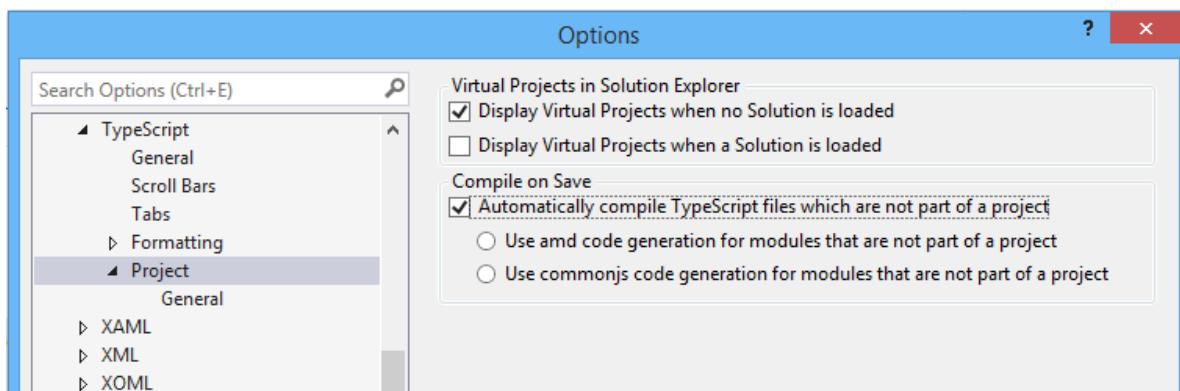
## Preparing the application

To begin, set up a new empty web application and add TypeScript example files. TypeScript files are automatically compiled into JavaScript using default Visual Studio settings and will be our raw material to process using Grunt.

1. In Visual Studio, create a new `ASP.NET Web Application`.
2. In the **New ASP.NET Project** dialog, select the ASP.NET Core **Empty** template and click the OK button.
3. In the Solution Explorer, review the project structure. The `\src` folder includes empty `wwwroot` and `Dependencies` nodes.



- Add a new folder named `TypeScript` to your project directory.
- Before adding any files, make sure that Visual Studio has the option 'compile on save' for TypeScript files checked. Navigate to **Tools > Options > Text Editor > Typescript > Project**:



- Right-click the `TypeScript` directory and select **Add > New Item** from the context menu. Select the **JavaScript file** item and name the file `Tastes.ts` (note the `.ts` extension). Copy the line of TypeScript code below into the file (when you save, a new `Tastes.js` file will appear with the JavaScript source).

```
enum Tastes { Sweet, Sour, Salty, Bitter }
```

- Add a second file to the `TypeScript` directory and name it `Food.ts`. Copy the code below into the file.

```
class Food {
    constructor(name: string, calories: number) {
        this._name = name;
        this._calories = calories;
    }

    private _name: string;
    get Name() {
        return this._name;
    }

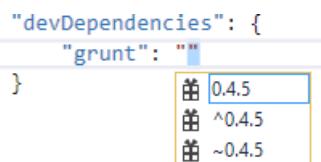
    private _calories: number;
    get Calories() {
        return this._calories;
    }

    private _taste: Tastes;
    get Taste(): Tastes { return this._taste }
    set Taste(value: Tastes) {
        this._taste = value;
    }
}
```

## Configuring NPM

Next, configure NPM to download grunt and grunt-tasks.

- In the Solution Explorer, right-click the project and select **Add > New Item** from the context menu. Select the **NPM configuration file** item, leave the default name, `package.json`, and click the **Add** button.
- In the `package.json` file, inside the `devDependencies` object braces, enter "grunt". Select `grunt` from the Intellisense list and press the Enter key. Visual Studio will quote the grunt package name, and add a colon. To the right of the colon, select the latest stable version of the package from the top of the Intellisense list (press `Ctrl-Space` if Intellisense doesn't appear).



#### NOTE

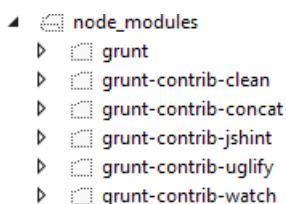
NPM uses [semantic versioning](#) to organize dependencies. Semantic versioning, also known as SemVer, identifies packages with the numbering scheme ... Intellisense simplifies semantic versioning by showing only a few common choices. The top item in the Intellisense list (0.4.5 in the example above) is considered the latest stable version of the package. The caret (^) symbol matches the most recent major version and the tilde (~) matches the most recent minor version. See the [NPM semver version parser reference](#) as a guide to the full expressivity that SemVer provides.

3. Add more dependencies to load grunt-contrib-\* packages for *clean*, *jshint*, *concat*, *uglify*, and *watch* as shown in the example below. The versions don't need to match the example.

```
"devDependencies": {  
  "grunt": "0.4.5",  
  "grunt-contrib-clean": "0.6.0",  
  "grunt-contrib-jshint": "0.11.0",  
  "grunt-contrib-concat": "0.5.1",  
  "grunt-contrib-uglify": "0.8.0",  
  "grunt-contrib-watch": "0.6.1"  
}
```

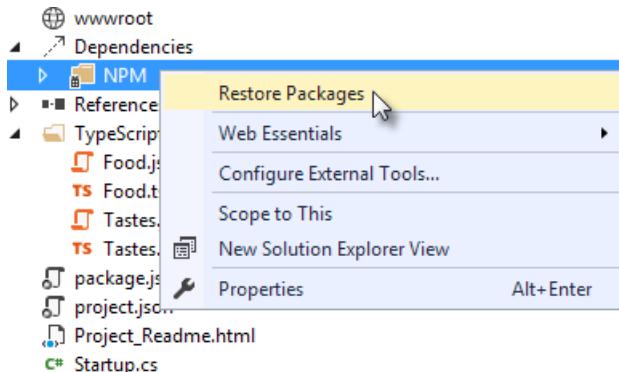
4. Save the *package.json* file.

The packages for each devDependencies item will download, along with any files that each package requires. You can find the package files in the `node_modules` directory by enabling the **Show All Files** button in the Solution Explorer.



#### NOTE

If you need to, you can manually restore dependencies in Solution Explorer by right-clicking on `Dependencies\NPM` and selecting the **Restore Packages** menu option.



## Configuring Grunt

Grunt is configured using a manifest named *Gruntfile.js* that defines, loads and registers tasks that can be run manually or configured to run automatically based on events in Visual Studio.

1. Right-click the project and select **Add > New Item**. Select the **Grunt Configuration file** option, leave the default name, *Gruntfile.js*, and click the **Add** button.

The initial code includes a module definition and the `grunt.initConfig()` method. The `initConfig()` is used to set options for each package, and the remainder of the module will load and register tasks.

```
module.exports = function (grunt) {  
  grunt.initConfig({  
  });  
};
```

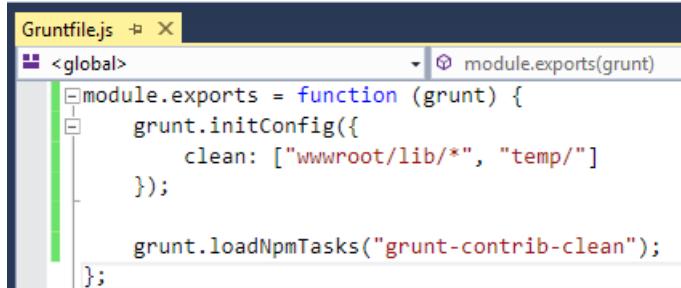
2. Inside the `initConfig()` method, add options for the `clean` task as shown in the example *Gruntfile.js* below. The clean task accepts an array of directory strings. This task removes files from `wwwroot/lib` and removes the entire `/temp` directory.

```
module.exports = function (grunt) {  
  grunt.initConfig({  
    clean: ["wwwroot/lib/*", "temp/"],  
  });  
};
```

3. Below the `initConfig()` method, add a call to `grunt.loadNpmTasks()`. This will make the task runnable from Visual Studio.

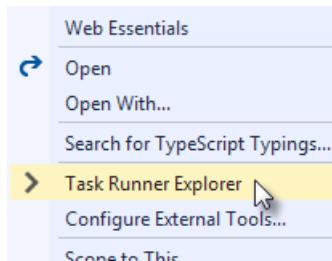
```
grunt.loadNpmTasks("grunt-contrib-clean");
```

4. Save *Gruntfile.js*. The file should look something like the screenshot below.

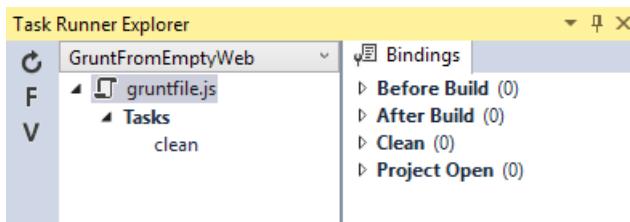


```
Gruntfile.js  ↗ X  
  ↗ <global>  ↗ module.exports(grunt)  
    ↗ module.exports = function (grunt) {  
      ↗ grunt.initConfig({  
        ↗ clean: ["wwwroot/lib/*", "temp/"]  
      });  
      ↗ grunt.loadNpmTasks("grunt-contrib-clean");  
    };
```

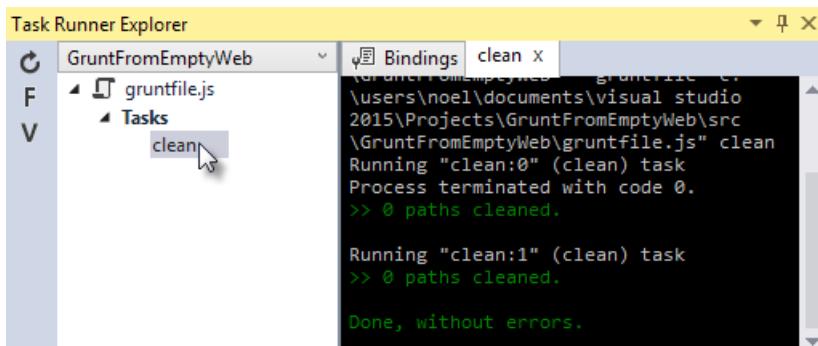
5. Right-click *Gruntfile.js* and select **Task Runner Explorer** from the context menu. The Task Runner Explorer window will open.



6. Verify that `clean` shows under **Tasks** in the Task Runner Explorer.



7. Right-click the clean task and select **Run** from the context menu. A command window displays progress of the task.



#### NOTE

There are no files or directories to clean yet. If you like, you can manually create them in the Solution Explorer and then run the clean task as a test.

8. In the `initConfig()` method, add an entry for `concat` using the code below.

The `src` property array lists files to combine, in the order that they should be combined. The `dest` property assigns the path to the combined file that's produced.

```
concat: {  
  all: {  
    src: ['TypeScript/Tastes.js', 'TypeScript/Food.js'],  
    dest: 'temp/combined.js'  
  }  
},
```

#### NOTE

The `all` property in the code above is the name of a target. Targets are used in some Grunt tasks to allow multiple build environments. You can view the built-in targets using Intellisense or assign your own.

9. Add the `jshint` task using the code below.

The `jshint` code-quality utility is run against every JavaScript file found in the `temp` directory.

```
jshint: {  
  files: ['temp/*.js'],  
  options: {  
    '-W069': false,  
  }  
},
```

#### NOTE

The option "-W069" is an error produced by jshint when JavaScript uses bracket syntax to assign a property instead of dot notation, i.e. `Tastes["Sweet"]` instead of `Tastes.Sweet`. The option turns off the warning to allow the rest of the process to continue.

10. Add the `uglify` task using the code below.

The task minifies the `combined.js` file found in the `temp` directory and creates the result file in `wwwroot/lib` following the standard naming convention `<file name>.min.js`.

```
uglify: {  
  all: {  
    src: ['temp/combined.js'],  
    dest: 'wwwroot/lib/combined.min.js'  
  }  
},
```

11. Under the call `grunt.loadNpmTasks()` that loads `grunt-contrib-clean`, include the same call for `jshint`, `concat` and `uglify` using the code below.

```
grunt.loadNpmTasks('grunt-contrib-jshint');  
grunt.loadNpmTasks('grunt-contrib-concat');  
grunt.loadNpmTasks('grunt-contrib-uglify');
```

12. Save `Gruntfile.js`. The file should look something like the example below.

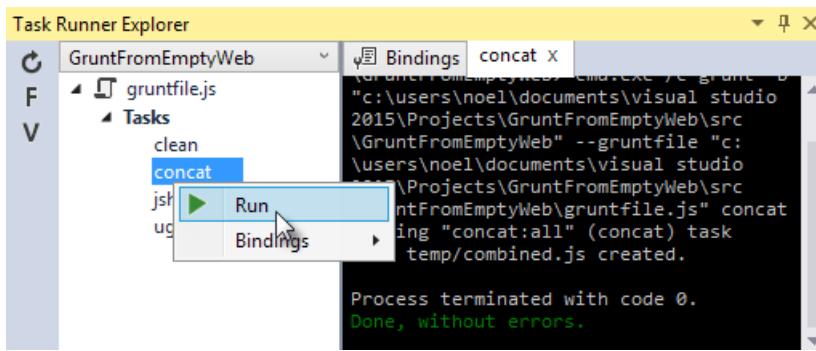


A screenshot of the Visual Studio Task Runner Explorer. The title bar says "Gruntfile.js". The tasks list shows the following configuration:

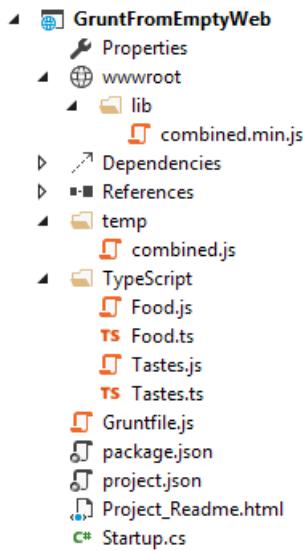
```
module.exports = function (grunt) {  
  grunt.initConfig({  
    clean: ["wwwroot/lib/*", "temp/*"],  
    concat: {  
      all: {  
        src: ['TypeScript/Tastes.js', 'TypeScript/Food.js'],  
        dest: 'temp/combined.js'  
      }  
    },  
    jshint: { files: ['temp/*.js'], options: { '-W069': false, } },  
    uglify: {  
      all: {  
        src: ['temp/combined.js'],  
        dest: 'wwwroot/lib/combined.min.js'  
      }  
    }  
  });  
  
  grunt.loadNpmTasks('grunt-contrib-clean');  
  grunt.loadNpmTasks('grunt-contrib-jshint');  
  grunt.loadNpmTasks('grunt-contrib-concat');  
  grunt.loadNpmTasks('grunt-contrib-uglify');  
};
```

The "Task Runner Explorer Tasks" list includes `clean`, `concat`, `jshint` and `uglify` tasks. A small orange bull icon is visible in the bottom right corner of the editor window.

13. Notice that the Task Runner Explorer Tasks list includes `clean`, `concat`, `jshint` and `uglify` tasks. Run each task in order and observe the results in Solution Explorer. Each task should run without errors.



The concat task creates a new *combined.js* file and places it into the temp directory. The jshint task simply runs and doesn't produce output. The uglify task creates a new *combined.min.js* file and places it into wwwroot/lib. On completion, the solution should look something like the screenshot below:



#### NOTE

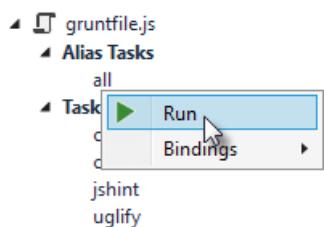
For more information on the options for each package, visit <https://www.npmjs.com/> and lookup the package name in the search box on the main page. For example, you can look up the grunt-contrib-clean package to get a documentation link that explains all of its parameters.

### All together now

Use the Grunt `registerTask()` method to run a series of tasks in a particular sequence. For example, to run the example steps above in the order clean -> concat -> jshint -> uglify, add the code below to the module. The code should be added to the same level as the `loadNpmTasks()` calls, outside `initConfig`.

```
grunt.registerTask("all", ['clean', 'concat', 'jshint', 'uglify']);
```

The new task shows up in Task Runner Explorer under Alias Tasks. You can right-click and run it just as you would other tasks. The `all` task will run `clean`, `concat`, `jshint` and `uglify`, in order.



## Watching for changes

A `watch` task keeps an eye on files and directories. The watch triggers tasks automatically if it detects changes.

Add the code below to `initConfig` to watch for changes to `*.js` files in the TypeScript directory. If a JavaScript file is changed, `watch` will run the `all` task.

```
watch: {  
  files: ["TypeScript/*.js"],  
  tasks: ["all"]  
}
```

Add a call to `loadNpmTasks()` to show the `watch` task in Task Runner Explorer.

```
grunt.loadNpmTasks('grunt-contrib-watch');
```

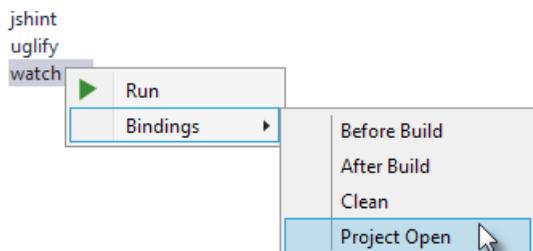
Right-click the `watch` task in Task Runner Explorer and select Run from the context menu. The command window that shows the `watch` task running will display a "Waiting..." message. Open one of the TypeScript files, add a space, and then save the file. This will trigger the `watch` task and trigger the other tasks to run in order. The screenshot below shows a sample run.

```
Bindings watch (running) x  
2015\Projects\GruntFromEmptyWeb\src  
\GruntFromEmptyWeb" --gruntfile "c:  
\users\noel\documents\visual studio  
2015\Projects\GruntFromEmptyWeb\src  
\GruntFromEmptyWeb\gruntfile.js" watch  
Running "watch" task  
Waiting...  
>> File "TypeScript\Tastes.js" changed.  
Running "clean:0" (clean) task  
>> 1 path cleaned.  
  
Running "clean:1" (clean) task  
>> 1 path cleaned.  
  
Running "concat:all" (concat) task  
File temp/combined.js created.  
  
Running "jshint:files" (jshint) task  
>> 1 file lint free.  
  
Running "uglify:all" (uglify) task  
>> 1 file created.  
  
Done, without errors.  
Completed in 1.236s at Fri Mar 13 2015  
17:12:36 GMT-0700 (Pacific Daylight  
Time) - Waiting...
```

## Binding to Visual Studio events

Unless you want to manually start your tasks every time you work in Visual Studio, you can bind tasks to **Before Build**, **After Build**, **Clean**, and **Project Open** events.

Let's bind `watch` so that it runs every time Visual Studio opens. In Task Runner Explorer, right-click the `watch` task and select **Bindings > Project Open** from the context menu.



Unload and reload the project. When the project loads again, the `watch` task will start running automatically.

## Summary

Grunt is a powerful task runner that can be used to automate most client-build tasks. Grunt leverages NPM to deliver its packages, and features tooling integration with Visual Studio. Visual Studio's Task Runner Explorer detects changes to configuration files and provides a convenient interface to run tasks, view running tasks, and bind tasks to Visual Studio events.

## Additional resources

- [Use Gulp](#)

# Manage client-side packages with Bower in ASP.NET Core

6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [Noel Rice](#), and [Scott Addie](#)

## IMPORTANT

While Bower is maintained, its maintainers recommend using a different solution. [Library Manager](#) (LibMan for short) is Visual Studio's new client-side static content management system (Visual Studio 15.8 or later). For more information, see [Library Manager: Client-side content manager for web apps](#). Bower is supported in Visual Studio through version 15.5.

Yarn with Webpack is one popular alternative for which [migration instructions](#) are available.

Bower calls itself "A package manager for the web". Within the .NET ecosystem, it fills the void left by NuGet's inability to deliver static content files. For ASP.NET Core projects, these static files are inherent to client-side libraries like [jQuery](#) and [Bootstrap](#). For .NET libraries, you still use [NuGet](#) package manager.

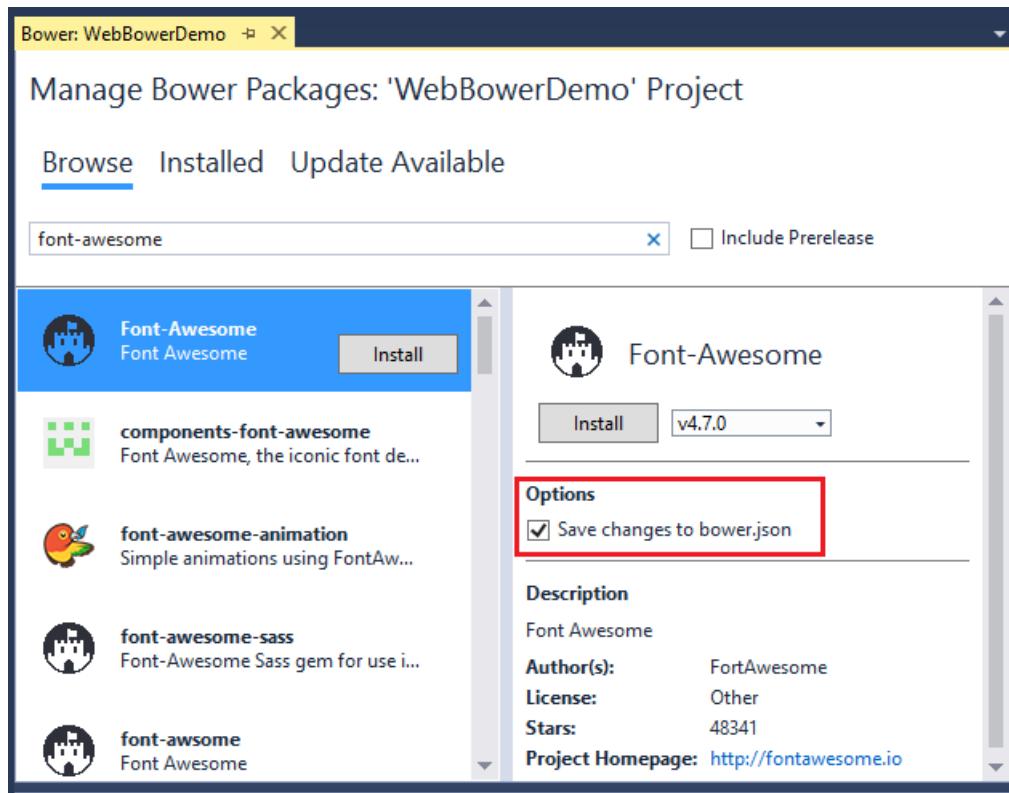
New projects created with the ASP.NET Core project templates set up the client-side build process. [jQuery](#) and [Bootstrap](#) are installed, and Bower is supported.

Client-side packages are listed in the *bower.json* file. The ASP.NET Core project templates configures *bower.json* with jQuery, jQuery validation, and Bootstrap.

In this tutorial, we'll add support for [Font Awesome](#). Bower packages can be installed with the **Manage Bower Packages** UI or manually in the *bower.json* file.

## Installation via Manage Bower Packages UI

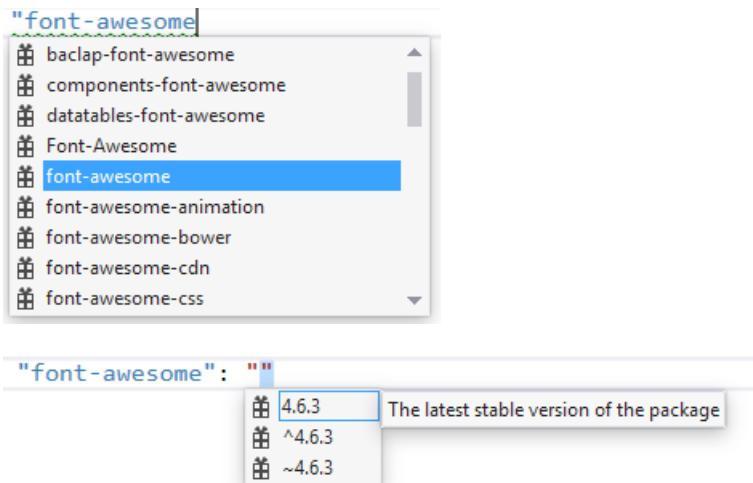
- Create a new ASP.NET Core Web app with the **ASP.NET Core Web Application (.NET Core)** template. Select **Web Application** and **No Authentication**.
- Right-click the project in Solution Explorer and select **Manage Bower Packages** (alternatively from the main menu, **Project > Manage Bower Packages**).
- In the **Bower: <project name>** window, click the "Browse" tab, and then filter the packages list by entering `font-awesome` in the search box:



- Confirm that the "Save changes to *bower.json*" checkbox is checked. Select a version from the drop-down list and click the **Install** button. The **Output** window shows the installation details.

### Manual installation in *bower.json*

Open the *bower.json* file and add "font-awesome" to the dependencies. IntelliSense shows the available packages. When a package is selected, the available versions are displayed. The images below are older and won't match what you see.



Bower uses [semantic versioning](#) to organize dependencies. Semantic versioning, also known as SemVer, identifies packages with the numbering scheme <major>.<minor>.<patch>. IntelliSense simplifies semantic versioning by showing only a few common choices. The top item in the IntelliSense list (4.6.3 in the example above) is considered the latest stable version of the package. The caret (^) symbol matches the most recent major version and the tilde (~) matches the most recent minor version.

Save the *bower.json* file. Visual Studio watches the *bower.json* file for changes. Upon saving, the *bower install* command is executed. See the Output window's **Bower/npm** view for the exact command executed.

Open the *.bowerrc* file under *bower.json*. The `directory` property is set to `wwwroot/lib` which indicates the location Bower will install the package assets.

```
{  
  "directory": "wwwroot/lib"  
}
```

You can use the search box in Solution Explorer to find and display the font-awesome package.

Open the `Views\Shared_Layout.cshtml` file and add the font-awesome CSS file to the environment [Tag Helper for Development](#). From Solution Explorer, drag and drop `font-awesome.css` inside the `<environment names="Development">` element.

```
<environment names="Development">  
  <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />  
  <link rel="stylesheet" href("~/css/site.css" />  
  <link href="~/lib/font-awesome/css/font-awesome.css" rel="stylesheet" />  
</environment>
```

In a production app you would add `font-awesome.min.css` to the environment tag helper for [Staging,Production](#).

Replace the contents of the `Views\Home\About.cshtml` Razor file with the following markup:

```
@{  
  ViewData["Title"] = "About";  
}  
  
<div class="list-group">  
  <a class="list-group-item" href="#"></i>&nbsp; Home</a>  
  <a class="list-group-item" href="#"></i>&nbsp; Library</a>  
  <a class="list-group-item" href="#"></i>&nbsp;  
Applications</a>  
  <a class="list-group-item" href="#"></i>&nbsp; Settings</a>  
</div>
```

Run the app and navigate to the About view to verify the font-awesome package works.

## Exploring the client-side build process

Most ASP.NET Core project templates are already configured to use Bower. This next walkthrough starts with an empty ASP.NET Core project and adds each piece manually, so you can get a feel for how Bower is used in a project. You can see what happens to the project structure and the runtime output as each configuration change is made.

The general steps to use the client-side build process with Bower are:

- Define packages used in your project.
- Reference packages from your web pages.

### Define packages

Once you list packages in the `bower.json` file, Visual Studio will download them. The following example uses Bower to load jQuery and Bootstrap to the `wwwroot` folder.

- Create a new ASP.NET Core Web app with the **ASP.NET Core Web Application (.NET Core)** template. Select the **Empty** project template and click **OK**.
- In Solution Explorer, right-click the project > **Add New Item** and select **Bower Configuration File**. Note: A `.bowerrc` file is also added.
- Open `bower.json`, and add jquery and bootstrap to the `dependencies` section. The resulting `bower.json` file

will look like the following example. The versions will change over time and may not match the image below.

```
{  
  "name": "asp.net",  
  "private": true,  
  "dependencies": {  
    "jquery": "3.1.1",  
    "bootstrap": "3.3.7"  
  }  
}
```

- Save the *bower.json* file.

Verify the project includes the *bootstrap* and *jQuery* directories in *wwwroot/lib*. Bower uses the *.bowerrc* file to install the assets in *wwwroot/lib*.

Note: The "Manage Bower Packages" UI provides an alternative to manual file editing.

## Enable static files

- Add the `Microsoft.AspNetCore.StaticFiles` NuGet package to the project.
- Enable static files to be served with the [Static file middleware](#). Add a call to `UseStaticFiles` to the `Configure` method of `Startup`.

```
using Microsoft.AspNetCore.Builder;  
using Microsoft.AspNetCore.Hosting;  
using Microsoft.AspNetCore.Http;  
  
public class Startup  
{  
  public void Configure(IApplicationBuilder app)  
  {  
    app.UseStaticFiles();  
  
    app.Run(async (context) =>  
    {  
      await context.Response.WriteAsync("Hello World!");  
    });  
  }  
}
```

## Reference packages

In this section, you will create an HTML page to verify it can access the deployed packages.

- Add a new HTML page named *Index.html* to the *wwwroot* folder. Note: You must add the HTML file to the *wwwroot* folder. By default, static content cannot be served outside *wwwroot*. See [Static files](#) for more information.

Replace the contents of *Index.html* with the following markup:

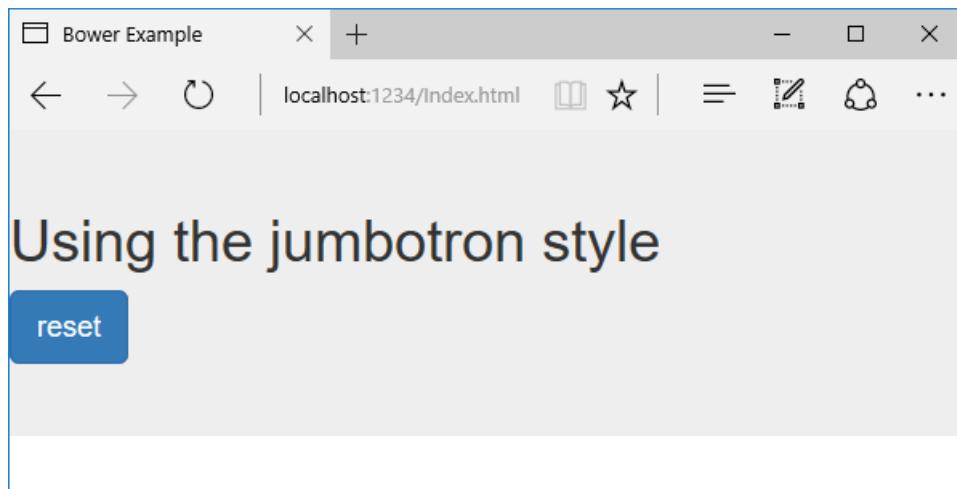
```

<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8" />
    <title>Bower Example</title>
    <link href="lib/bootstrap/dist/css/bootstrap.css" rel="stylesheet" />
</head>
<body>
    <div class="jumbotron">
        <h1>Using the jumbotron style</h1>
        <p>
            <a class="btn btn-primary btn-lg" role="button">Stateful button</a>
        </p>
    </div>
    <script src="lib/jquery/dist/jquery.js"></script>
    <script src="lib/bootstrap/dist/js/bootstrap.js"></script>
    <script>
        $(".btn").click(function () {
            $(this).text('loading')
                .delay(1000)
                .queue(function () {
                    $(this).text('reset');
                    $(this).dequeue();
                });
        });
    </script>
</body>

</html>

```

- Run the app and navigate to `http://localhost:<port>/Index.html`. Alternatively, with `Index.html` opened, press `Ctrl+Shift+W`. Verify that the jumbotron styling is applied, the jQuery code responds when the button is clicked, and that the Bootstrap button changes state.



# Build beautiful, responsive sites with Bootstrap and ASP.NET Core

6/21/2018 • 11 minutes to read • [Edit Online](#)

By [Steve Smith](#)

Bootstrap is currently the most popular web framework for developing responsive web applications. It offers a number of features and benefits that can improve your users' experience with your web site, whether you're a novice at front-end design and development or an expert. Bootstrap is deployed as a set of CSS and JavaScript files, and is designed to help your website or application scale efficiently from phones to tablets to desktops.

## Get started

There are several ways to get started with Bootstrap. If you're starting a new web application in Visual Studio, you can choose the default starter template for ASP.NET Core, in which case Bootstrap will come pre-installed:



Adding Bootstrap to an ASP.NET Core project is simply a matter of adding it to *bower.json* as a dependency:

```
{
  "name": "asp.net",
  "private": true,
  "dependencies": {
    "bootstrap": "3.3.6",
    "jquery": "2.2.0",
    "jquery-validation": "1.14.0",
    "jquery-validation-unobtrusive": "3.2.6"
  }
}
```

This is the recommended way to add Bootstrap to an ASP.NET Core project.

You can also install bootstrap using one of several package managers, such as Bower, npm, or NuGet. In each case, the process is essentially the same:

### Bower

```
bower install bootstrap
```

## npm

```
npm install bootstrap
```

## NuGet

```
Install-Package bootstrap
```

### NOTE

The recommended way to install client-side dependencies like Bootstrap in ASP.NET Core is via Bower (using `bower.json`, as shown above). The use of npm/NuGet are shown to demonstrate how easily Bootstrap can be added to other kinds of web applications, including earlier versions of ASP.NET.

If you're referencing your own local versions of Bootstrap, you'll need to reference them in any pages that will use it. In production you should reference bootstrap using a CDN. In the default ASP.NET site template, the `_Layout.cshtml` file does so like this:

```
<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>@ViewData["Title"] - WebApplication1</title>

    <environment names="Development">
        <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />
        <link rel="stylesheet" href="~/css/site.css" />
    </environment>
    <environment names="Staging,Production">
        <link rel="stylesheet" href="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.6/css/bootstrap.min.css"
              asp-fallback-href="~/lib/bootstrap/dist/css/bootstrap.min.css"
              asp-fallback-test-class="sr-only" asp-fallback-test-property="position" asp-fallback-test-value="absolute" />
        <link rel="stylesheet" href="~/css/site.min.css" asp-append-version="true" />
    </environment>
</head>
<body>
    <div class="navbar navbar-inverse navbar-fixed-top">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a asp-area="" asp-controller="Home" asp-action="Index" class="navbar-brand">WebApplication1</a>
            </div>
            <div class="navbar-collapse collapse">
                <ul class="nav navbar-nav">
                    <li><a asp-area="" asp-controller="Home" asp-action="Index">Home</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="About">About</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="Contact">Contact</a></li>
                </ul>
                @await Html.PartialAsync("LoginPartial")
            </div>
        </div>
    </div>
</body>
```

```

</div>
</div>
</div>
<div class="container body-content">
    @RenderBody()
    <hr />
    <footer>
        <p>&copy; 2016 - WebApplication1</p>
    </footer>
</div>

<environment names="Development">
    <script src="~/lib/jquery/dist/jquery.js"></script>
    <script src="~/lib/bootstrap/dist/js/bootstrap.js"></script>
    <script src="~/js/site.js" asp-append-version="true"></script>
</environment>
<environment names="Staging,Production">
    <script src="https://ajax.aspnetcdn.com/ajax/jquery/jquery-2.2.0.min.js"
        asp-fallback-src="~/lib/jquery/dist/jquery.min.js"
        asp-fallback-test="window.jQuery">
    </script>
    <script src="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.6/bootstrap.min.js"
        asp-fallback-src="~/lib/bootstrap/dist/js/bootstrap.min.js"
        asp-fallback-test="window.jQuery && window.jQuery.fn && window.jQuery.fn.modal">
    </script>
    <script src="~/js/site.min.js" asp-append-version="true"></script>
</environment>

    @RenderSection("scripts", required: false)
</body>
</html>

```

#### NOTE

If you're going to be using any of Bootstrap's jQuery plugins, you will also need to reference jQuery.

## Basic templates and features

The most basic Bootstrap template looks very much like the `_Layout.cshtml` file shown above, and simply includes a basic menu for navigation and a place to render the rest of the page.

### Basic navigation

The default template uses a set of `<div>` elements to render a top navbar and the main body of the page. If you're using HTML5, you can replace the first `<div>` tag with a `<nav>` tag to get the same effect, but with more precise semantics. Within this first `<div>` you can see there are several others. First, a `<div>` with a class of "container", and then within that, two more `<div>` elements: "navbar-header" and "navbar-collapse". The navbar-header div includes a button that will appear when the screen is below a certain minimum width, showing 3 horizontal lines (a so-called "hamburger icon"). The icon is rendered using pure HTML and CSS; no image is required. This is the code that displays the icon, with each of the tags rendering one of the white bars:

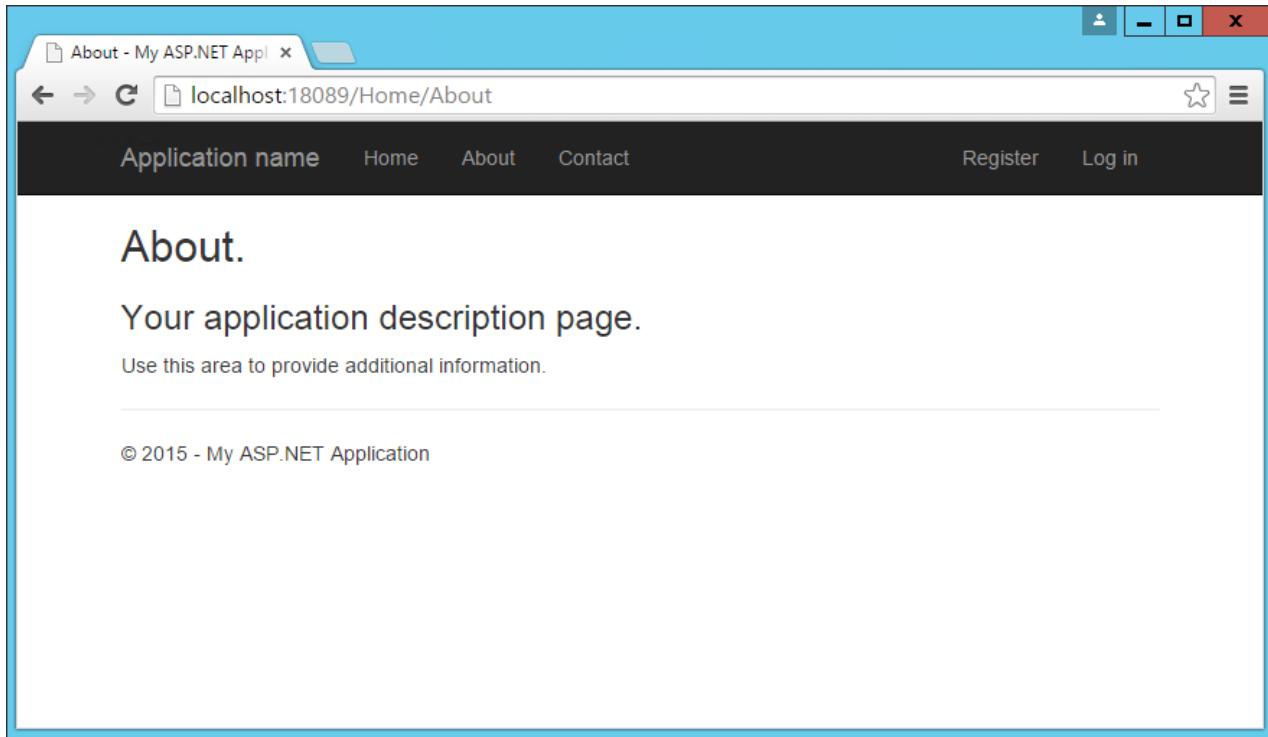
```

<button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-collapse">
    <span class="icon-bar"></span>
    <span class="icon-bar"></span>
    <span class="icon-bar"></span>
</button>

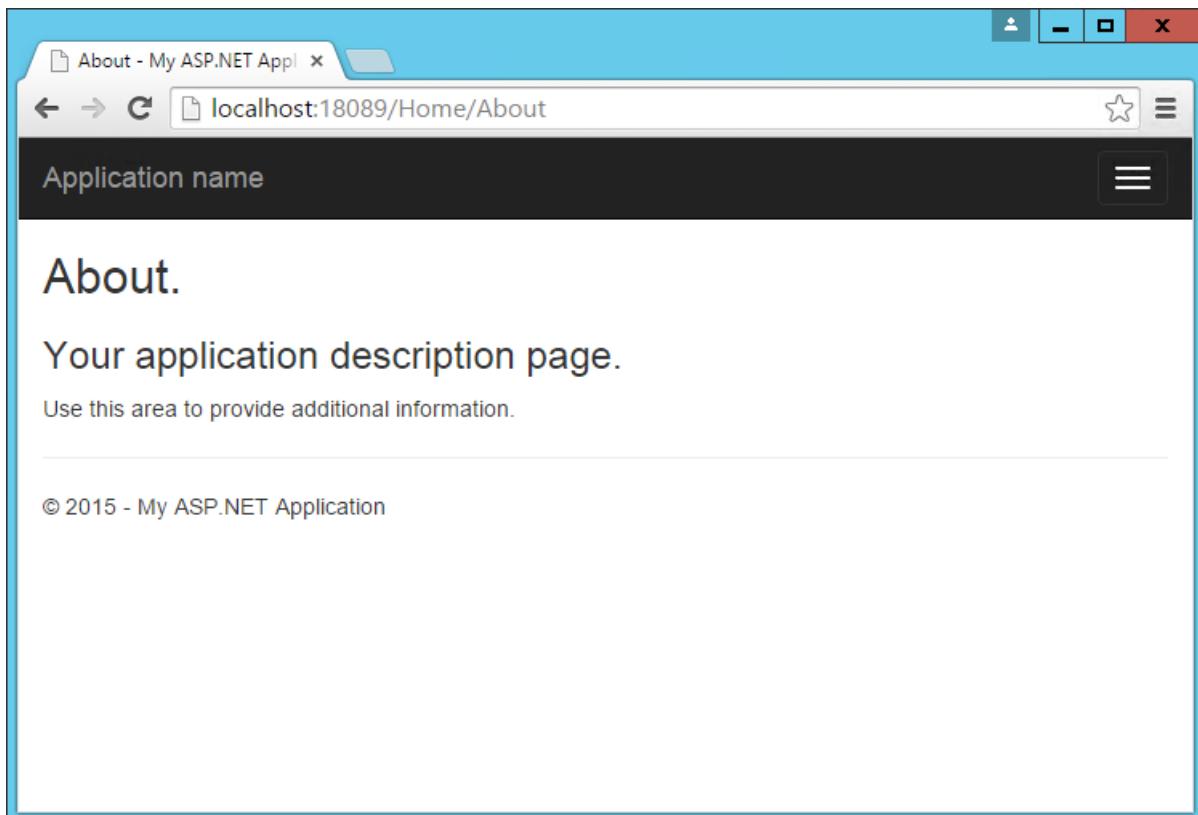
```

It also includes the application name, which appears in the top left. The main navigation menu is rendered by the `<ul>` element within the second div, and includes links to Home, About, and Contact. Below the navigation, the main body of each page is rendered in another `<div>`, marked with the "container" and "body-content" classes. In

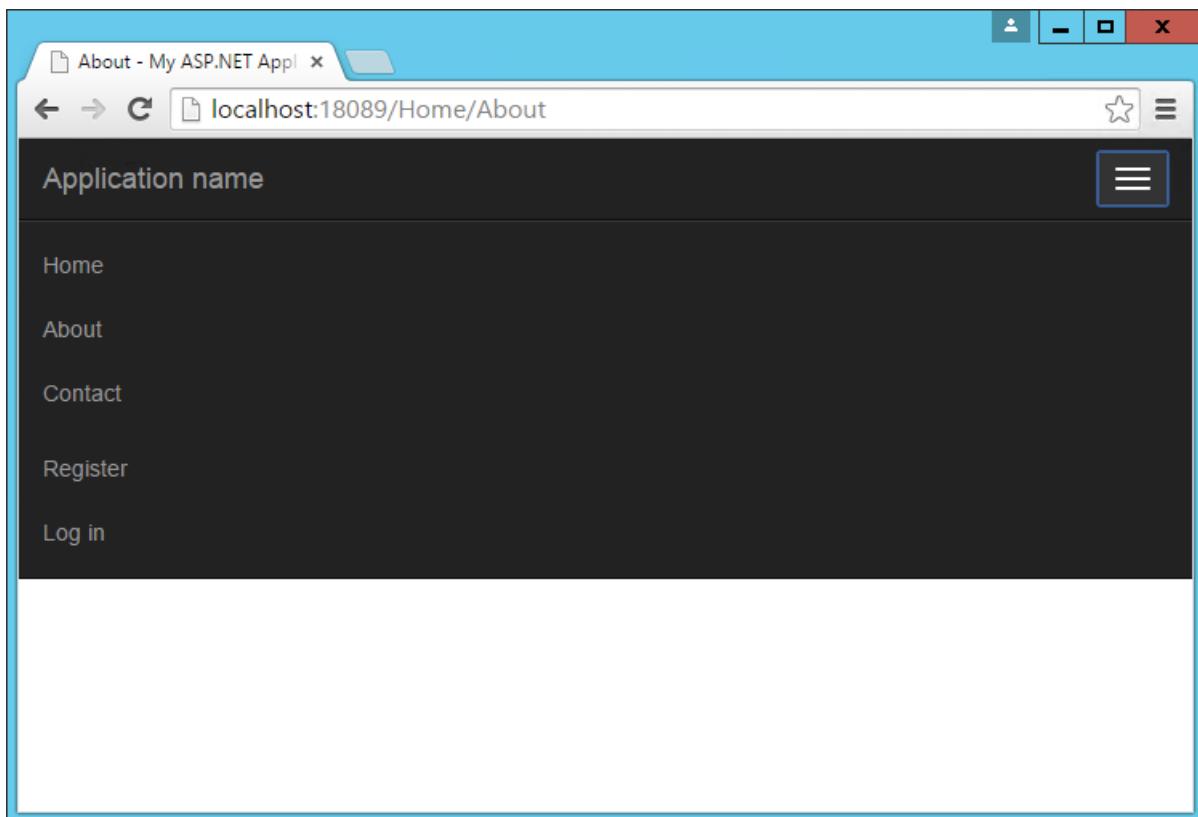
the simple default \_Layout file shown here, the contents of the page are rendered by the specific View associated with the page, and then a simple <footer> is added to the end of the <div> element. You can see how the built-in About page appears using this template:



The collapsed navbar, with "hamburger" button in the top right, appears when the window drops below a certain width:



Clicking the icon reveals the menu items in a vertical drawer that slides down from the top of the page:



## Typography and links

Bootstrap sets up the site's basic typography, colors, and link formatting in its CSS file. This CSS file includes default styles for tables, buttons, form elements, images, and more ([learn more](#)). One particularly useful feature is the grid layout system, covered next.

### Grids

One of the most popular features of Bootstrap is its grid layout system. Modern web applications should avoid using the `<table>` tag for layout, instead restricting the use of this element to actual tabular data. Instead, columns and rows can be laid out using a series of `<div>` elements and the appropriate CSS classes. There are several advantages to this approach, including the ability to adjust the layout of grids to display vertically on narrow screens, such as on phones.

[Bootstrap's grid layout system](#) is based on twelve columns. This number was chosen because it can be divided evenly into 1, 2, 3, or 4 columns, and column widths can vary to within 1/12th of the vertical width of the screen. To start using the grid layout system, you should begin with a container `<div>` and then add a row `<div>`, as shown here:

```
<div class="container">
  <div class="row">
    ...
  </div>
</div>
```

Next, add additional `<div>` elements for each column, and specify the number of columns that `<div>` should occupy (out of 12) as part of a CSS class starting with "col-md-". For instance, if you want to simply have two columns of equal size, you would use a class of "col-md-6" for each one. In this case "md" is short for "medium" and refers to standard-sized desktop computer display sizes. There are four different options you can choose from, and each will be used for higher widths unless overridden (so if you want the layout to be fixed regardless of screen width, you can just specify xs classes).

CSS CLASS PREFIX	DEVICE TIER	WIDTH
col-xs-	Phones	< 768px
col-sm-	Tablets	>= 768px
col-md-	Desktops	>= 992px
col-lg-	Larger Desktop Displays	>= 1200px

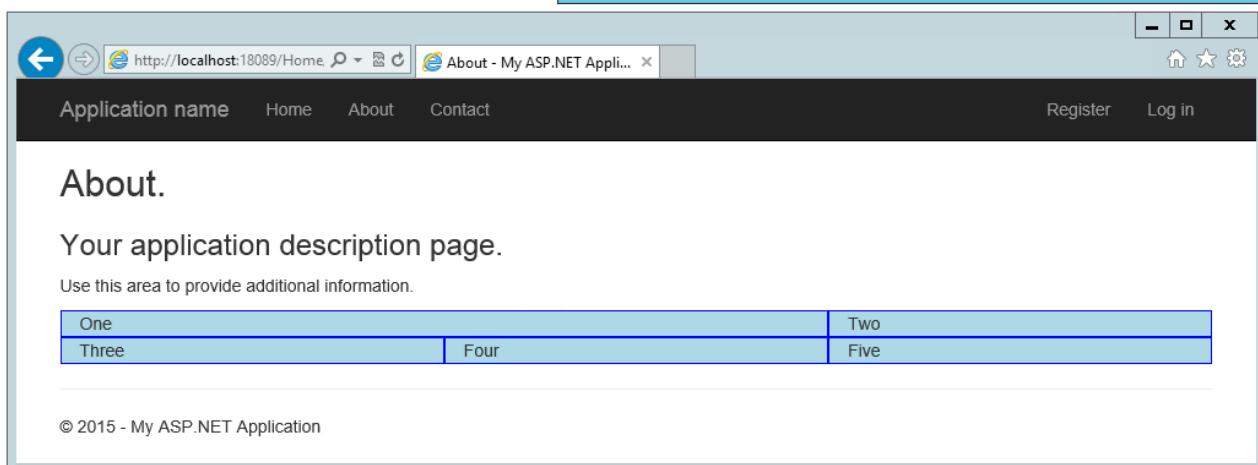
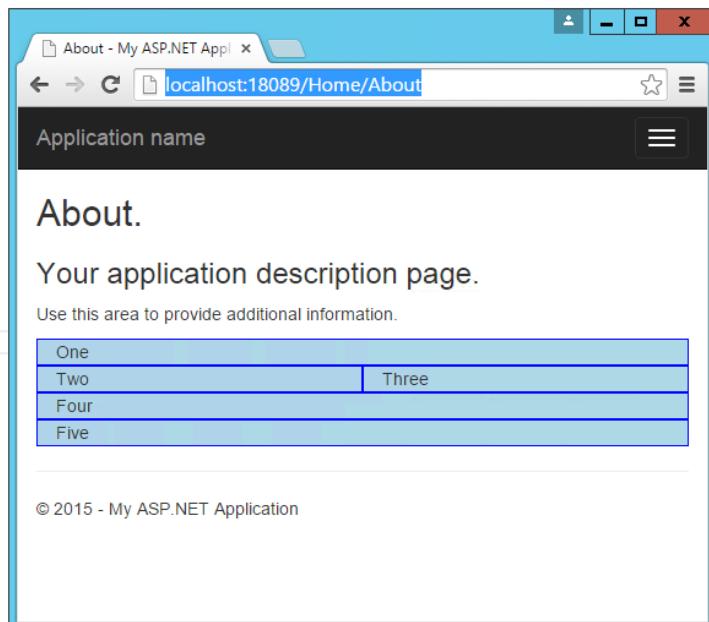
When specifying two columns both with "col-md-6" the resulting layout will be two columns at desktop resolutions, but these two columns will stack vertically when rendered on smaller devices (or a narrower browser window on a desktop), allowing users to easily view content without the need to scroll horizontally.

Bootstrap will always default to a single-column layout, so you only need to specify columns when you want more than one column. The only time you would want to explicitly specify that a `<div>` take up all 12 columns would be to override the behavior of a larger device tier. When specifying multiple device tier classes, you may need to reset the column rendering at certain points. Adding a clearfix div that's only visible within a certain viewport can achieve this, as shown here:

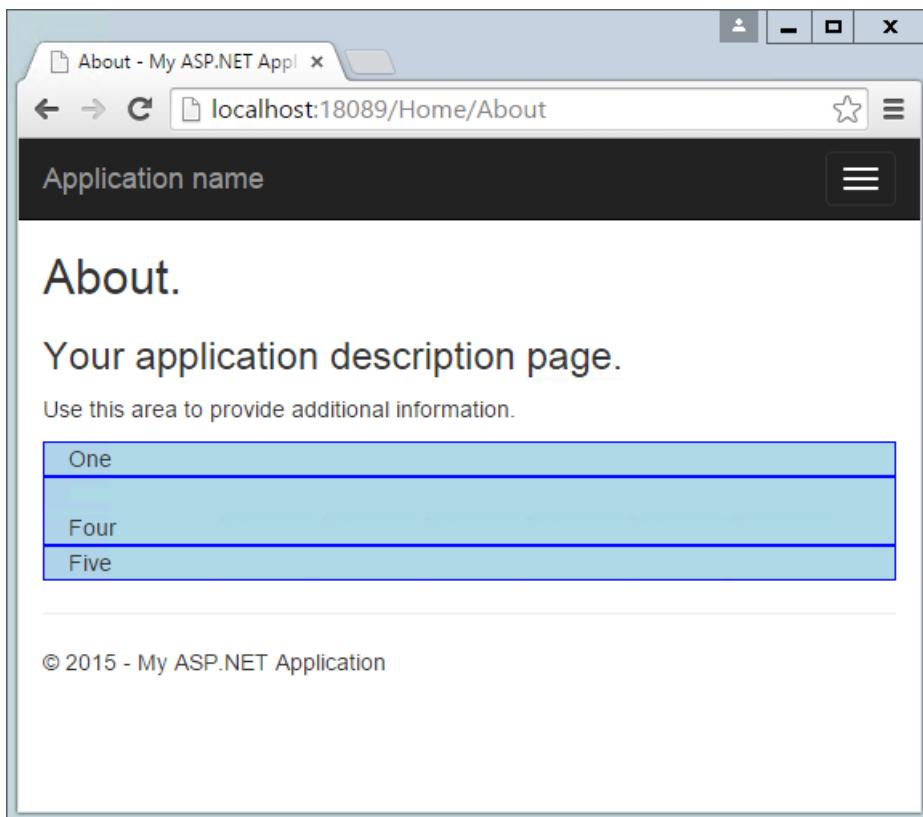
```

<p>Use this area to provide additional information.</p>
<style>
    [class*="col-"] {
        background-color: lightblue;
        border: 1px solid blue;
    }
</style>
<div class="container">
    <div class="row">
        <div class="col-xs-12 col-md-8">
            One
        </div>
        <div class="col-xs-6 col-md-4">
            Two
        </div>
        <div class="col-xs-6 col-md-4">
            Three
        </div>
        <div class="clearfix visible-xs"></div>
        <div class="col-xs-12 col-md-4">
            Four
        </div>
        <div class="col-xs-12 col-md-4">
            Five
        </div>
    </div>
</div>

```



In the above example, One and Two share a row in the "md" layout, while Two and Three share a row in the "xs" layout. Without the clearfix `<div>`, Two and Three are not shown correctly in the "xs" view (note that only One, Four, and Five are shown):



In this example, only a single row `<div>` was used, and Bootstrap still mostly did the right thing with regard to the layout and stacking of the columns. Typically, you should specify a row `<div>` for each horizontal row your layout requires, and of course you can nest Bootstrap grids within one another. When you do, each nested grid will occupy 100% of the width of the element in which it's placed, which can then be subdivided using column classes.

## Jumbotron

If you've used the default ASP.NET MVC templates in Visual Studio 2012 or 2013, you've probably seen the Jumbotron in action. It refers to a large full-width section of a page that can be used to display a large background image, a call to action, a rotator, or similar elements. To add a jumbotron to a page, simply add a `<div>` and give it a class of "jumbotron", then place a container `<div>` inside and add your content. We can easily adjust the standard About page to use a jumbotron for the main headings it displays:

```
<style>
    .jumbotron {
        background-color: lightblue;
    }
</style>

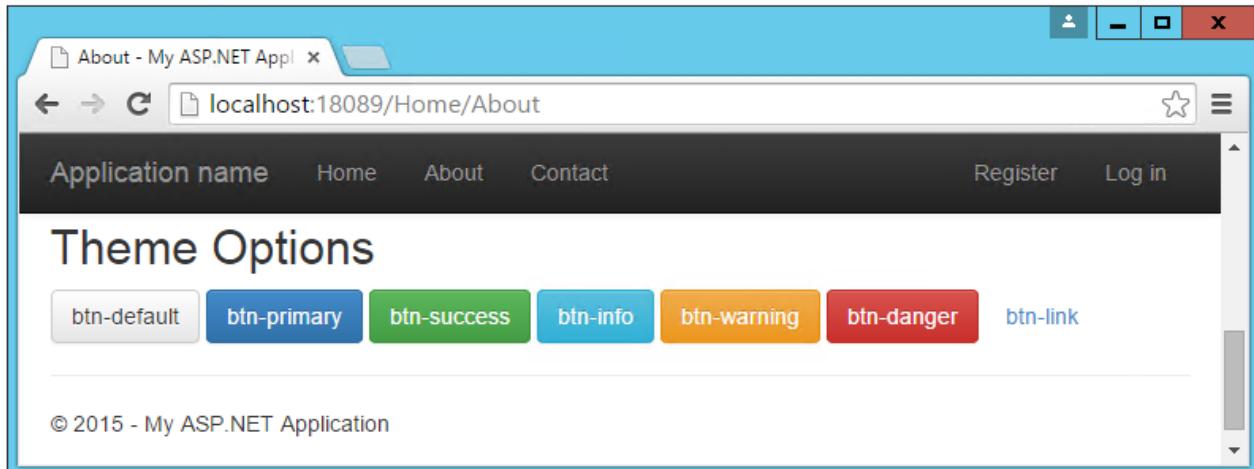
<div class="jumbotron">
    <div class="container">
        <h2>@ViewBag.Title.</h2>
        <h3>@ViewBag.Message</h3>
    </div>
</div>
<p>Use this area to provide additional information.</p>
```

A screenshot of a web browser displaying an 'About' page from 'My ASP.NET App'. The URL is 'localhost:18089/Home/About'. The page has a dark header bar with the text 'Application name' and a menu icon. Below the header is a large blue section with rounded corners containing the text 'About.' and 'Your application description page.'. Below this is a smaller white section with a thin border containing the note 'Use this area to provide additional information.'

## Buttons

The default button classes and their colors are shown in the figure below.

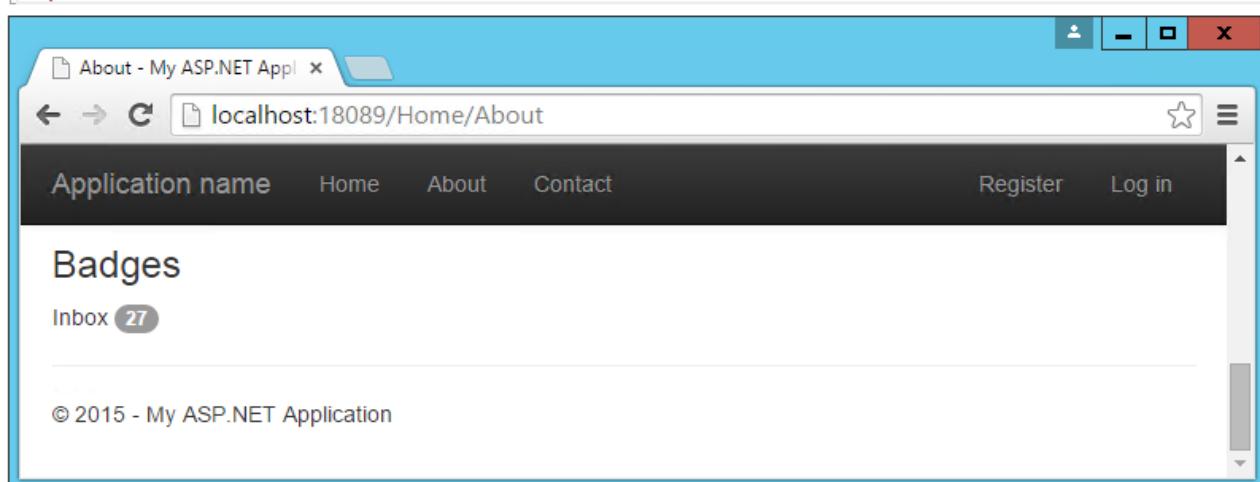
```
<h2>Theme Options</h2>
<p>
    <button type="button" class="btn btn-default">btn-default</button>
    <button type="button" class="btn btn-primary">btn-primary</button>
    <button type="button" class="btn btn-success">btn-success</button>
    <button type="button" class="btn btn-info">btn-info</button>
    <button type="button" class="btn btn-warning">btn-warning</button>
    <button type="button" class="btn btn-danger">btn-danger</button>
    <button type="button" class="btn btn-link">btn-link</button>
</p>
```



## Badges

Badges refer to small, usually numeric callouts next to a navigation item. They can indicate a number of messages or notifications waiting, or the presence of updates. Specifying such badges is as simple as adding a `<span>` containing the text, with a class of "badge":

```
<h3>Badges</h3>
<p>
    Inbox <span class="badge">27</span>
</p>
```



## Alerts

You may need to display some kind of notification, alert, or error message to your application's users. That's where the standard alert classes are useful. There are four different severity levels with associated color schemes:

```

<h3>Alerts</h3>


<strong>Success!</strong> Well done.



<strong>FYI</strong> You might need to know this.

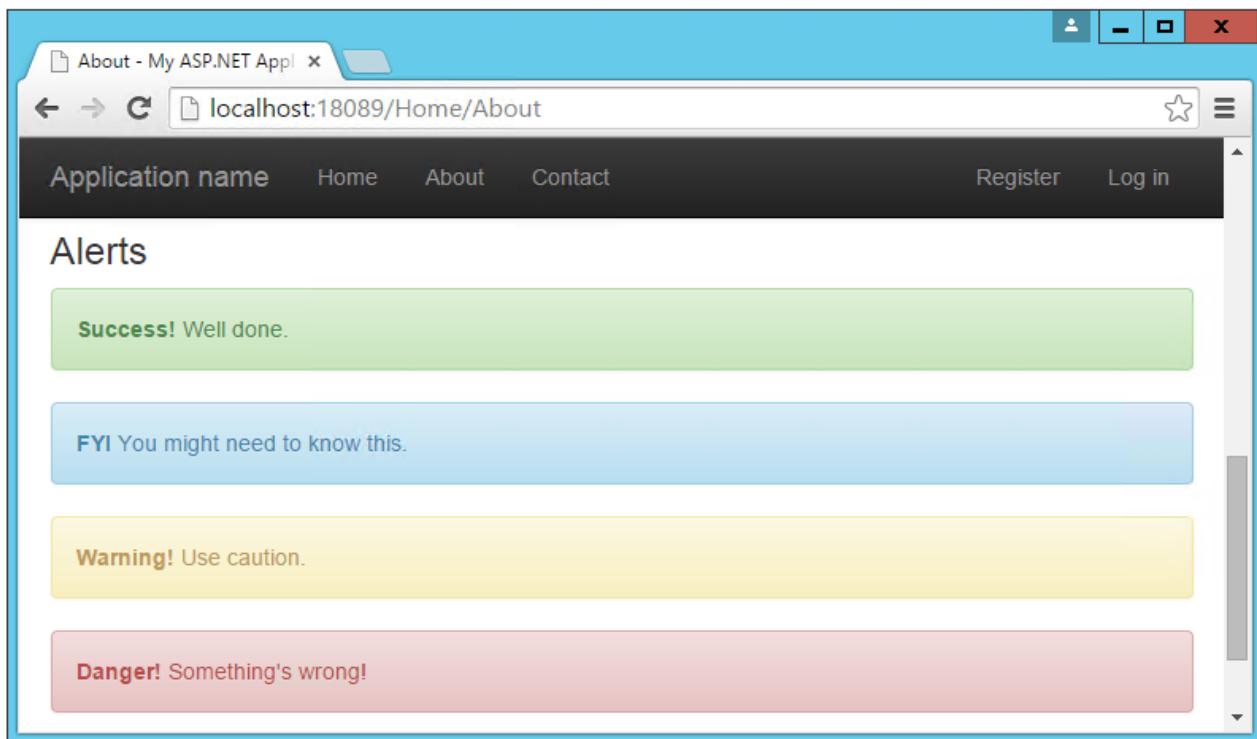


<strong>Warning!</strong> Use caution.



<strong>Danger!</strong> Something's wrong!


```



## Navbars and menus

Our layout already includes a standard navbar, but the Bootstrap theme supports additional styling options. We can also easily opt to display the navbar vertically rather than horizontally if that's preferred, as well as adding sub-navigation items in flyout menus. Simple navigation menus, like tab strips, are built on top of `<ul>` elements. These can be created very simply by just providing them with the CSS classes "nav" and "nav-tabs":

```

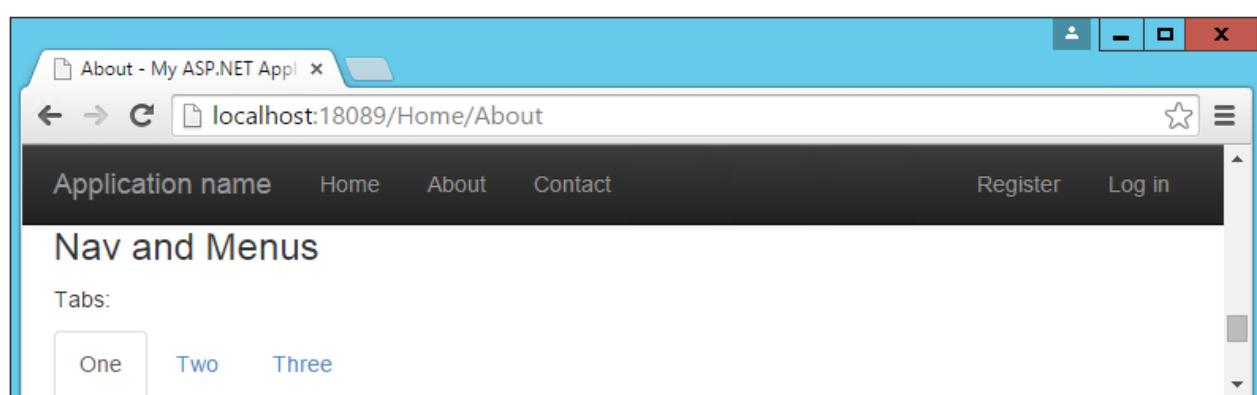
<h3>Nav and Menus</h3>


Tabs:



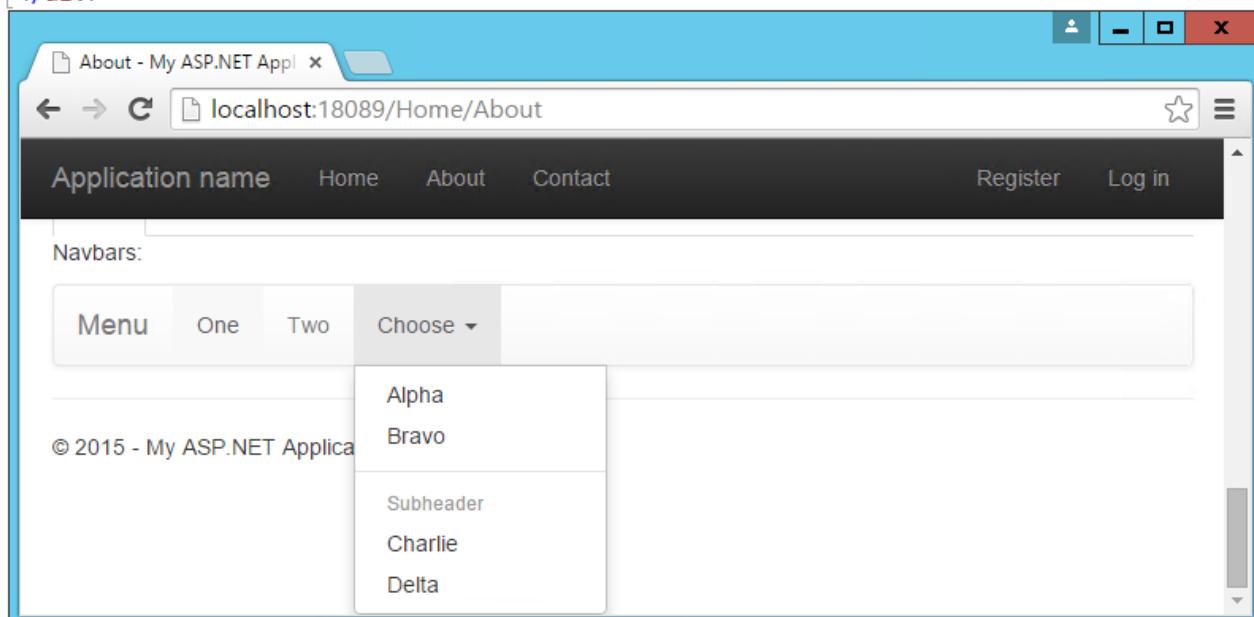
- One
- Two
- Three

```



Navbars are built similarly, but are a bit more complex. They start with a `<nav>` or `<div>` with a class of "navbar", within which a container div holds the rest of the elements. Our page includes a navbar in its header already – the one shown below simply expands on this, adding support for a dropdown menu:

```
<p>Navbars:</p>
<div class="navbar navbar-default">
    <div class="container">
        <div class="navbar-header">
            <button type="button" class="navbar-toggle collapsed" data-toggle="collapse"
                data-target=".navbar-collapse">
                <span class="icon-bar"></span>
                <span class="icon-bar"></span>
                <span class="icon-bar"></span>
            </button>
            <a class="navbar-brand" href="#">Menu</a>
        </div>
        <div class="navbar-collapse collapse">
            <ul class="nav navbar-nav">
                <li class="active"><a href="#">One</a></li>
                <li><a href="#">Two</a></li>
                <li class="dropdown">
                    <a href="#" class="dropdown-toggle" data-toggle="dropdown"
                        role="button" aria-expanded="false">Choose <span class="caret"></span>
                    <ul class="dropdown-menu" role="menu">
                        <li><a href="#">Alpha</a></li>
                        <li><a href="#">Bravo</a></li>
                        <li class="divider"></li>
                        <li class="dropdown-header">Subheader</li>
                        <li><a href="#">Charlie</a></li>
                        <li><a href="#">Delta</a></li>
                    </ul>
                </li>
            </ul>
        </div>
    </div>
</div>
```



## Additional elements

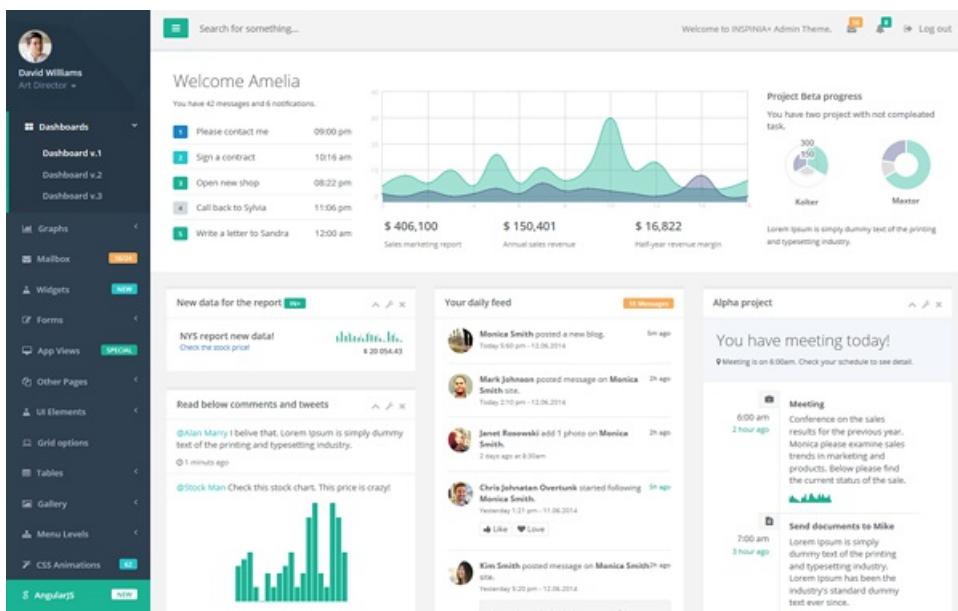
The default theme can also be used to present HTML tables in a nicely formatted style, including support for striped views. There are labels with styles that are similar to those of the buttons. You can create custom Dropdown menus that support additional styling options beyond the standard HTML `<select>` element, along with Navbars like the one our default starter site is already using. If you need a progress bar, there are several styles to choose from, as well as List Groups and panels that include a title and content. Explore additional options

within the standard Bootstrap Theme here:

<http://getbootstrap.com/examples/theme/>

## More themes

You can extend the standard Bootstrap theme by overriding some or all of its CSS, adjusting the colors and styles to suit your own application's needs. If you'd like to start from a ready-made theme, there are several theme galleries available online that specialize in Bootstrap themes, such as WrapBootstrap.com (which has a variety of commercial themes) and Bootswatch.com (which offers free themes). Some of the paid templates available provide a great deal of functionality on top of the basic Bootstrap theme, such as rich support for administrative menus, and dashboards with rich charts and gauges. An example of a popular paid template is Inspinia, currently for sale for \$18, which includes an ASP.NET MVC5 template in addition to AngularJS and static HTML versions. A sample screenshot is shown below.



If you want to change your Bootstrap theme, put the `bootstrap.css` file for the theme you want in the `wwwroot/css` folder and change the references in `_Layout.cshtml` to point it. Change the links for all environments:

```
<environment names="Development">
    <link rel="stylesheet" href="~/css/bootstrap.css" />
```

```
<environment names="Staging,Production">
    <link rel="stylesheet" href="~/css/bootstrap.min.css" />
```

If you want to build your own dashboard, you can start from the free example available here:

<http://getbootstrap.com/examples/dashboard/>.

## Components

In addition to those elements already discussed, Bootstrap includes support for a variety of [built-in UI components](#).

### Glyphicon

Bootstrap includes icon sets from Glyphicons (<http://glyphicons.com>), with over 200 icons freely available for use within your Bootstrap-enabled web application. Here's just a small sample:

indent-right	facetime-video	picture	map-marker	adjust	cut	copy	share
							
glyphicon glyphicon-check	glyphicon glyphicon-move	glyphicon glyphicon-step-backward	glyphicon glyphicon-fast-backward	glyphicon glyphicon-backward	glyphicon glyphicon-play	glyphicon glyphicon-pause	glyphicon glyphicon-stop
							
glyphicon glyphicon-forward	glyphicon glyphicon-fast-forward	glyphicon glyphicon-step-forward	glyphicon glyphicon-eject	glyphicon glyphicon-chevron-left	glyphicon glyphicon-chevron-right	glyphicon glyphicon-plus-sign	glyphicon glyphicon-minus-sign
							
glyphicon glyphicon-remove-sign	glyphicon glyphicon-ok-sign	glyphicon glyphicon-question-sign	glyphicon glyphicon-info-sign	glyphicon glyphicon-screenshot	glyphicon glyphicon-remove-circle	glyphicon glyphicon-ok-circle	glyphicon glyphicon-ban-circle
							
glyphicon glyphicon-arrow-left	glyphicon glyphicon-arrow-right	glyphicon glyphicon-arrow-up	glyphicon glyphicon-arrow-down	glyphicon glyphicon-share-alt	glyphicon glyphicon-resize-full	glyphicon glyphicon-resize-small	glyphicon glyphicon-exclamation-sign
							
glyphicon	glyphicon	glyphicon	glyphicon	glyphicon	glyphicon	glyphicon	glyphicon

## Input groups

Input groups allow bundling of additional text or buttons with an input element, providing the user with a more intuitive experience:

@example.com

## Breadcrumbs

Breadcrumbs are a common UI component used to show a user their recent history or depth within a site's navigation hierarchy. Add them easily by applying the "breadcrumb" class to any `<ol>` list element. Include built-in support for pagination by using the "pagination" class on a `<ul>` element within a `<nav>`. Add responsive embedded slideshows and video by using `<iframe>`, `<embed>`, `<video>`, or `<object>` elements, which Bootstrap will style automatically. Specify a particular aspect ratio by using specific classes like "embed-responsive-16by9".

## JavaScript support

Bootstrap's JavaScript library includes API support for the included components, allowing you to control their behavior programmatically within your application. In addition, `bootstrap.js` includes over a dozen custom jQuery plugins, providing additional features like transitions, modal dialogs, scroll detection (updating styles based on where the user has scrolled in the document), collapse behavior, carousels, and affixing menus to the window so they don't scroll off the screen. There's not sufficient room to cover all of the JavaScript add-ons built into Bootstrap – to learn more please visit <http://getbootstrap.com/javascript/>.

## Summary

Bootstrap provides a web framework that can be used to quickly and productively lay out and style a wide variety of websites and applications. Its basic typography and styles provide a pleasant look and feel that can easily be manipulated through custom theme support, which can be hand-crafted or purchased commercially. It supports a host of web components that in the past would've required expensive third-party controls to accomplish, while supporting modern and open web standards.

# Less, Sass, and Font Awesome in ASP.NET Core

6/21/2018 • 12 minutes to read • [Edit Online](#)

By [Steve Smith](#)

Users of web applications have increasingly high expectations when it comes to style and overall experience. Modern web applications frequently leverage rich tools and frameworks for defining and managing their look and feel in a consistent manner. Frameworks like [Bootstrap](#) can go a long way toward defining a common set of styles and layout options for web sites. However, most non-trivial sites also benefit from being able to effectively define and maintain styles and cascading style sheet (CSS) files, as well as having easy access to non-image icons that help make the site's interface more intuitive. That's where languages and tools that support [Less](#) and [Sass](#), and libraries like [Font Awesome](#), come in.

## CSS preprocessor languages

Languages that are compiled into other languages, in order to improve the experience of working with the underlying language, are referred to as preprocessors. There are two popular preprocessors for CSS: Less and Sass. These preprocessors add features to CSS, such as support for variables and nested rules, which improve the maintainability of large, complex stylesheets. CSS as a language is very basic, lacking support even for something as simple as variables, and this tends to make CSS files repetitive and bloated. Adding real programming language features via preprocessors can help reduce duplication and provide better organization of styling rules. Visual Studio provides built-in support for both Less and Sass, as well as extensions that can further improve the development experience when working with these languages.

As a quick example of how preprocessors can improve readability and maintainability of style information, consider this CSS:

```
.header {  
    color: black;  
    font-weight: bold;  
    font-size: 18px;  
    font-family: Helvetica, Arial, sans-serif;  
}  
  
.small-header {  
    color: black;  
    font-weight: bold;  
    font-size: 14px;  
    font-family: Helvetica, Arial, sans-serif;  
}
```

Using Less, this can be rewritten to eliminate all of the duplication, using a *mixin* (so named because it allows you to "mix in" properties from one class or rule-set into another):

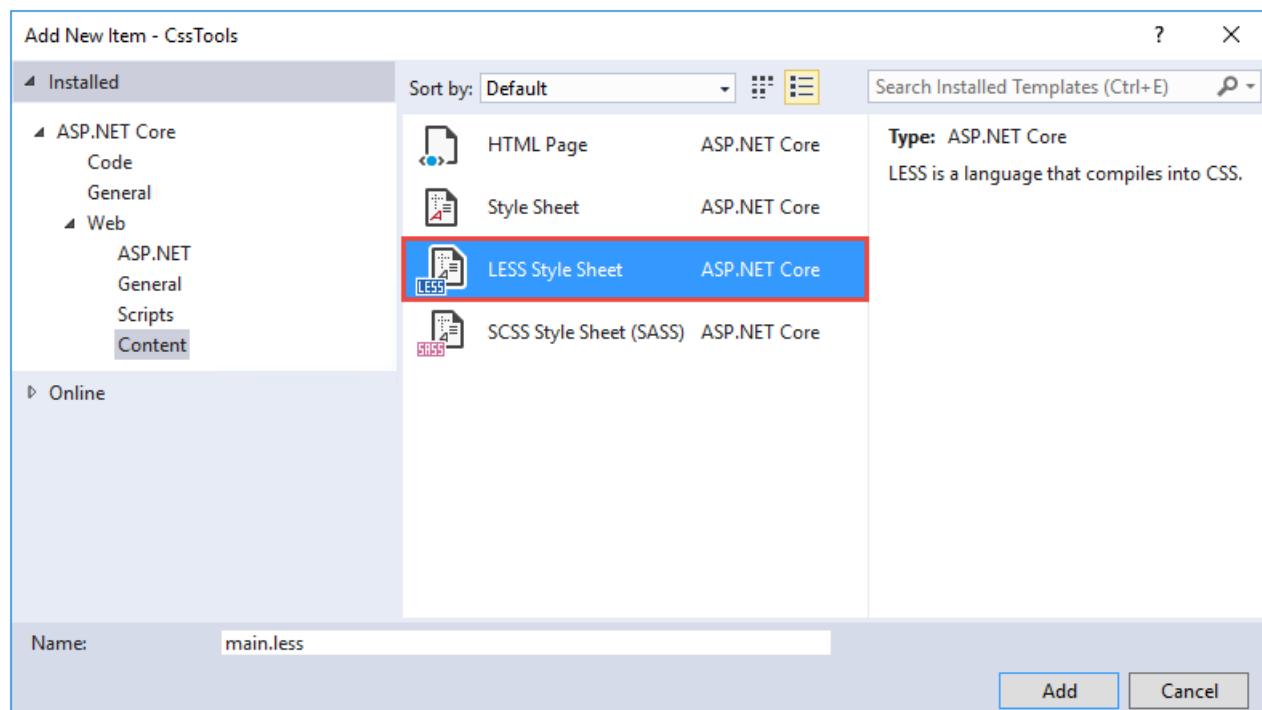
```
.header {  
    color: black;  
    font-weight: bold;  
    font-size: 18px;  
    font-family: Helvetica, Arial, sans-serif;  
}  
  
.small-header {  
    .header;  
    font-size: 14px;  
}
```

## Less

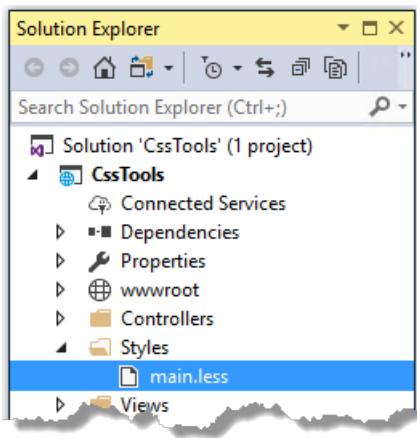
The Less CSS preprocessor runs using Node.js. To install Less, use Node Package Manager (npm) from a command prompt (-g means "global"):

```
npm install -g less
```

If you're using Visual Studio, you can get started with Less by adding one or more Less files to your project, and then configuring Gulp (or Grunt) to process them at compile-time. Add a *Styles* folder to your project, and then add a new Less file named *main.less* to this folder.



Once added, your folder structure should look something like this:



Now you can add some basic styling to the file, which will be compiled into CSS and deployed to the wwwroot folder by Gulp.

Modify `main.less` to include the following content, which creates a simple color palette from a single base color.

```
@base: #663333;
@background: spin(@base, 180);
@lighter: lighten(spin(@base, 5), 10%);
@lighter2: lighten(spin(@base, 10), 20%);
@darker: darken(spin(@base, -5), 10%);
@darker2: darken(spin(@base, -10), 20%);

body {
    background-color:@background;
}
.baseColor {color:@base}
.bgLight {color:@lighter}
.bgLight2 {color:@lighter2}
.bgDark {color:@darker}
.bgDark2 {color:@darker2}
```

`@base` and the other `@`-prefixed items are variables. Each of them represents a color. Except for `@base`, they're set using color functions: `lighten`, `darken`, and `spin`. `Lighten` and `darken` do pretty much what you would expect; `spin` adjusts the hue of a color by a number of degrees (around the color wheel). The Less processor is smart enough to ignore variables that aren't used, so to demonstrate how these variables work, we need to use them somewhere. The classes `.baseColor`, etc. will demonstrate the calculated values of each of the variables in the CSS file that's produced.

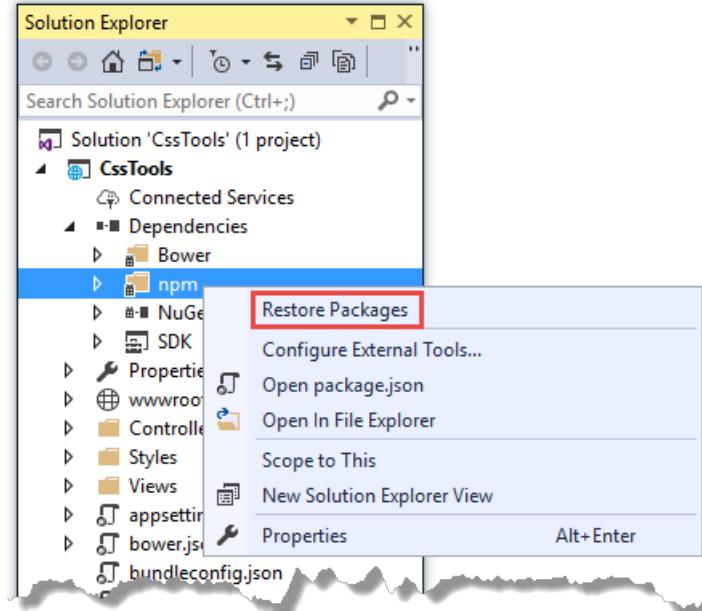
## Get started

Create an **npm Configuration File** (`package.json`) in your project folder and edit it to reference `gulp` and `gulp-less`:

```
{
  "version": "1.0.0",
  "name": "asp.net",
  "private": true,
  "devDependencies": {
    "gulp": "3.9.1",
    "gulp-less": "3.3.0"
  }
}
```

Install the dependencies either at a command prompt in your project folder, or in Visual Studio **Solution Explorer** (**Dependencies > npm > Restore packages**).

```
npm install
```



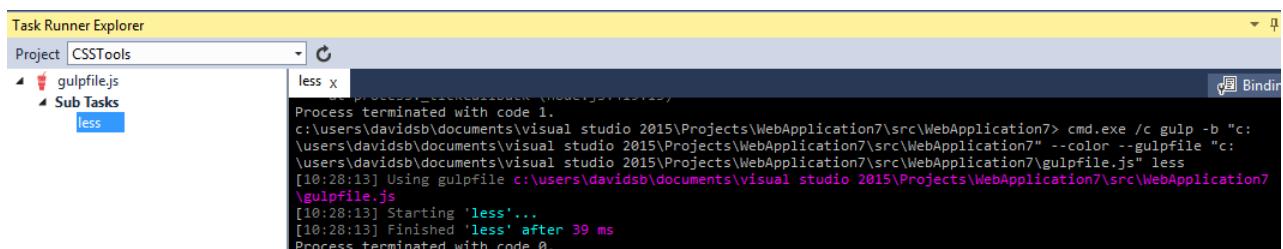
In the project folder, create a **Gulp Configuration File** (`gulpfile.js`) to define the automated process. Add a variable at the top of the file to represent Less, and a task to run Less:

```
var gulp = require("gulp"),
    fs = require("fs"),
    less = require("gulp-less");

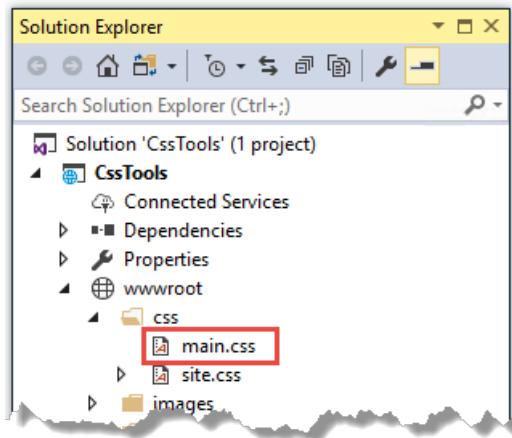
gulp.task("less", function () {
    return gulp.src('Styles/main.less')
        .pipe(less())
        .pipe(gulp.dest('wwwroot/css'));
});
```

Open the **Task Runner Explorer** (**View > Other Windows > Task Runner Explorer**). Among the tasks, you should see a new task named `less`. You might have to refresh the window.

Run the `less` task, and you see output similar to what is shown here:



The `wwwroot/css` folder now contains a new file, `main.css`:



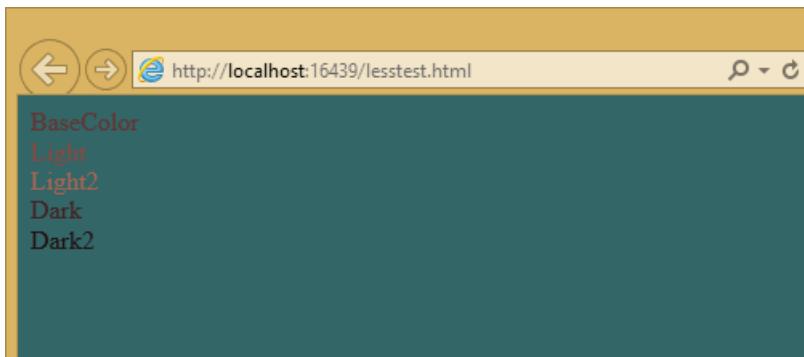
Open *main.css* and you see something like the following:

```
body {  
    background-color: #336666;  
}  
.baseColor {  
    color: #663333;  
}  
.bgLight {  
    color: #884a44;  
}  
.bgLight2 {  
    color: #aa6355;  
}  
.bgDark {  
    color: #442225;  
}  
.bgDark2 {  
    color: #221114;  
}
```

Add a simple HTML page to the *wwwroot* folder, and reference *main.css* to see the color palette in action.

```
<!DOCTYPE html>  
<html>  
<head>  
    <meta charset="utf-8" />  
    <link href="css/main.css" rel="stylesheet" />  
    <title></title>  
</head>  
<body>  
    <div>  
        <div class="baseColor">BaseColor</div>  
        <div class="bgLight">Light</div>  
        <div class="bgLight2">Light2</div>  
        <div class="bgDark">Dark</div>  
        <div class="bgDark2">Dark2</div>  
    </div>  
</body>  
</html>
```

You can see that the 180 degree spin on `@base` used to produce `@background` resulted in the color wheel opposing color of `@base`:



Less also provides support for nested rules, as well as nested media queries. For example, defining nested hierarchies like menus can result in verbose CSS rules like these:

```
nav {  
    height: 40px;  
    width: 100%;  
}  
nav li {  
    height: 38px;  
    width: 100px;  
}  
nav li a:link {  
    color: #000;  
    text-decoration: none;  
}  
nav li a:visited {  
    text-decoration: none;  
    color: #CC3333;  
}  
nav li a:hover {  
    text-decoration: underline;  
    font-weight: bold;  
}  
nav li a:active {  
    text-decoration: underline;  
}
```

Ideally all of the related style rules will be placed together within the CSS file, but in practice there's nothing enforcing this rule except convention and perhaps block comments.

Defining these same rules using Less looks like this:

```
nav {  
    height: 40px;  
    width: 100%;  
    li {  
        height: 38px;  
        width: 100px;  
        a {  
            color: #000;  
            &:link { text-decoration:none}  
            &:visited { color: #CC3333; text-decoration:none}  
            &:hover { text-decoration:underline; font-weight:bold}  
            &:active {text-decoration:underline}  
        }  
    }  
}
```

Note that in this case, all of the subordinate elements of `nav` are contained within its scope. There's no longer any repetition of parent elements (`nav`, `li`, `a`), and the total line count has dropped as well (though some of that's a result of putting values on the same lines in the second example). It can be very helpful, organizationally, to see all

of the rules for a given UI element within an explicitly bounded scope, in this case set off from the rest of the file by curly braces.

The `&` syntax is a Less selector feature, with `&` representing the current selector parent. So, within the `a{...}` block, `&` represents an `a` tag, and thus `&:link` is equivalent to `a:link`.

Media queries, extremely useful in creating responsive designs, can also contribute heavily to repetition and complexity in CSS. Less allows media queries to be nested within classes, so that the entire class definition doesn't need to be repeated within different top-level `@media` elements. For example, here is CSS for a responsive menu:

```
.navigation {
  margin-top: 30%;
  width: 100%;
}
@media screen and (min-width: 40em) {
  .navigation {
    margin: 0;
  }
}
@media screen and (min-width: 62em) {
  .navigation {
    width: 960px;
    margin: 0;
  }
}
```

This can be better defined in Less as:

```
.navigation {
  margin-top: 30%;
  width: 100%;
  @media screen and (min-width: 40em) {
    margin: 0;
  }
  @media screen and (min-width: 62em) {
    width: 960px;
    margin: 0;
  }
}
```

Another feature of Less that we have already seen is its support for mathematical operations, allowing style attributes to be constructed from pre-defined variables. This makes updating related styles much easier, since the base variable can be modified and all dependent values change automatically.

CSS files, especially for large sites (and especially if media queries are being used), tend to get quite large over time, making working with them unwieldy. Less files can be defined separately, then pulled together using `@import` directives. Less can also be used to import individual CSS files, as well, if desired.

*Mixins* can accept parameters, and Less supports conditional logic in the form of mixin guards, which provide a declarative way to define when certain mixins take effect. A common use for mixin guards is to adjust colors based on how light or dark the source color is. Given a mixin that accepts a parameter for color, a mixin guard can be used to modify the mixin based on that color:

```

.box (@color) when (lightness(@color) >= 50%) {
    background-color: #000;
}
.box (@color) when (lightness(@color) < 50%) {
    background-color: #FFF;
}
.box (@color) {
    color: @color;
}

.feature {
    .box (@base);
}

```

Given our current `@base` value of `#663333`, this Less script will produce the following CSS:

```

.feature {
    background-color: #FFF;
    color: #663333;
}

```

Less provides a number of additional features, but this should give you some idea of the power of this preprocessing language.

## Sass

Sass is similar to Less, providing support for many of the same features, but with slightly different syntax. It's built using Ruby, rather than JavaScript, and so has different setup requirements. The original Sass language didn't use curly braces or semicolons, but instead defined scope using white space and indentation. In version 3 of Sass, a new syntax was introduced, **SCSS** ("Sassy CSS"). SCSS is similar to CSS in that it ignores indentation levels and whitespace, and instead uses semicolons and curly braces.

To install Sass, typically you would first install Ruby (pre-installed on macOS), and then run:

```
gem install sass
```

However, if you're running Visual Studio, you can get started with Sass in much the same way as you would with Less. Open `package.json` and add the "gulp-sass" package to `devDependencies`:

```

"devDependencies": {
    "gulp": "3.9.1",
    "gulp-less": "3.3.0",
    "gulp-sass": "3.1.0"
}

```

Next, modify `gulpfile.js` to add a sass variable and a task to compile your Sass files and place the results in the `wwwroot` folder:

```

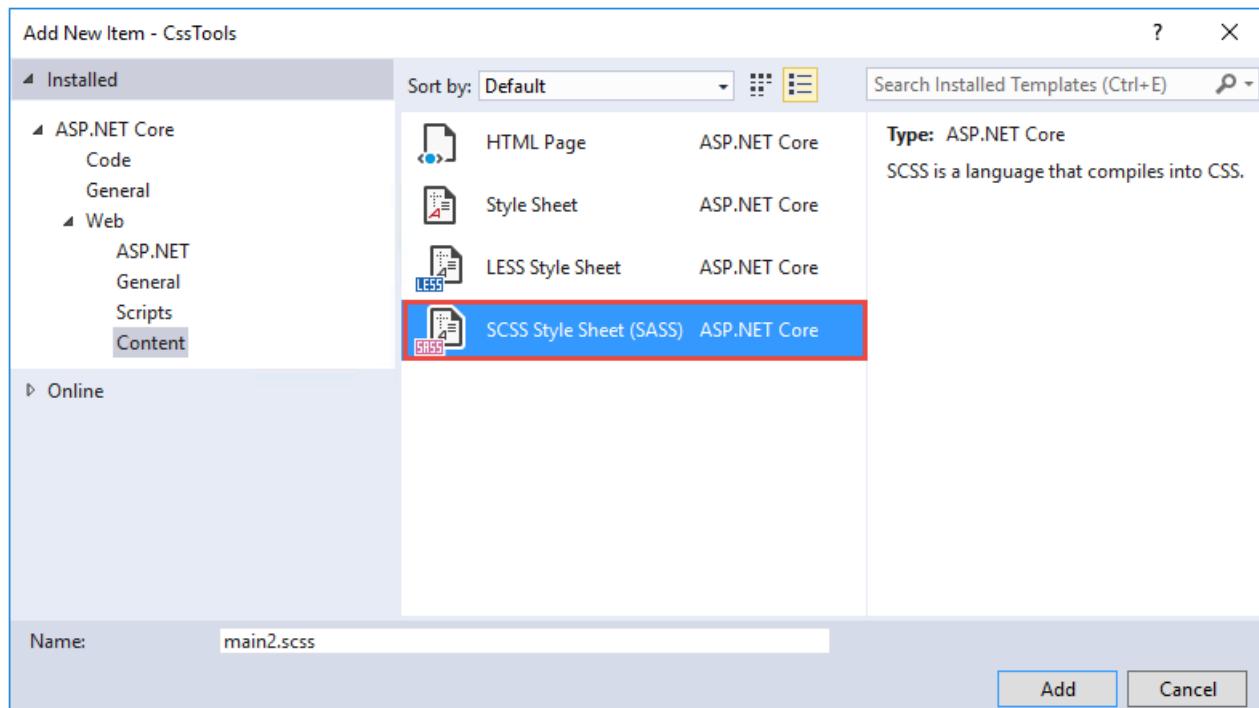
var gulp = require("gulp"),
  fs = require("fs"),
  less = require("gulp-less"),
  sass = require("gulp-sass");

// other content removed

gulp.task("sass", function () {
  return gulp.src('Styles/main2.scss')
    .pipe(sass())
    .pipe(gulp.dest('wwwroot/css'));
});

```

Now you can add the Sass file *main2.scss* to the *Styles* folder in the root of the project:



Open *main2.scss* and add the following:

```

$base: #CC0000;
body {
  background-color: $base;
}

```

Save all of your files. Now when you refresh **Task Runner Explorer**, you see a `sass` task. Run it, and look in the `/wwwroot/css` folder. There's now a *main2.css* file, with these contents:

```

body {
  background-color: #CC0000;
}

```

Sass supports nesting in much the same way that Less does, providing similar benefits. Files can be split up by function and included using the `@import` directive:

```

@import 'anotherfile';

```

Sass supports mixins as well, using the `@mixin` keyword to define them and `@include` to include them, as in this

example from [sass-lang.com](http://sass-lang.com):

```
@mixin border-radius($radius) {  
  -webkit-border-radius: $radius;  
  -moz-border-radius: $radius;  
  -ms-border-radius: $radius;  
  border-radius: $radius;  
}  
  
.box { @include border-radius(10px); }
```

In addition to mixins, Sass also supports the concept of inheritance, allowing one class to extend another. It's conceptually similar to a mixin, but results in less CSS code. It's accomplished using the `@extend` keyword. To try out mixins, add the following to your `main2.scss` file:

```
@mixin alert {  
  border: 1px solid black;  
  padding: 5px;  
  color: #333333;  
}  
  
.success {  
  @include alert;  
  border-color: green;  
}  
  
.error {  
  @include alert;  
  color: red;  
  border-color: red;  
  font-weight:bold;  
}
```

Examine the output in `main2.css` after running the `sass` task in **Task Runner Explorer**:

```
.success {  
  border: 1px solid black;  
  padding: 5px;  
  color: #333333;  
  border-color: green;  
}  
  
.error {  
  border: 1px solid black;  
  padding: 5px;  
  color: #333333;  
  color: red;  
  border-color: red;  
  font-weight: bold;  
}
```

Notice that all of the common properties of the alert mixin are repeated in each class. The mixin did a good job of helping eliminate duplication at development time, but it's still creating CSS with a lot of duplication in it, resulting in larger than necessary CSS files - a potential performance issue.

Now replace the alert mixin with a `.alert` class, and change `@include` to `@extend` (remembering to extend `.alert`, not `alert`):

```
.alert {  
    border: 1px solid black;  
    padding: 5px;  
    color: #333333;  
}  
  
.success {  
    @extend .alert;  
    border-color: green;  
}  
  
.error {  
    @extend .alert;  
    color: red;  
    border-color: red;  
    font-weight:bold;  
}
```

Run Sass once more, and examine the resulting CSS:

```
.alert, .success, .error {  
    border: 1px solid black;  
    padding: 5px;  
    color: #333333;  
}  
  
.success {  
    border-color: green;  
}  
  
.error {  
    color: red;  
    border-color: red;  
    font-weight: bold;  
}
```

Now the properties are defined only as many times as needed, and better CSS is generated.

Sass also includes functions and conditional logic operations, similar to Less. In fact, the two languages' capabilities are very similar.

## Less or Sass?

There's still no consensus as to whether it's generally better to use Less or Sass (or even whether to prefer the original Sass or the newer SCSS syntax within Sass). Probably the most important decision is to **use one of these tools**, as opposed to just hand-coding your CSS files. Once you've made that decision, both Less and Sass are good choices.

## Font Awesome

In addition to CSS preprocessors, another great resource for styling modern web applications is Font Awesome. Font Awesome is a toolkit that provides over 500 scalable vector icons that can be freely used in your web applications. It was originally designed to work with Bootstrap, but it has no dependency on that framework or on any JavaScript libraries.

The easiest way to get started with Font Awesome is to add a reference to it, using its public content delivery network (CDN) location:

```
<link rel="stylesheet" href="//maxcdn.bootstrapcdn.com/font-awesome/4.3.0/css/font-awesome.min.css">
```

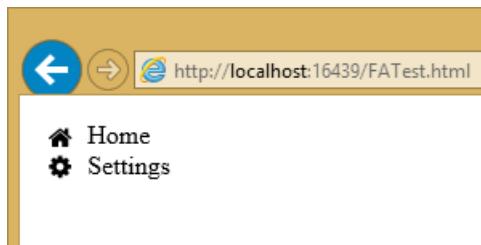
You can also add it to your Visual Studio project by adding it to the "dependencies" in *bower.json*:

```
{  
  "name": "ASP.NET",  
  "private": true,  
  "dependencies": {  
    "bootstrap": "3.0.0",  
    "jquery": "1.10.2",  
    "jquery-validation": "1.11.1",  
    "jquery-validation-unobtrusive": "3.2.2",  
    "hammer.js": "2.0.4",  
    "bootstrap-touch-carousel": "0.8.0",  
    "Font-Awesome": "4.3.0"  
  }  
}
```

Once you have a reference to Font Awesome on a page, you can add icons to your application by applying Font Awesome classes, typically prefixed with "fa-", to your inline HTML elements (such as `<span>` or `<i>`). For example, you can add icons to simple lists and menus using code like this:

```
<!DOCTYPE html>  
<html>  
<head>  
  <meta charset="utf-8" />  
  <title></title>  
  <link href="lib/font-awesome/css/font-awesome.css" rel="stylesheet" />  
</head>  
<body>  
  <ul class="fa-ul">  
    <li><i class="fa fa-li fa-home"></i> Home</li>  
    <li><i class="fa fa-li fa-cog"></i> Settings</li>  
  </ul>  
</body>  
</html>
```

This produces the following in the browser - note the icon beside each item:



You can view a complete list of the available icons here:

<http://fontawesome.io/icons/>

## Summary

Modern web applications increasingly demand responsive, fluid designs that are clean, intuitive, and easy to use from a variety of devices. Managing the complexity of the CSS stylesheets required to achieve these goals is best done using a preprocessor like Less or Sass. In addition, toolkits like Font Awesome quickly provide well-known icons to textual navigation menus and buttons, improving the overall user experience of your application.

# Bundle and minify static assets in ASP.NET Core

6/21/2018 • 10 minutes to read • [Edit Online](#)

By [Scott Addie](#)

This article explains the benefits of applying bundling and minification, including how these features can be used with ASP.NET Core web apps.

## What is bundling and minification?

Bundling and minification are two distinct performance optimizations you can apply in a web app. Used together, bundling and minification improve performance by reducing the number of server requests and reducing the size of the requested static assets.

Bundling and minification primarily improve the first page request load time. Once a web page has been requested, the browser caches the static assets (JavaScript, CSS, and images). Consequently, bundling and minification don't improve performance when requesting the same page, or pages, on the same site requesting the same assets. If the expires header isn't set correctly on the assets and if bundling and minification isn't used, the browser's freshness heuristics mark the assets stale after a few days. Additionally, the browser requires a validation request for each asset. In this case, bundling and minification provide a performance improvement even after the first page request.

### Bundling

Bundling combines multiple files into a single file. Bundling reduces the number of server requests which are necessary to render a web asset, such as a web page. You can create any number of individual bundles specifically for CSS, JavaScript, etc. Fewer files means fewer HTTP requests from the browser to the server or from the service providing your application. This results in improved first page load performance.

### Minification

Minification removes unnecessary characters from code without altering functionality. The result is a significant size reduction in requested assets (such as CSS, images, and JavaScript files). Common side effects of minification include shortening variable names to one character and removing comments and unnecessary whitespace.

Consider the following JavaScript function:

```
AddAltToImg = function (imageTagAndImageID, imageContext) {
    ///<signature>
    ///<summary> Adds an alt tab to the image
    // </summary>
    //<param name="imgElement" type="String">The image selector.</param>
    //<param name="ContextForImage" type="String">The image context.</param>
    ///</signature>
    var imageElement = $(imageTagAndImageID, imageContext);
    imageElement.attr('alt', imageElement.attr('id').replace(/ID/, ''));
}
```

Minification reduces the function to the following:

```
AddAltToImg=function(n,t){var i=$(n,t);i.attr("alt",i.attr("id").replace(/ID/,""))};
```

In addition to removing the comments and unnecessary whitespace, the following parameter and variable names were renamed as follows:

ORIGINAL	RENAMED
imageTagAndImageID	t
imageContext	a
imageElement	r

## Impact of bundling and minification

The following table outlines differences between individually loading assets and using bundling and minification:

ACTION	WITH B/M	WITHOUT B/M	CHANGE
File Requests	7	18	157%
KB Transferred	156	264.68	70%
Load Time (ms)	885	2360	167%

Browsers are fairly verbose with regard to HTTP request headers. The total bytes sent metric saw a significant reduction when bundling. The load time shows a significant improvement, however this example ran locally. Greater performance gains are realized when using bundling and minification with assets transferred over a network.

## Choose a bundling and minification strategy

The MVC and Razor Pages project templates provide an out-of-the-box solution for bundling and minification consisting of a JSON configuration file. Third-party tools, such as the [Gulp](#) and [Grunt](#) task runners, accomplish the same tasks with a bit more complexity. A third-party tool is a great fit when your development workflow requires processing beyond bundling and minification—such as linting and image optimization. By using design-time bundling and minification, the minified files are created prior to the app's deployment. Bundling and minifying before deployment provides the advantage of reduced server load. However, it's important to recognize that design-time bundling and minification increases build complexity and only works with static files.

## Configure bundling and minification

The MVC and Razor Pages project templates provide a `bundleconfig.json` configuration file which defines the options for each bundle. By default, a single bundle configuration is defined for the custom JavaScript (`wwwroot/js/site.js`) and stylesheet (`wwwroot/css/site.css`) files:

```
[
  {
    "outputFileName": "wwwroot/css/site.min.css",
    "inputFiles": [
      "wwwroot/css/site.css"
    ]
  },
  {
    "outputFileName": "wwwroot/js/site.min.js",
    "inputFiles": [
      "wwwroot/js/site.js"
    ],
    "minify": {
      "enabled": true,
      "renameLocals": true
    },
    "sourceMap": false
  }
]
```

Configuration options include:

- `outputFileName` : The name of the bundle file to output. Can contain a relative path from the `bundleconfig.json` file. **required**
- `inputFiles` : An array of files to bundle together. These are relative paths to the configuration file. **optional**, \*an empty value results in an empty output file. [globbing](#) patterns are supported.
- `minify` : The minification options for the output type. **optional**, `default - minify: { enabled: true }`
  - Configuration options are available per output file type.
    - [CSS Minifier](#)
    - [JavaScript Minifier](#)
    - [HTML Minifier](#)
- `includeInProject` : Flag indicating whether to add generated files to project file. **optional**, `default - false`
- `sourceMap` : Flag indicating whether to generate a source map for the bundled file. **optional**, `default - false`
- `sourceMapRootPath` : The root path for storing the generated source map file.

## Build-time execution of bundling and minification

The [BuildBundlerMinifier](#) NuGet package enables the execution of bundling and minification at build time. The package injects [MSBuild Targets](#) which run at build and clean time. The `bundleconfig.json` file is analyzed by the build process to produce the output files based on the defined configuration.

### NOTE

`BuildBundlerMinifier` belongs to a community-driven project on GitHub for which Microsoft provides no support. Issues should be filed [here](#).

- [Visual Studio](#)
- [.NET Core CLI](#)

Add the `BuildBundlerMinifier` package to your project.

Build the project. The following appears in the Output window:

```
1>----- Build started: Project: BuildBundlerMinifierApp, Configuration: Debug Any CPU -----
1>
1>Bundler: Begin processing bundleconfig.json
1> Minified wwwroot/css/site.min.css
1> Minified wwwroot/js/site.min.js
1>Bundler: Done processing bundleconfig.json
1>BuildBundlerMinifierApp -> C:\BuildBundlerMinifierApp\bin\Debug\netcoreapp2.0\BuildBundlerMinifierApp.dll
===== Build: 1 succeeded, 0 failed, 0 up-to-date, 0 skipped =====
```

Clean the project. The following appears in the Output window:

```
1>----- Clean started: Project: BuildBundlerMinifierApp, Configuration: Debug Any CPU -----
1>
1>Bundler: Cleaning output from bundleconfig.json
1>Bundler: Done cleaning output file from bundleconfig.json
===== Clean: 1 succeeded, 0 failed, 0 skipped =====
```

## Ad hoc execution of bundling and minification

It's possible to run the bundling and minification tasks on an ad hoc basis, without building the project. Add the [BundlerMinifier.Core](#) NuGet package to your project:

```
<DotNetCliToolReference Include="BundlerMinifier.Core" Version="2.6.362" />
```

### NOTE

BundlerMinifier.Core belongs to a community-driven project on GitHub for which Microsoft provides no support. Issues should be filed [here](#).

This package extends the .NET Core CLI to include the *dotnet-bundle* tool. The following command can be executed in the Package Manager Console (PMC) window or in a command shell:

```
dotnet bundle
```

### IMPORTANT

NuGet Package Manager adds dependencies to the \*.csproj file as `<PackageReference />` nodes. The `dotnet bundle` command is registered with the .NET Core CLI only when a `<DotNetCliToolReference />` node is used. Modify the \*.csproj file accordingly.

## Add files to workflow

Consider an example in which an additional *custom.css* file is added resembling the following:

```
.about, [role=main], [role=complementary] {
    margin-top: 60px;
}

footer {
    margin-top: 10px;
}
```

To minify `custom.css` and bundle it with `site.css` into a `site.min.css` file, add the relative path to `bundleconfig.json`:

```
[  
  {  
    "outputFileName": "wwwroot/css/site.min.css",  
    "inputFiles": [  
      "wwwroot/css/site.css",  
      "wwwroot/css/custom.css"  
    ]  
  },  
  {  
    "outputFileName": "wwwroot/js/site.min.js",  
    "inputFiles": [  
      "wwwroot/js/site.js"  
    ],  
    "minify": {  
      "enabled": true,  
      "renameLocals": true  
    },  
    "sourceMap": false  
  }  
]
```

#### NOTE

Alternatively, the following globbing pattern could be used:

```
"inputFiles": ["wwwroot/**/*(*.css|!(*.min.css)"]
```

This globbing pattern matches all CSS files and excludes the minified file pattern.

Build the application. Open `site.min.css` and notice the content of `custom.css` is appended to the end of the file.

## Environment-based bundling and minification

As a best practice, the bundled and minified files of your app should be used in a production environment. During development, the original files make for easier debugging of the app.

Specify which files to include in your pages by using the [Environment Tag Helper](#) in your views. The Environment Tag Helper only renders its contents when running in specific [environments](#).

The following `<environment>` tag renders the unprocessed CSS files when running in the `Development` environment:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
<environment include="Development">  
  <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />  
  <link rel="stylesheet" href="~/css/site.css" />  
</environment>
```

The following `<environment>` tag renders the bundled and minified CSS files when running in an environment other than `Development`. For example, running in `Production` or `Staging` triggers the rendering of these stylesheets:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
<environment exclude="Development">
  <link rel="stylesheet" href="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/css/bootstrap.min.css"
    asp-fallback-href="~/lib/bootstrap/dist/css/bootstrap.min.css"
    asp-fallback-test-class="sr-only" asp-fallback-test-property="position" asp-fallback-test-
    value="absolute" />
  <link rel="stylesheet" href="~/css/site.min.css" asp-append-version="true" />
</environment>
```

## Consume bundleconfig.json from Gulp

There are cases in which an app's bundling and minification workflow requires additional processing. Examples include image optimization, cache busting, and CDN asset processing. To satisfy these requirements, you can convert the bundling and minification workflow to use Gulp.

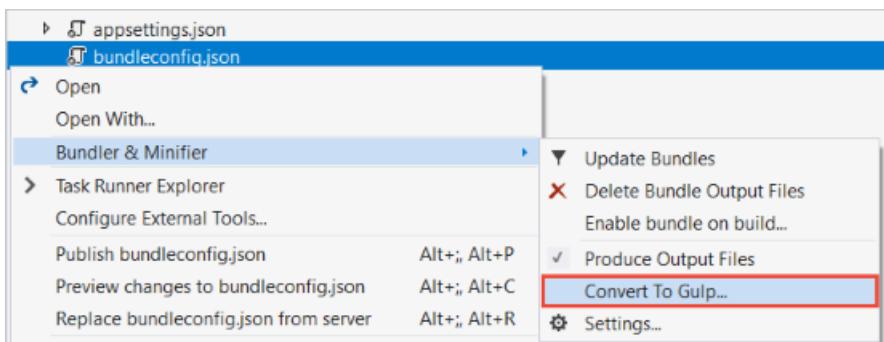
### Use the Bundler & Minifier extension

The Visual Studio [Bundler & Minifier](#) extension handles the conversion to Gulp.

#### NOTE

The Bundler & Minifier extension belongs to a community-driven project on GitHub for which Microsoft provides no support. Issues should be filed [here](#).

Right-click the `bundleconfig.json` file in Solution Explorer and select **Bundler & Minifier > Convert To Gulp...**:



The `gulpfile.js` and `package.json` files are added to the project. The supporting [npm](#) packages listed in the `package.json` file's `devDependencies` section are installed.

Run the following command in the PMC window to install the Gulp CLI as a global dependency:

```
npm i -g gulp-cli
```

The `gulpfile.js` file reads the `bundleconfig.json` file for the inputs, outputs, and settings.

```
"use strict";

var gulp = require("gulp"),
  concat = require("gulp-concat"),
  cssmin = require("gulp-cssmin"),
  htmlmin = require("gulp-htmlmin"),
  uglify = require("gulp-uglify"),
  merge = require("merge-stream"),
  del = require("del"),
  bundleconfig = require("./bundleconfig.json");

// Code omitted for brevity
```

## Convert manually

If Visual Studio and/or the Bundler & Minifier extension aren't available, convert manually.

Add a `package.json` file, with the following `devDependencies`, to the project root:

```
"devDependencies": {  
  "del": "^3.0.0",  
  "gulp": "^3.9.1",  
  "gulp-concat": "^2.6.1",  
  "gulp-cssmin": "^0.2.0",  
  "gulp-htmlmin": "^3.0.0",  
  "gulp-uglify": "^3.0.0",  
  "merge-stream": "^1.0.1"  
}
```

Install the dependencies by running the following command at the same level as `package.json`:

```
npm i
```

Install the Gulp CLI as a global dependency:

```
npm i -g gulp-cli
```

Copy the `gulpfile.js` file below to the project root:

```
"use strict";  
  
var gulp = require("gulp"),  
    concat = require("gulp-concat"),  
    cssmin = require("gulp-cssmin"),  
    htmlmin = require("gulp-htmlmin"),  
    uglify = require("gulp-uglify"),  
    merge = require("merge-stream"),  
    del = require("del"),  
    bundleconfig = require("./bundleconfig.json");  
  
var regex = {  
  css: /\.css$/,  
  html: /\.(html|htm)$/,  
  js: /\.js$/  
};  
  
gulp.task("min", ["min:js", "min:css", "min:html"]);  
  
gulp.task("min:js", function () {  
  var tasks = getBundles(regex.js).map(function (bundle) {  
    return gulp.src(bundle.inputFiles, { base: "." })  
      .pipe(concat(bundle.outputFileName))  
      .pipe(uglify())  
      .pipe(gulp.dest("."));  
  });  
  return merge(tasks);  
});  
  
gulp.task("min:css", function () {  
  var tasks = getBundles(regex.css).map(function (bundle) {  
    return gulp.src(bundle.inputFiles, { base: "." })  
      .pipe(concat(bundle.outputFileName))  
      .pipe(cssmin())  
      .pipe(gulp.dest("."));  
  });  
  return merge(tasks);  
});
```

```

});

gulp.task("min:html", function () {
    var tasks = getBundles(regex.html).map(function (bundle) {
        return gulp.src(bundle.inputFiles, { base: "." })
            .pipe(concat(bundle.outputFileName))
            .pipe(htmlmin({ collapseWhitespace: true, minifyCSS: true, minifyJS: true }))
            .pipe(gulp.dest("."));
    });
    return merge(tasks);
});

gulp.task("clean", function () {
    var files = bundleconfig.map(function (bundle) {
        return bundle.outputFileName;
    });

    return del(files);
});

gulp.task("watch", function () {
    getBundles(regex.js).forEach(function (bundle) {
        gulp.watch(bundle.inputFiles, ["min:js"]);
    });

    getBundles(regex.css).forEach(function (bundle) {
        gulp.watch(bundle.inputFiles, ["min:css"]);
    });

    getBundles(regex.html).forEach(function (bundle) {
        gulp.watch(bundle.inputFiles, ["min:html"]);
    });
});

function getBundles(regexPattern) {
    return bundleconfig.filter(function (bundle) {
        return regexPattern.test(bundle.outputFileName);
    });
}
}

```

## Run Gulp tasks

To trigger the Gulp minification task before the project builds in Visual Studio, add the following [MSBuild Target](#) to the \*.csproj file:

```

<Target Name="MyPreCompileTarget" BeforeTargets="Build">
    <Exec Command="gulp min" />
</Target>

```

In this example, any tasks defined within the `MyPreCompileTarget` target run before the predefined `Build` target. Output similar to the following appears in Visual Studio's Output window:

```

1>----- Build started: Project: BuildBundlerMinifierApp, Configuration: Debug Any CPU -----
1>BuildBundlerMinifierApp -> C:\BuildBundlerMinifierApp\bin\Debug\netcoreapp2.0\BuildBundlerMinifierApp.dll
1>[14:17:49] Using gulpfile C:\BuildBundlerMinifierApp\gulpfile.js
1>[14:17:49] Starting 'min:js'...
1>[14:17:49] Starting 'min:css'...
1>[14:17:49] Starting 'min:html'...
1>[14:17:49] Finished 'min:js' after 83 ms
1>[14:17:49] Finished 'min:css' after 88 ms
===== Build: 1 succeeded, 0 failed, 0 up-to-date, 0 skipped =====

```

Alternatively, Visual Studio's Task Runner Explorer may be used to bind Gulp tasks to specific Visual Studio events.

See [Running default tasks](#) for instructions on doing that.

## Additional resources

- [Use Gulp](#)
- [Use Grunt](#)
- [Use multiple environments](#)
- [Tag Helpers](#)

# Browser Link in ASP.NET Core

7/6/2018 • 3 minutes to read • [Edit Online](#)

By [Nicolò Carandini](#), [Mike Wasson](#), and [Tom Dykstra](#)

Browser Link is a feature in Visual Studio that creates a communication channel between the development environment and one or more web browsers. You can use Browser Link to refresh your web application in several browsers at once, which is useful for cross-browser testing.

## Browser Link setup

When converting an ASP.NET Core 2.0 project to ASP.NET Core 2.1 and transitioning to the [Microsoft.AspNetCore.App metapackage](#), install the [Microsoft.VisualStudio.Web.BrowserLink](#) package for BrowserLink functionality. The ASP.NET Core 2.1 project templates use the `Microsoft.AspNetCore.App` metapackage by default.

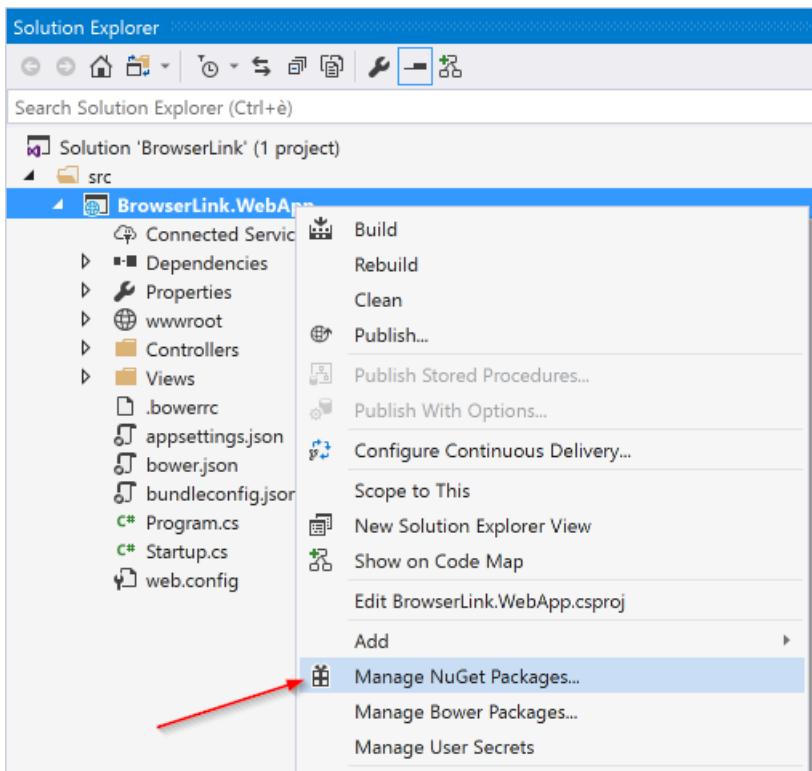
The ASP.NET Core 2.0 **Web Application**, **Empty**, and **Web API** project templates use the [Microsoft.AspNetCore.All metapackage](#), which contains a package reference for [Microsoft.VisualStudio.Web.BrowserLink](#). Therefore, using the `Microsoft.AspNetCore.All` metapackage requires no further action to make Browser Link available for use.

The ASP.NET Core 1.x **Web Application** project template has a package reference for the [Microsoft.VisualStudio.Web.BrowserLink](#) package. The **Empty** or **Web API** template projects require you to add a package reference to `Microsoft.VisualStudio.Web.BrowserLink`.

Since this is a Visual Studio feature, the easiest way to add the package to an **Empty** or **Web API** template project is to open the **Package Manager Console** (**View > Other Windows > Package Manager Console**) and run the following command:

```
install-package Microsoft.VisualStudio.Web.BrowserLink
```

Alternatively, you can use **NuGet Package Manager**. Right-click the project name in **Solution Explorer** and choose **Manage NuGet Packages**:



Find and install the package:

The screenshot shows the NuGet Package Manager interface. The search bar at the top contains the text 'Microsoft.VisualStudio.Web.BrowserLink.Loader'. The results pane displays a single item: 'Microsoft.VisualStudio.Web.BrowserLink.Loader' by Microsoft, version v14.1.0. The description states: 'A middleware that supports creating a communication channel between the development environment and one or more web browsers.' On the right side, there is a detailed view of the package. It shows the version 'Latest stable 14.1.0' and an 'Install' button, which is highlighted with a red arrow. Below the main pane, there are tabs for 'Options' and 'Description'.

## Configuration

In the `Startup.Configure` method:

```
app.UseBrowserLink();
```

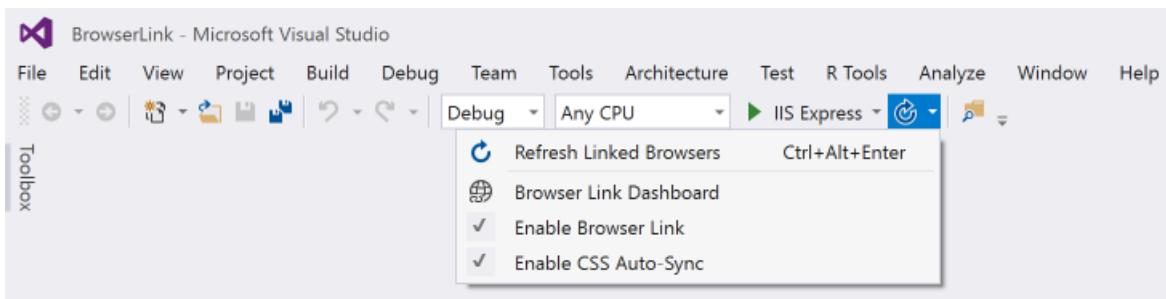
Usually the code is inside an `if` block that only enables Browser Link in the Development environment, as shown here:

```
if (env.IsDevelopment())
{
    app.UseDeveloperExceptionPage();
    app.UseBrowserLink();
}
```

For more information, see [Use multiple environments](#).

## How to use Browser Link

When you have an ASP.NET Core project open, Visual Studio shows the Browser Link toolbar control next to the **Debug Target** toolbar control:



From the Browser Link toolbar control, you can:

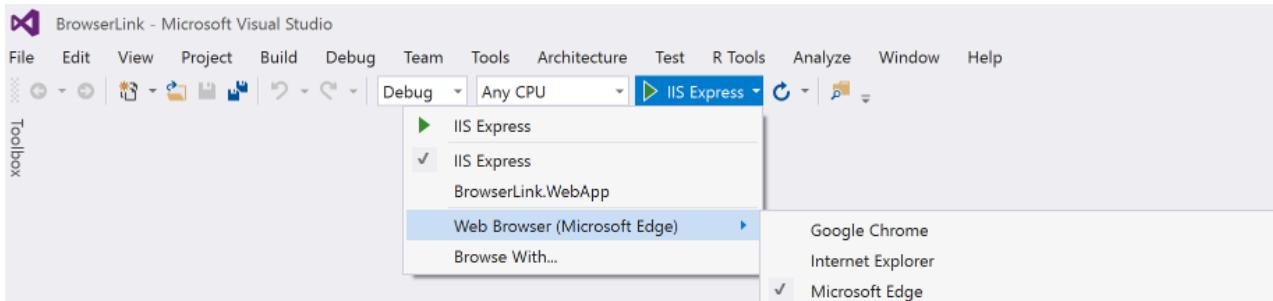
- Refresh the web application in several browsers at once.
- Open the **Browser Link Dashboard**.
- Enable or disable **Browser Link**. Note: Browser Link is disabled by default in Visual Studio 2017 (15.3).
- Enable or disable [CSS Auto-Sync](#).

#### NOTE

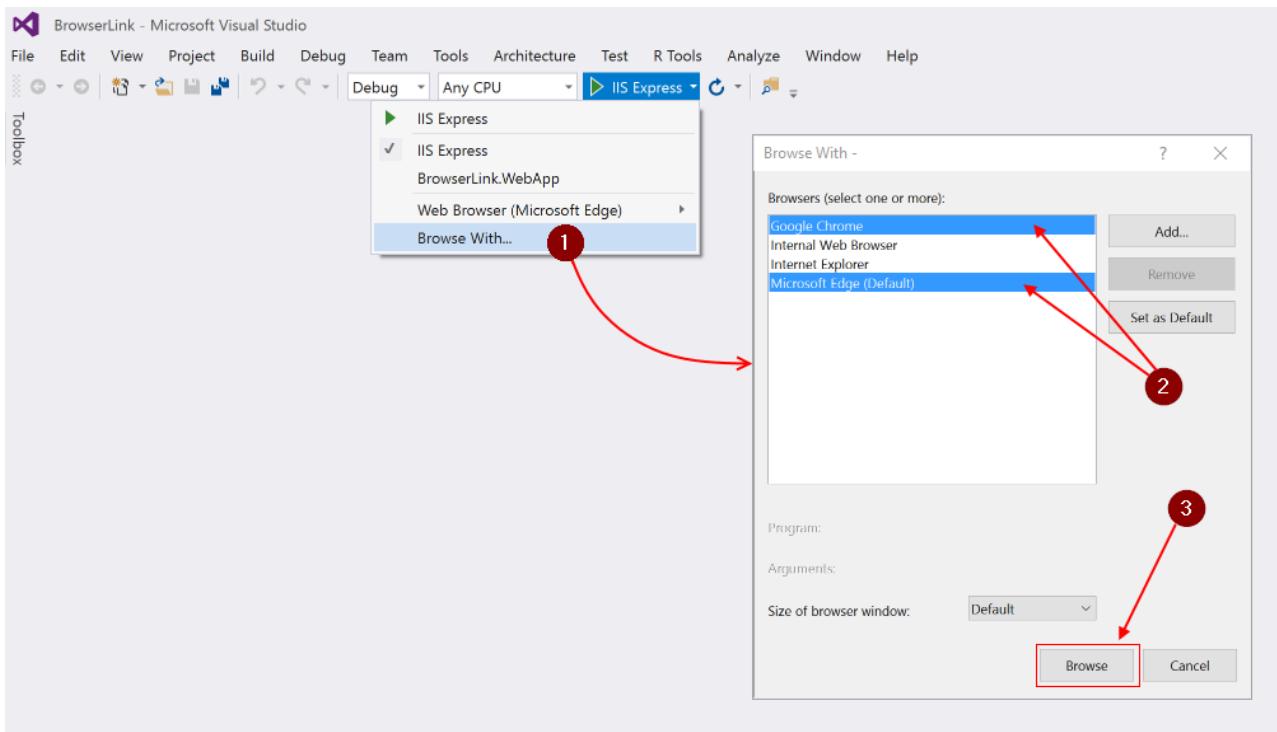
Some Visual Studio plug-ins, most notably *Web Extension Pack 2015* and *Web Extension Pack 2017*, offer extended functionality for Browser Link, but some of the additional features don't work with ASP.NET Core projects.

## Refresh the web app in several browsers at once

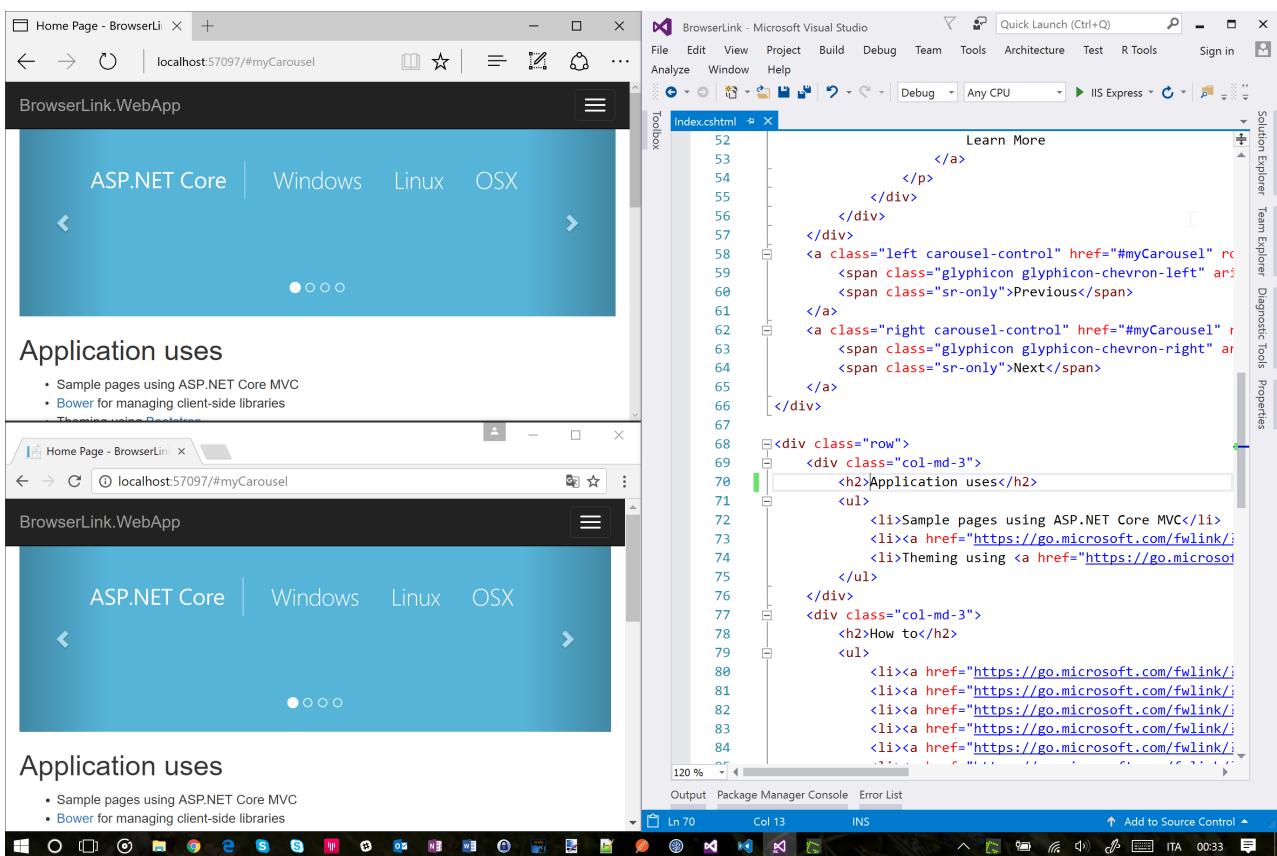
To choose a single web browser to launch when starting the project, use the drop-down menu in the **Debug Target** toolbar control:



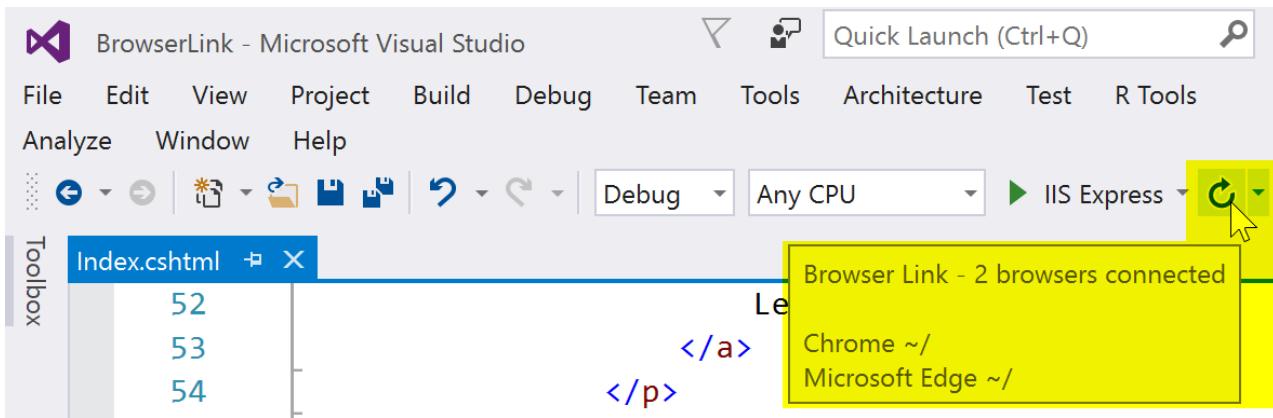
To open multiple browsers at once, choose **Browse with...** from the same drop-down. Hold down the CTRL key to select the browsers you want, and then click **Browse**:



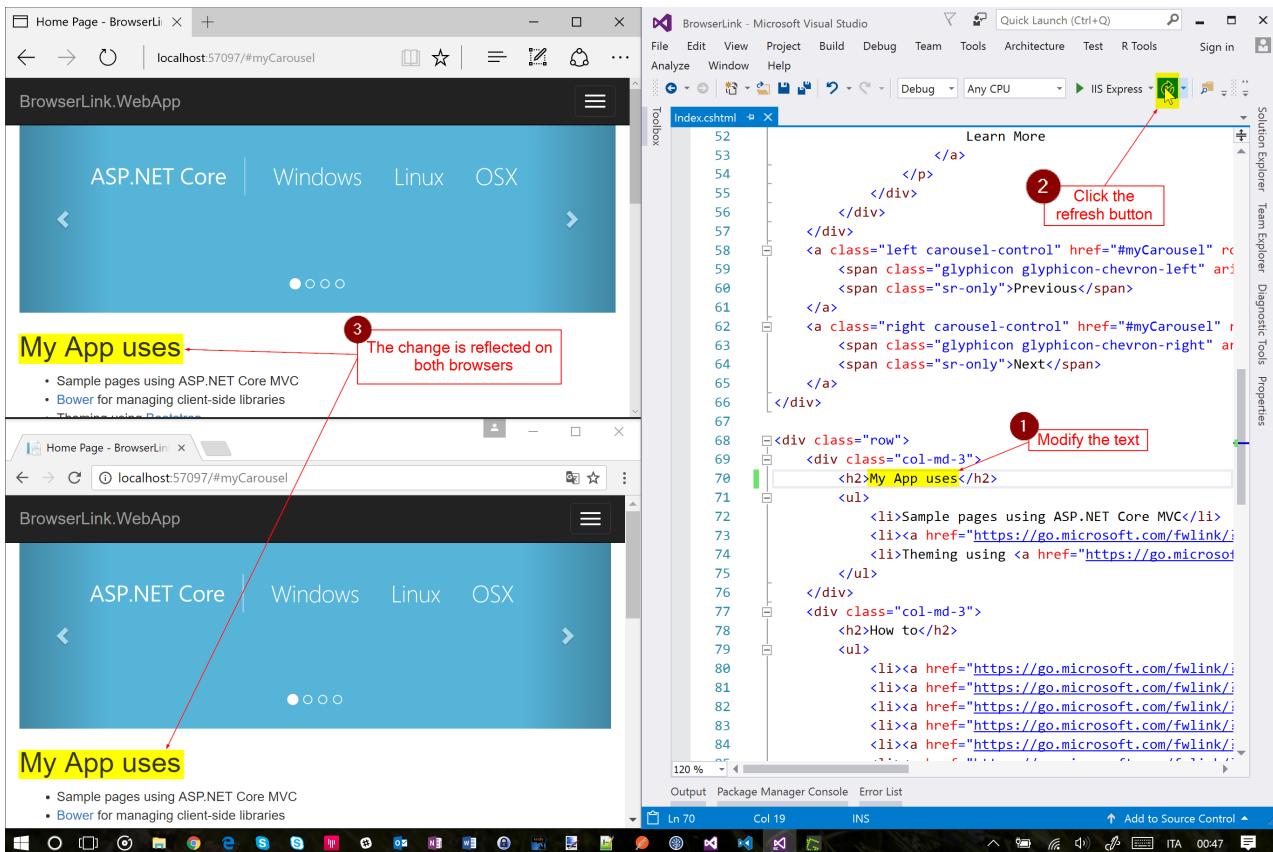
Here's a screenshot showing Visual Studio with the Index view open and two open browsers:



Hover over the Browser Link toolbar control to see the browsers that are connected to the project:



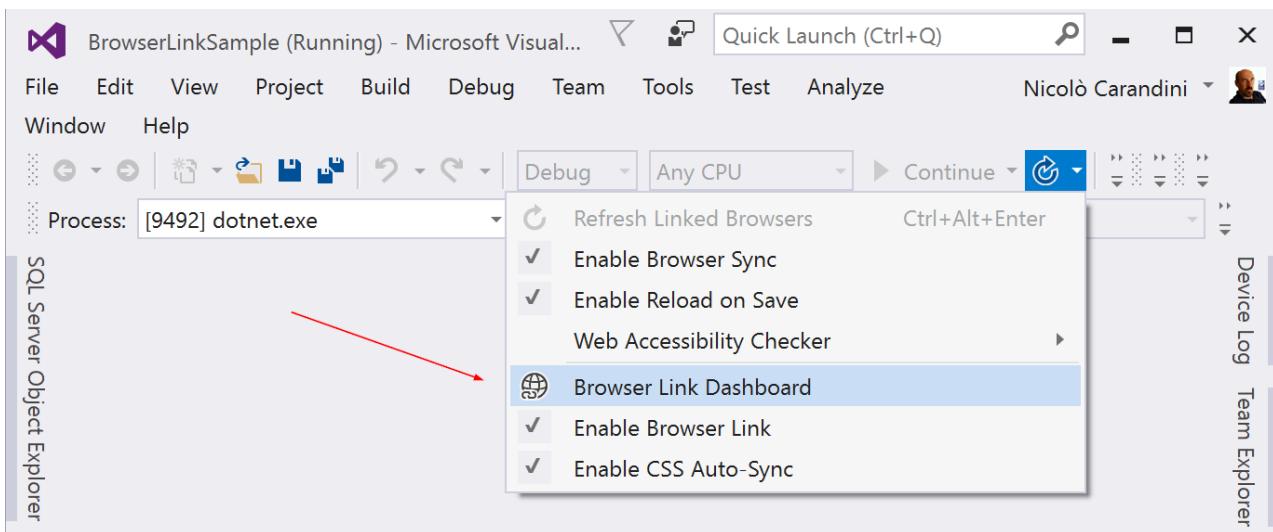
Change the Index view, and all connected browsers are updated when you click the Browser Link refresh button:



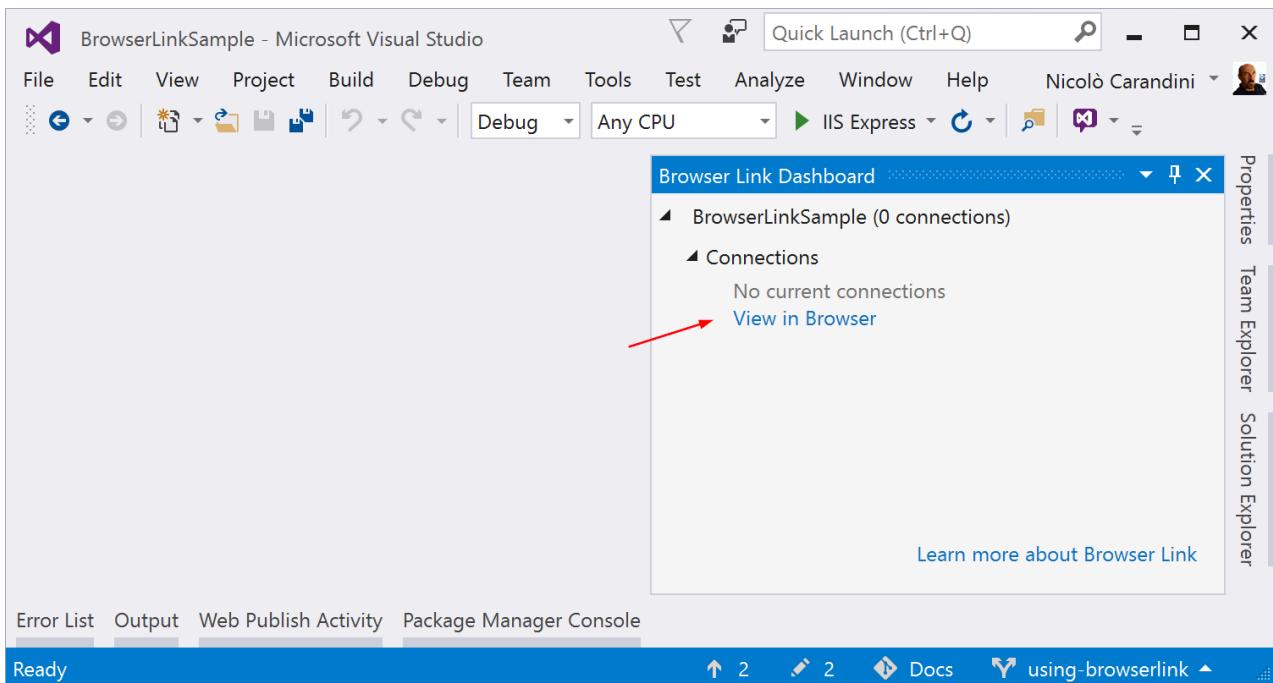
Browser Link also works with browsers that you launch from outside Visual Studio and navigate to the application URL.

## The Browser Link Dashboard

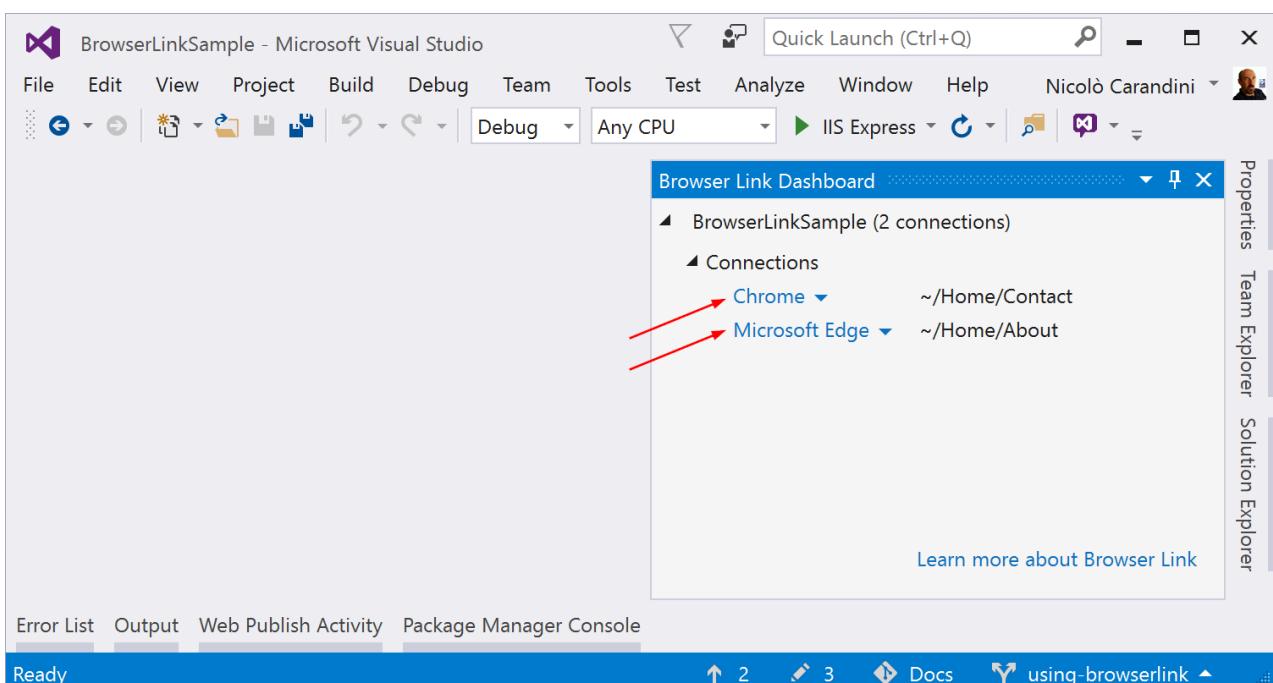
Open the Browser Link Dashboard from the Browser Link drop down menu to manage the connection with open browsers:



If no browser is connected, you can start a non-debugging session by selecting the *View in Browser* link:



Otherwise, the connected browsers are shown with the path to the page that each browser is showing:



If you like, you can click on a listed browser name to refresh that single browser.

### Enable or disable Browser Link

When you re-enable Browser Link after disabling it, you must refresh the browsers to reconnect them.

### Enable or disable CSS Auto-Sync

When CSS Auto-Sync is enabled, connected browsers are automatically refreshed when you make any change to CSS files.

## How it works

Browser Link uses SignalR to create a communication channel between Visual Studio and the browser. When Browser Link is enabled, Visual Studio acts as a SignalR server that multiple clients (browsers) can connect to. Browser Link also registers a middleware component in the ASP.NET request pipeline. This component injects special `<script>` references into every page request from the server. You can see the script references by selecting **View source** in the browser and scrolling to the end of the `<body>` tag content:

```
<!-- Visual Studio Browser Link -->
<script type="application/json" id="__browserLink_initializationData">
    {"requestId":"a717d5a07c1741949a7cefd6fa2bad08","requestMappingFromServer":false}
</script>
<script type="text/javascript" src="http://localhost:54139/b6e36e429d034f578ebccd6a79bf19bf/browserLink"
async="async"></script>
<!-- End Browser Link -->
</body>
```

Your source files aren't modified. The middleware component injects the script references dynamically.

Because the browser-side code is all JavaScript, it works on all browsers that SignalR supports without requiring a browser plug-in.

# Use JavaScriptServices to Create Single Page Applications in ASP.NET Core

7/3/2018 • 11 minutes to read • [Edit Online](#)

By [Scott Addie](#) and [Fiyaz Hasan](#)

A Single Page Application (SPA) is a popular type of web application due to its inherent rich user experience. Integrating client-side SPA frameworks or libraries, such as [Angular](#) or [React](#), with server-side frameworks like ASP.NET Core can be difficult. [JavaScriptServices](#) was developed to reduce friction in the integration process. It enables seamless operation between the different client and server technology stacks.

[View or download sample code \(how to download\)](#)

## What is JavaScriptServices?

JavaScriptServices is a collection of client-side technologies for ASP.NET Core. Its goal is to position ASP.NET Core as developers' preferred server-side platform for building SPAs.

JavaScriptServices consists of three distinct NuGet packages:

- [Microsoft.AspNetCore.NodeServices](#) (NodeServices)
- [Microsoft.AspNetCore.SpaServices](#) (SpaServices)
- [Microsoft.AspNetCore.SpaTemplates](#) (SpaTemplates)

These packages are useful if you:

- Run JavaScript on the server
- Use a SPA framework or library
- Build client-side assets with Webpack

Much of the focus in this article is placed on using the SpaServices package.

## What is SpaServices?

SpaServices was created to position ASP.NET Core as developers' preferred server-side platform for building SPAs. SpaServices isn't required to develop SPAs with ASP.NET Core, and it doesn't lock you into a particular client framework.

SpaServices provides useful infrastructure such as:

- [Server-side prerendering](#)
- [Webpack Dev Middleware](#)
- [Hot Module Replacement](#)
- [Routing helpers](#)

Collectively, these infrastructure components enhance both the development workflow and the runtime experience. The components can be adopted individually.

## Prerequisites for using SpaServices

To work with SpaServices, install the following:

- [Node.js](#) (version 6 or later) with npm
  - To verify these components are installed and can be found, run the following from the command line:

```
node -v && npm -v
```

Note: If you're deploying to an Azure web site, you don't need to do anything here — Node.js is installed and available in the server environments.

- [.NET Core SDK 2.0 or later](#)
  - If you're on Windows using Visual Studio 2017, the SDK is installed by selecting the **.NET Core cross-platform development** workload.
- [Microsoft.AspNetCore.SpaServices](#) NuGet package

## Server-side prerendering

A universal (also known as isomorphic) application is a JavaScript application capable of running both on the server and the client. Angular, React, and other popular frameworks provide a universal platform for this application development style. The idea is to first render the framework components on the server via Node.js, and then delegate further execution to the client.

ASP.NET Core [Tag Helpers](#) provided by SpaServices simplify the implementation of server-side prerendering by invoking the JavaScript functions on the server.

### Prerequisites

Install the following:

- [aspnet-prerendering](#) npm package:

```
npm i -S aspnet-prerendering
```

### Configuration

The Tag Helpers are made discoverable via namespace registration in the project's `_ViewImports.cshtml` file:

```
@using SpaServicesSampleApp  
@addTagHelper "*", Microsoft.AspNetCore.Mvc.TagHelpers"  
@addTagHelper "*", Microsoft.AspNetCore.SpaServices"
```

These Tag Helpers abstract away the intricacies of communicating directly with low-level APIs by leveraging an HTML-like syntax inside the Razor view:

```
<app asp-prerender-module="ClientApp/dist/main-server">Loading...</app>
```

### The `asp-prerender-module` Tag Helper

The `asp-prerender-module` Tag Helper, used in the preceding code example, executes `ClientApp/dist/main-server.js` on the server via Node.js. For clarity's sake, `main-server.js` file is an artifact of the TypeScript-to-JavaScript transpilation task in the [Webpack](#) build process. Webpack defines an entry point alias of `main-server`; and, traversal of the dependency graph for this alias begins at the `ClientApp/boot-server.ts` file:

```
entry: { 'main-server': './ClientApp/boot-server.ts' },
```

In the following Angular example, the `ClientApp/boot-server.ts` file utilizes the `createServerRenderer` function and `RenderResult` type of the `aspnet-prerendering` npm package to configure server rendering via Node.js. The HTML markup destined for server-side rendering is passed to a resolve function call, which is wrapped in a strongly-typed JavaScript `Promise` object. The `Promise` object's significance is that it asynchronously supplies the HTML markup to the page for injection in the DOM's placeholder element.

```
import { createServerRenderer, RenderResult } from 'aspnet-prerendering';

export default createServerRenderer(params => {
    const providers = [
        { provide: INITIAL_CONFIG, useValue: { document: '<app></app>', url: params.url } },
        { provide: 'ORIGIN_URL', useValue: params.origin }
    ];

    return platformDynamicServer(providers).bootstrapModule(AppModule).then(moduleRef => {
        const appRef = moduleRef.injector.get(ApplicationRef);
        const state = moduleRef.injector.get(PlatformState);
        const zone = moduleRef.injector.get(NgZone);

        return new Promise<RenderResult>((resolve, reject) => {
            zone.onError.subscribe(errorInfo => reject(errorInfo));
            appRef.isStable.first(isStable => isStable).subscribe(() => {
                // Because 'onStable' fires before 'onError', we have to delay slightly before
                // completing the request in case there's an error to report
                setImmediate(() => {
                    resolve({
                        html: state.renderToString()
                    });
                    moduleRef.destroy();
                });
            });
        });
    });
});
```

## The `asp-prerender-data` Tag Helper

When coupled with the `asp-prerender-module` Tag Helper, the `asp-prerender-data` Tag Helper can be used to pass contextual information from the Razor view to the server-side JavaScript. For example, the following markup passes user data to the `main-server` module:

```
<app asp-prerender-module="ClientApp/dist/main-server"
    asp-prerender-data='new {
        UserName = "John Doe"
    }'>Loading...</app>
```

The received `UserName` argument is serialized using the built-in JSON serializer and is stored in the `params.data` object. In the following Angular example, the data is used to construct a personalized greeting within an `h1` element:

```

import { createServerRenderer, RenderResult } from 'aspnet-prerendering';

export default createServerRenderer(params => {
    const providers = [
        { provide: INITIAL_CONFIG, useValue: { document: '<app></app>', url: params.url } },
        { provide: 'ORIGIN_URL', useValue: params.origin }
    ];

    return platformDynamicServer(providers).bootstrapModule(AppModule).then(moduleRef => {
        const appRef = moduleRef.injector.get(ApplicationRef);
        const state = moduleRef.injector.get(PlatformState);
        const zone = moduleRef.injector.get(NgZone);

        return new Promise<RenderResult>((resolve, reject) => {
            const result = `<h1>Hello, ${params.data.userName}</h1>`;

            zone.onError.subscribe(errorInfo => reject(errorInfo));
            appRef.isStable.first(isStable => isStable).subscribe(() => {
                // Because 'onStable' fires before 'onError', we have to delay slightly before
                // completing the request in case there's an error to report
                setImmediate(() => {
                    resolve({
                        html: result
                    });
                    moduleRef.destroy();
                });
            });
        });
    });
});

```

Note: Property names passed in Tag Helpers are represented with **PascalCase** notation. Contrast that to JavaScript, where the same property names are represented with **camelCase**. The default JSON serialization configuration is responsible for this difference.

To expand upon the preceding code example, data can be passed from the server to the view by hydrating the `globals` property provided to the `resolve` function:

```

import { createServerRenderer, RenderResult } from 'aspnet-prerendering';

export default createServerRenderer(params => {
    const providers = [
        { provide: INITIAL_CONFIG, useValue: { document: '<app></app>', url: params.url } },
        { provide: 'ORIGIN_URL', useValue: params.origin }
    ];

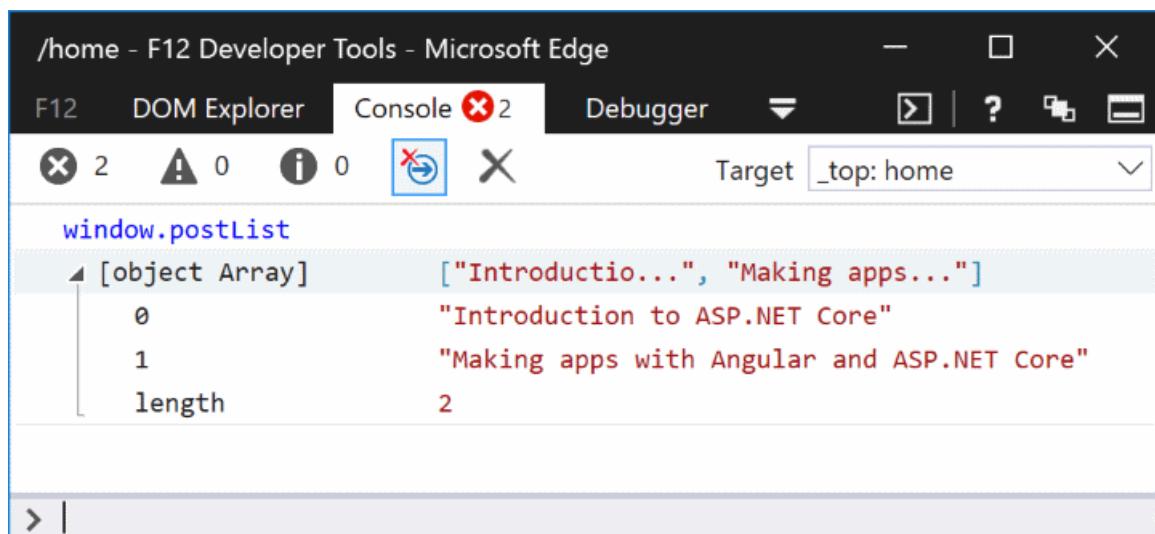
    return platformDynamicServer(providers).bootstrapModule(AppModule).then(moduleRef => {
        const appRef = moduleRef.injector.get(ApplicationRef);
        const state = moduleRef.injector.get(PlatformState);
        const zone = moduleRef.injector.get(NgZone);

        return new Promise<RenderResult>((resolve, reject) => {
            const result = `<h1>Hello, ${params.data.userName}</h1>`;

            zone.onError.subscribe(errorInfo => reject(errorInfo));
            appRef.isStable.first(isStable => isStable).subscribe(() => {
                // Because 'onStable' fires before 'onError', we have to delay slightly before
                // completing the request in case there's an error to report
                setImmediate(() => {
                    resolve({
                        html: result,
                        globals: {
                            postList: [
                                'Introduction to ASP.NET Core',
                                'Making apps with Angular and ASP.NET Core'
                            ]
                        }
                    });
                    moduleRef.destroy();
                });
            });
        });
    });
});

```

The `window.postList` array defined inside the `globals` object is attached to the browser's global `window` object. This variable hoisting to global scope eliminates duplication of effort, particularly as it pertains to loading the same data once on the server and again on the client.



## Webpack Dev Middleware

[Webpack Dev Middleware](#) introduces a streamlined development workflow whereby Webpack builds resources on demand. The middleware automatically compiles and serves client-side resources when a page is reloaded in the browser. The alternate approach is to manually invoke Webpack via the project's npm build script when a

third-party dependency or the custom code changes. An npm build script in the `package.json` file is shown in the following example:

```
"build": "npm run build:vendor && npm run build:custom",
```

## Prerequisites

Install the following:

- [aspnet-webpack](#) npm package:

```
npm i -D aspnet-webpack
```

## Configuration

Webpack Dev Middleware is registered into the HTTP request pipeline via the following code in the `Startup.cs` file's `Configure` method:

```
if (env.IsDevelopment())
{
    app.UseDeveloperExceptionPage();
    app.UseWebpackDevMiddleware();
}
else
{
    app.UseExceptionHandler("/Home/Error");
}

// Call UseWebpackDevMiddleware before UseStaticFiles
app.UseStaticFiles();
```

The `UseWebpackDevMiddleware` extension method must be called before [registering static file hosting](#) via the `UseStaticFiles` extension method. For security reasons, register the middleware only when the app runs in development mode.

The `webpack.config.js` file's `output.publicPath` property tells the middleware to watch the `dist` folder for changes:

```
module.exports = (env) => {
    output: {
        filename: '[name].js',
        publicPath: '/dist/' // Webpack dev middleware, if enabled, handles requests for this URL prefix
    },
}
```

## Hot Module Replacement

Think of Webpack's [Hot Module Replacement](#) (HMR) feature as an evolution of [Webpack Dev Middleware](#). HMR introduces all the same benefits, but it further streamlines the development workflow by automatically updating page content after compiling the changes. Don't confuse this with a refresh of the browser, which would interfere with the current in-memory state and debugging session of the SPA. There's a live link between the Webpack Dev Middleware service and the browser, which means changes are pushed to the browser.

## Prerequisites

Install the following:

- [webpack-hot-middleware](#) npm package:

```
npm i -D webpack-hot-middleware
```

## Configuration

The HMR component must be registered into MVC's HTTP request pipeline in the `Configure` method:

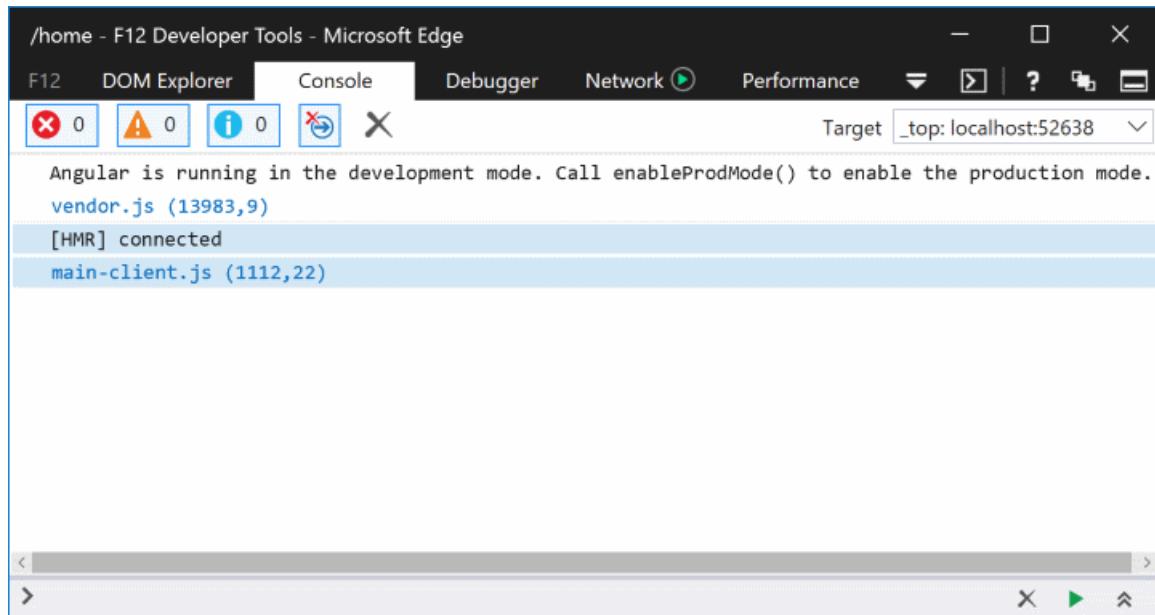
```
app.UseWebpackDevMiddleware(new WebpackDevMiddlewareOptions {
    HotModuleReplacement = true
});
```

As was true with [Webpack Dev Middleware](#), the `UseWebpackDevMiddleware` extension method must be called before the `UseStaticFiles` extension method. For security reasons, register the middleware only when the app runs in development mode.

The `webpack.config.js` file must define a `plugins` array, even if it's left empty:

```
module.exports = (env) => {
    plugins: [new CheckerPlugin()]
```

After loading the app in the browser, the developer tools' Console tab provides confirmation of HMR activation:



## Routing helpers

In most ASP.NET Core-based SPAs, you'll want client-side routing in addition to server-side routing. The SPA and MVC routing systems can work independently without interference. There's, however, one edge case posing challenges: identifying 404 HTTP responses.

Consider the scenario in which an extensionless route of `/some/page` is used. Assume the request doesn't pattern-match a server-side route, but its pattern does match a client-side route. Now consider an incoming request for `/images/user-512.png`, which generally expects to find an image file on the server. If that requested resource path doesn't match any server-side route or static file, it's unlikely that the client-side application would handle it — you generally want to return a 404 HTTP status code.

### Prerequisites

Install the following:

- The client-side routing npm package. Using Angular as an example:

```
npm i -S @angular/router
```

## Configuration

An extension method named `MapSpaFallbackRoute` is used in the `Configure` method:

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");

    routes.MapSpaFallbackRoute(
        name: "spa-fallback",
        defaults: new { controller = "Home", action = "Index" });
});
```

Tip: Routes are evaluated in the order in which they're configured. Consequently, the `default` route in the preceding code example is used first for pattern matching.

## Creating a new project

JavaScriptServices provides pre-configured application templates. SpaServices is used in these templates, in conjunction with different frameworks and libraries such as Angular, React, and Redux.

These templates can be installed via the .NET Core CLI by running the following command:

```
dotnet new --install Microsoft.AspNetCore.SpaTemplates::*
```

A list of available SPA templates is displayed:

TEMPLATES	SHORT NAME	LANGUAGE	TAGS
MVC ASP.NET Core with Angular	angular	[C#]	Web/MVC/SPA
MVC ASP.NET Core with React.js	react	[C#]	Web/MVC/SPA
MVC ASP.NET Core with React.js and Redux	reactredux	[C#]	Web/MVC/SPA

To create a new project using one of the SPA templates, include the **Short Name** of the template in the `dotnet new` command. The following command creates an Angular application with ASP.NET Core MVC configured for the server side:

```
dotnet new angular
```

## Set the runtime configuration mode

Two primary runtime configuration modes exist:

- **Development:**

- Includes source maps to ease debugging.
- Doesn't optimize the client-side code for performance.

- **Production:**

- Excludes source maps.
- Optimizes the client-side code via bundling & minification.

ASP.NET Core uses an environment variable named `ASPNETCORE_ENVIRONMENT` to store the configuration mode. See [Set the environment](#) for more information.

## Running with .NET Core CLI

Restore the required NuGet and npm packages by running the following command at the project root:

```
dotnet restore && npm i
```

Build and run the application:

```
dotnet run
```

The application starts on localhost according to the [runtime configuration mode](#). Navigating to `http://localhost:5000` in the browser displays the landing page.

## Running with Visual Studio 2017

Open the `.csproj` file generated by the [dotnet new](#) command. The required NuGet and npm packages are restored automatically upon project open. This restoration process may take up to a few minutes, and the application is ready to run when it completes. Click the green run button or press `Ctrl + F5`, and the browser opens to the application's landing page. The application runs on localhost according to the [runtime configuration mode](#).

## Testing the app

SpaServices templates are pre-configured to run client-side tests using [Karma](#) and [Jasmine](#). Jasmine is a popular unit testing framework for JavaScript, whereas Karma is a test runner for those tests. Karma is configured to work with the [Webpack Dev Middleware](#) such that the developer isn't required to stop and run the test every time changes are made. Whether it's the code running against the test case or the test case itself, the test runs automatically.

Using the Angular application as an example, two Jasmine test cases are already provided for the `CounterComponent` in the `counter.component.spec.ts` file:

```
it('should display a title', async(() => {
  const titleText = fixture.nativeElement.querySelector('h1').textContent;
  expect(titleText).toEqual('Counter');
}));

it('should start with count 0, then increments by 1 when clicked', async(() => {
  const countElement = fixture.nativeElement.querySelector('strong');
  expect(countElement.textContent).toEqual('0');

  const incrementButton = fixture.nativeElement.querySelector('button');
  incrementButton.click();
  fixture.detectChanges();
  expect(countElement.textContent).toEqual('1');
}));
```

Open the command prompt in the `ClientApp` directory. Run the following command:

```
npm test
```

The script launches the Karma test runner, which reads the settings defined in the `karma.conf.js` file. Among other settings, the `karma.conf.js` identifies the test files to be executed via its `files` array:

```
module.exports = function (config) {
  config.set({
    files: [
      '../..../wwwroot/dist/vendor.js',
      './boot-tests.ts'
    ],
  },
```

## Publishing the application

Combining the generated client-side assets and the published ASP.NET Core artifacts into a ready-to-deploy package can be cumbersome. Thankfully, SpaServices orchestrates that entire publication process with a custom MSBuild target named `RunWebpack`:

```
<Target Name="RunWebpack" AfterTargets="ComputeFilesToPublish">
  <!-- As part of publishing, ensure the JS resources are freshly built in production mode -->
  <Exec Command="npm install" />
  <Exec Command="node node_modules/webpack/bin/webpack.js --config webpack.config.vendor.js --env.prod" />
  <Exec Command="node node_modules/webpack/bin/webpack.js --env.prod" />

  <!-- Include the newly-built files in the publish output -->
  <ItemGroup>
    <DistFiles Include="wwwroot\dist\**; ClientApp\dist\**" />
    <ResolvedFileToPublish Include="@{DistFiles->'%{FullPath}'}" Exclude="@{ResolvedFileToPublish}">
      <RelativePath>%{DistFiles.Identity}</RelativePath>
      <CopyToPublishDirectory>PreserveNewest</CopyToPublishDirectory>
    </ResolvedFileToPublish>
  </ItemGroup>
</Target>
```

The MSBuild target has the following responsibilities:

1. Restore the npm packages
2. Create a production-grade build of the third-party, client-side assets
3. Create a production-grade build of the custom client-side assets
4. Copy the Webpack-generated assets to the publish folder

The MSBuild target is invoked when running:

```
dotnet publish -c Release
```

## Additional resources

- [Angular Docs](#)

# Use the Single Page Application templates with ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

## NOTE

The released .NET Core 2.0.x SDK includes older project templates for Angular, React, and React with Redux. This documentation isn't about those older project templates. This documentation is for the latest Angular, React, and React with Redux templates, which can be installed manually into ASP.NET Core 2.0. The templates are included by default with ASP.NET Core 2.1.

## Prerequisites

- [.NET Core SDK 2.0 or later](#)
- [Node.js](#), version 6 or later

## Installation

The templates are already installed with ASP.NET Core 2.1.

If you have ASP.NET Core 2.0, run the following command to install the updated ASP.NET Core templates for Angular, React, and React with Redux:

```
dotnet new --install Microsoft.DotNet.Web.Spa.ProjectTemplates::2.0.0
```

## Use the templates

- [Use the Angular project template](#)
- [Use the React project template](#)
- [Use the React with Redux project template](#)

# Use the Angular project template with ASP.NET Core

6/21/2018 • 10 minutes to read • [Edit Online](#)

## NOTE

This documentation isn't about the Angular project template included in ASP.NET Core 2.0. It's about the newer Angular template to which you can update manually. The template is included in ASP.NET Core 2.1 by default.

The updated Angular project template provides a convenient starting point for ASP.NET Core apps using Angular and the Angular CLI to implement a rich, client-side user interface (UI).

The template is equivalent to creating an ASP.NET Core project to act as an API backend and an Angular CLI project to act as a UI. The template offers the convenience of hosting both project types in a single app project. Consequently, the app project can be built and published as a single unit.

## Create a new app

If using ASP.NET Core 2.0, ensure you've [installed the updated React project template](#).

If you have ASP.NET Core 2.1 installed, there's no need to install the Angular project template.

Create a new project from a command prompt using the command `dotnet new angular` in an empty directory. For example, the following commands create the app in a *my-new-app* directory and switch to that directory:

```
dotnet new angular -o my-new-app
cd my-new-app
```

Run the app from either Visual Studio or the .NET Core CLI:

- [Visual Studio](#)
- [.NET Core CLI](#)

Open the generated *.csproj* file, and run the app as normal from there.

The build process restores npm dependencies on the first run, which can take several minutes. Subsequent builds are much faster.

The project template creates an ASP.NET Core app and an Angular app. The ASP.NET Core app is intended to be used for data access, authorization, and other server-side concerns. The Angular app, residing in the *ClientApp* subdirectory, is intended to be used for all UI concerns.

## Add pages, images, styles, modules, etc.

The *ClientApp* directory contains a standard Angular CLI app. See the official [Angular documentation](#) for more information.

There are slight differences between the Angular app created by this template and the one created by Angular CLI itself (via `ng new`); however, the app's capabilities are unchanged. The app created by the template contains a [Bootstrap](#)-based layout and a basic routing example.

## Run ng commands

In a command prompt, switch to the *ClientApp* subdirectory:

```
cd ClientApp
```

If you have the `ng` tool installed globally, you can run any of its commands. For example, you can run `ng lint`, `ng test`, or any of the other [Angular CLI commands](#). There's no need to run `ng serve` though, because your ASP.NET Core app deals with serving both server-side and client-side parts of your app. Internally, it uses `ng serve` in development.

If you don't have the `ng` tool installed, run `npm run ng` instead. For example, you can run `npm run ng lint` or `npm run ng test`.

## Install npm packages

To install third-party npm packages, use a command prompt in the *ClientApp* subdirectory. For example:

```
cd ClientApp
npm install --save <package_name>
```

## Publish and deploy

In development, the app runs in a mode optimized for developer convenience. For example, JavaScript bundles include source maps (so that when debugging, you can see your original TypeScript code). The app watches for TypeScript, HTML, and CSS file changes on disk and automatically recompiles and reloads when it sees those files change.

In production, serve a version of your app that's optimized for performance. This is configured to happen automatically. When you publish, the build configuration emits a minified, ahead-of-time (AoT) compiled build of your client-side code. Unlike the development build, the production build doesn't require Node.js to be installed on the server (unless you have enabled [server-side prerendering](#)).

You can use standard [ASP.NET Core hosting and deployment methods](#).

## Run "ng serve" independently

The project is configured to start its own instance of the Angular CLI server in the background when the ASP.NET Core app starts in development mode. This is convenient because you don't have to run a separate server manually.

There's a drawback to this default setup. Each time you modify your C# code and your ASP.NET Core app needs to restart, the Angular CLI server restarts. Around 10 seconds is required to start back up. If you're making frequent C# code edits and don't want to wait for Angular CLI to restart, run the Angular CLI server externally, independently of the ASP.NET Core process. To do so:

1. In a command prompt, switch to the *ClientApp* subdirectory, and launch the Angular CLI development server:

```
cd ClientApp
npm start
```

## IMPORTANT

Use `npm start` to launch the Angular CLI development server, not `ng serve`, so that the configuration in `package.json` is respected. To pass additional parameters to the Angular CLI server, add them to the relevant `scripts` line in your `package.json` file.

2. Modify your ASP.NET Core app to use the external Angular CLI instance instead of launching one of its own. In your `Startup` class, replace the `spa.UseAngularCliServer` invocation with the following:

```
spa.UseProxyToSpaDevelopmentServer("http://localhost:4200");
```

When you start your ASP.NET Core app, it won't launch an Angular CLI server. The instance you started manually is used instead. This enables it to start and restart faster. It's no longer waiting for Angular CLI to rebuild your client app each time.

## Server-side rendering

As a performance feature, you can choose to pre-render your Angular app on the server as well as running it on the client. This means that browsers receive HTML markup representing your app's initial UI, so they display it even before downloading and executing your JavaScript bundles. Most of the implementation of this comes from an Angular feature called [Angular Universal](#).

### TIP

Enabling server-side rendering (SSR) introduces a number of extra complications both during development and deployment. Read [drawbacks of SSR](#) to determine if SSR is a good fit for your requirements.

To enable SSR, you need to make a number of additions to your project.

In the `Startup` class, *after* the line that configures `spa.Options.SourcePath`, and *before* the call to `UseAngularCliServer` or `UseProxyToSpaDevelopmentServer`, add the following:

```
app.UseSpa(spa =>
{
    spa.Options.SourcePath = "ClientApp";

    spa.UseSpaPrerendering(options =>
    {
        options.BootModulePath = $"{spa.Options.SourcePath}/dist-server/main.bundle.js";
        options.BootModuleBuilder = env.IsDevelopment()
            ? new AngularCliBuilder(npmScript: "build:ssr")
            : null;
        options.ExcludeUrls = new[] { "/sockjs-node" };
    });

    if (env.IsDevelopment())
    {
        spa.UseAngularCliServer(npmScript: "start");
    }
});
```

In development mode, this code attempts to build the SSR bundle by running the script `build:ssr`, which is defined in `ClientApp\package.json`. This builds an Angular app named `ssr`, which isn't yet defined.

At the end of the `apps` array in `ClientApp/.angular-cli.json`, define an extra app with name `ssr`. Use the following

options:

```
{  
  "name": "ssr",  
  "root": "src",  
  "outDir": "dist-server",  
  "assets": [  
    "assets"  
,  
  "main": "main.server.ts",  
  "tsconfig": "tsconfig.server.json",  
  "prefix": "app",  
  "scripts": [],  
  "environmentSource": "environments/environment.ts",  
  "environments": {  
    "dev": "environments/environment.ts",  
    "prod": "environments/environment.prod.ts"  
,  
  "platform": "server"  
}
```

This new SSR-enabled app configuration requires two further files: `tsconfig.server.json` and `main.server.ts`. The `tsconfig.server.json` file specifies TypeScript compilation options. The `main.server.ts` file serves as the code entry point during SSR.

Add a new file called `tsconfig.server.json` inside `ClientApp/src` (alongside the existing `tsconfig.app.json`), containing the following:

```
{  
  "extends": "../tsconfig.json",  
  "compilerOptions": {  
    "baseUrl": "./",  
    "module": "commonjs"  
,  
    "angularCompilerOptions": {  
      "entryModule": "app/app.server.module#AppServerModule"  
,  
    }  
}
```

This file configures Angular's AoT compiler to look for a module called `app.server.module`. Add this by creating a new file at `ClientApp/src/app/app.server.module.ts` (alongside the existing `app.module.ts`) containing the following:

```
import { NgModule } from '@angular/core';  
import { ServerModule } from '@angular/platform-server';  
import { ModuleMapLoaderModule } from '@nguniversal/module-map-ngfactory-loader';  
import { AppComponent } from './app.component';  
import { AppModule } from './app.module';  
  
@NgModule({  
  imports: [AppModule, ServerModule, ModuleMapLoaderModule],  
  bootstrap: [AppComponent]  
})  
export class AppServerModule { }
```

This module inherits from your client-side `app.module` and defines which extra Angular modules are available during SSR.

Recall that the new `ssr` entry in `.angular-cli.json` referenced an entry point file called `main.server.ts`. You haven't yet added that file, and now is time to do so. Create a new file at `ClientApp/src/main.server.ts` (alongside the existing `main.ts`), containing the following:

```

import 'zone.js/dist/zone-node';
import 'reflect-metadata';
import { renderModule, renderModuleFactory } from '@angular/platform-server';
import { APP_BASE_HREF } from '@angular/common';
import { enableProdMode } from '@angular/core';
import { provideModuleMap } from '@nguniversal/module-map-ngfactory-loader';
import { createServerRenderer } from 'aspnet-prerendering';
export { AppServerModule } from './app/app.server.module';

enableProdMode();

export default createServerRenderer(params => {
  const { AppServerModule, AppServerModuleNgFactory, LAZY_MODULE_MAP } = (module as any).exports;

  const options = {
    document: params.data.originalHtml,
    url: params.url,
    extraProviders: [
      provideModuleMap(LAZY_MODULE_MAP),
      { provide: APP_BASE_HREF, useValue: params.baseUrl },
      { provide: 'BASE_URL', useValue: params.origin + params.baseUrl }
    ]
  };
}

const renderPromise = AppServerModuleNgFactory
  ? /* AoT */ renderModuleFactory(AppServerModuleNgFactory, options)
  : /* dev */ renderModule(AppServerModule, options);

return renderPromise.then(html => ({ html }));
});

```

This file's code is what ASP.NET Core executes for each request when it runs the `UseSpaPrerendering` middleware that you added to the `Startup` class. It deals with receiving `params` from the .NET code (such as the URL being requested), and making calls to Angular SSR APIs to get the resulting HTML.

Strictly-speaking, this is sufficient to enable SSR in development mode. It's essential to make one final change so that your app works correctly when published. In your app's main `.csproj` file, set the `BuildServerSideRenderer` property value to `true`:

```

<!-- Set this to true if you enable server-side prerendering -->
<BuildServerSideRenderer>true</BuildServerSideRenderer>

```

This configures the build process to run `build:ssr` during publishing and deploy the SSR files to the server. If you don't enable this, SSR fails in production.

When your app runs in either development or production mode, the Angular code pre-renders as HTML on the server. The client-side code executes as normal.

### Pass data from .NET code into TypeScript code

During SSR, you might want to pass per-request data from your ASP.NET Core app into your Angular app. For example, you could pass cookie information or something read from a database. To do this, edit your `Startup` class. In the callback for `UseSpaPrerendering`, set a value for `options.SupplyData` such as the following:

```

options.SupplyData = (context, data) =>
{
  // Creates a new value called isHttpsRequest that's passed to TypeScript code
  data["isHttpsRequest"] = context.Request.IsHttps;
};

```

The `SupplyData` callback lets you pass arbitrary, per-request, JSON-serializable data (for example, strings, booleans, or numbers). Your `main.server.ts` code receives this as `params.data`. For example, the preceding code sample passes a boolean value as `params.data.isHttpsRequest` into the `createServerRenderer` callback. You can pass this to other parts of your app in any way supported by Angular. For example, see how `main.server.ts` passes the `BASE_URL` value to any component whose constructor is declared to receive it.

## Drawbacks of SSR

Not all apps benefit from SSR. The primary benefit is perceived performance. Visitors reaching your app over a slow network connection or on slow mobile devices see the initial UI quickly, even if it takes a while to fetch or parse the JavaScript bundles. However, many SPAs are mainly used over fast, internal company networks on fast computers where the app appears almost instantly.

At the same time, there are significant drawbacks to enabling SSR. It adds complexity to your development process. Your code must run in two different environments: client-side and server-side (in a Node.js environment invoked from ASP.NET Core). Here are some things to bear in mind:

- SSR requires a Node.js installation on your production servers. This is automatically the case for some deployment scenarios, such as Azure App Services, but not for others, such as Azure Service Fabric.
- Enabling the `BuildServerSideRenderer` build flag causes your `node_modules` directory to publish. This folder contains 20,000+ files, which increases deployment time.
- To run your code in a Node.js environment, it can't rely on the existence of browser-specific JavaScript APIs such as `window` or `localStorage`. If your code (or some third-party library you reference) tries to use these APIs, you'll get an error during SSR. For example, don't use jQuery because it references browser-specific APIs in many places. To prevent errors, you must either avoid SSR or avoid browser-specific APIs or libraries. You can wrap any calls to such APIs in checks to ensure they aren't invoked during SSR. For example, use a check such as the following in JavaScript or TypeScript code:

```
if (typeof window !== 'undefined') {  
    // Call browser-specific APIs here  
}
```

# Use the React project template with ASP.NET Core

6/21/2018 • 3 minutes to read • [Edit Online](#)

## NOTE

This documentation isn't about the React project template included in ASP.NET Core 2.0. It's about the newer React template to which you can update manually. The template is included in ASP.NET Core 2.1 by default.

The updated React project template provides a convenient starting point for ASP.NET Core apps using React and [create-react-app](#) (CRA) conventions to implement a rich, client-side user interface (UI).

The template is equivalent to creating both an ASP.NET Core project to act as an API backend, and a standard CRA React project to act as a UI, but with the convenience of hosting both in a single app project that can be built and published as a single unit.

## Create a new app

If using ASP.NET Core 2.0, ensure you've [installed the updated React project template](#).

If you have ASP.NET Core 2.1 installed, there's no need to install the React project template.

Create a new project from a command prompt using the command `dotnet new react` in an empty directory. For example, the following commands create the app in a *my-new-app* directory and switch to that directory:

```
dotnet new react -o my-new-app
cd my-new-app
```

Run the app from either Visual Studio or the .NET Core CLI:

- [Visual Studio](#)
- [.NET Core CLI](#)

Open the generated *.csproj* file, and run the app as normal from there.

The build process restores npm dependencies on the first run, which can take several minutes. Subsequent builds are much faster.

The project template creates an ASP.NET Core app and a React app. The ASP.NET Core app is intended to be used for data access, authorization, and other server-side concerns. The React app, residing in the *ClientApp* subdirectory, is intended to be used for all UI concerns.

## Add pages, images, styles, modules, etc.

The *ClientApp* directory is a standard CRA React app. See the official [CRA documentation](#) for more information.

There are slight differences between the React app created by this template and the one created by CRA itself; however, the app's capabilities are unchanged. The app created by the template contains a [Bootstrap](#)-based layout and a basic routing example.

## Install npm packages

To install third-party npm packages, use a command prompt in the *ClientApp* subdirectory. For example:

```
cd ClientApp  
npm install --save <package_name>
```

## Publish and deploy

In development, the app runs in a mode optimized for developer convenience. For example, JavaScript bundles include source maps (so that when debugging, you can see your original source code). The app watches JavaScript, HTML, and CSS file changes on disk and automatically recompiles and reloads when it sees those files change.

In production, serve a version of your app that's optimized for performance. This is configured to happen automatically. When you publish, the build configuration emits a minified, transpiled build of your client-side code. Unlike the development build, the production build doesn't require Node.js to be installed on the server.

You can use standard [ASP.NET Core hosting and deployment methods](#).

## Run the CRA server independently

The project is configured to start its own instance of the CRA development server in the background when the ASP.NET Core app starts in development mode. This is convenient because it means you don't have to run a separate server manually.

There's a drawback to this default setup. Each time you modify your C# code and your ASP.NET Core app needs to restart, the CRA server restarts. A few seconds are required to start back up. If you're making frequent C# code edits and don't want to wait for the CRA server to restart, run the CRA server externally, independently of the ASP.NET Core process. To do so:

1. In a command prompt, switch to the *ClientApp* subdirectory, and launch the CRA development server:

```
cd ClientApp  
npm start
```

2. Modify your ASP.NET Core app to use the external CRA server instance instead of launching one of its own. In your *Startup* class, replace the `spa.UseReactDevelopmentServer` invocation with the following:

```
spa.UseProxyToSpaDevelopmentServer("http://localhost:3000");
```

When you start your ASP.NET Core app, it won't launch a CRA server. The instance you started manually is used instead. This enables it to start and restart faster. It's no longer waiting for your React app to rebuild each time.

# Use the React-with-Redux project template with ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

## NOTE

This documentation isn't about the React-with-Redux project template included in ASP.NET Core 2.0. It's about the newer React-with-Redux template to which you can update manually. The template is included in ASP.NET Core 2.1 by default.

The updated React-with-Redux project template provides a convenient starting point for ASP.NET Core apps using React, Redux, and [create-react-app](#) (CRA) conventions to implement a rich, client-side user interface (UI).

With the exception of the project creation command, all information about the React-with-Redux template is the same as the React template. To create this project type, run `dotnet new reactredux` instead of `dotnet new react`. For more information about the functionality common to both React-based templates, see [React template documentation](#).

# ASP.NET Core SignalR

7/12/2018 • 2 minutes to read • [Edit Online](#)

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# Introduction to ASP.NET Core SignalR

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Rachel Appel](#)

## What is SignalR?

ASP.NET Core SignalR is a library that simplifies adding real-time web functionality to apps. Real-time web functionality enables server-side code to push content to clients instantly.

Good candidates for SignalR:

- Apps that require high frequency updates from the server. Examples are gaming, social networks, voting, auction, maps, and GPS apps.
- Dashboards and monitoring apps. Examples include company dashboards, instant sales updates, or travel alerts.
- Collaborative apps. Whiteboard apps and team meeting software are examples of collaborative apps.
- Apps that require notifications. Social networks, email, chat, games, travel alerts, and many other apps use notifications.

SignalR provides an API for creating server-to-client [remote procedure calls \(RPC\)](#). The RPCs call JavaScript functions on clients from server-side .NET Core code.

SignalR for ASP.NET Core:

- Handles connection management automatically.
- Enables broadcasting messages to all connected clients simultaneously. For example, a chat room.
- Enables sending messages to specific clients or groups of clients.
- Is open-sourced at [GitHub](#).
- Scalable.

The connection between the client and server is persistent, unlike an HTTP connection.

## Transports

SignalR abstracts over a number of techniques for building real-time web applications. [WebSockets](#) is the optimal transport, but other techniques like Server-Sent Events and Long Polling can be used when those aren't available. SignalR will automatically detect and initialize the appropriate transport based on features supported on the server and client.

## Hubs

SignalR uses hubs to communicate between clients and servers.

A hub is a high-level pipeline that allows your client and server to call methods on each other. SignalR handles the dispatching across machine boundaries automatically, allowing clients to call methods on the server as easily as local methods, and vice versa. Hubs allow passing strongly-typed parameters to methods, which enables model binding. SignalR provides two built-in hub protocols: a text protocol based on JSON and a binary protocol based on [MessagePack](#). MessagePack generally creates smaller messages than when using JSON. Older browsers must support [XHR level 2](#) to provide MessagePack protocol support.

Hubs call client-side code by sending messages using the active transport. The messages contain the name and

parameters of the client-side method. Objects sent as method parameters are deserialized using the configured protocol. The client tries to match the name to a method in the client-side code. When a match happens, the client method runs using the serialized parameter data.

## Additional resources

- [Get started with SignalR for ASP.NET Core](#)
- [Supported Platforms](#)
- [Hubs](#)
- [JavaScript client](#)

# Get started with SignalR on ASP.NET Core

7/5/2018 • 5 minutes to read • [Edit Online](#)

By [Rachel Appel](#)

This tutorial teaches the basics of building a real-time app using SignalR for ASP.NET Core.

The image contains two side-by-side screenshots of a web browser displaying a SignalR chat application. Both screenshots show a dark-themed interface with a header bar and a message list area.

**Screenshot 1 (Top):**

- Header:** - SignalRChat
- Address Bar:** https://localhost:443
- Form Fields:** Name: Bill Gates, Message: Hello, computers!
- Message List:** 3/15/2018 11:12:10 PM **Bill Gates**: Hello, computers!  
3/15/2018 11:12:29 PM **Satya Nadella**: Hello, cloud computers!
- Copyright:** © 2018 - SignalRChat

**Screenshot 2 (Bottom):**

- Header:** - SignalRChat
- Address Bar:** https://localhost:443
- Form Fields:** Name: Satya Nadella, Message: Hello, cloud computers!
- Message List:** 3/15/2018 11:12:10 PM **Bill Gates**: Hello, computers!  
3/15/2018 11:12:29 PM **Satya Nadella**: Hello, cloud computers!
- Copyright:** © 2018 - SignalRChat

This tutorial demonstrates the following SignalR development tasks:

- Create a SignalR on ASP.NET Core web app.
- Create a SignalR hub to push content to clients.
- Modify the `Startup` class and configure the app.

[View or download sample code \(how to download\)](#)

## Prerequisites

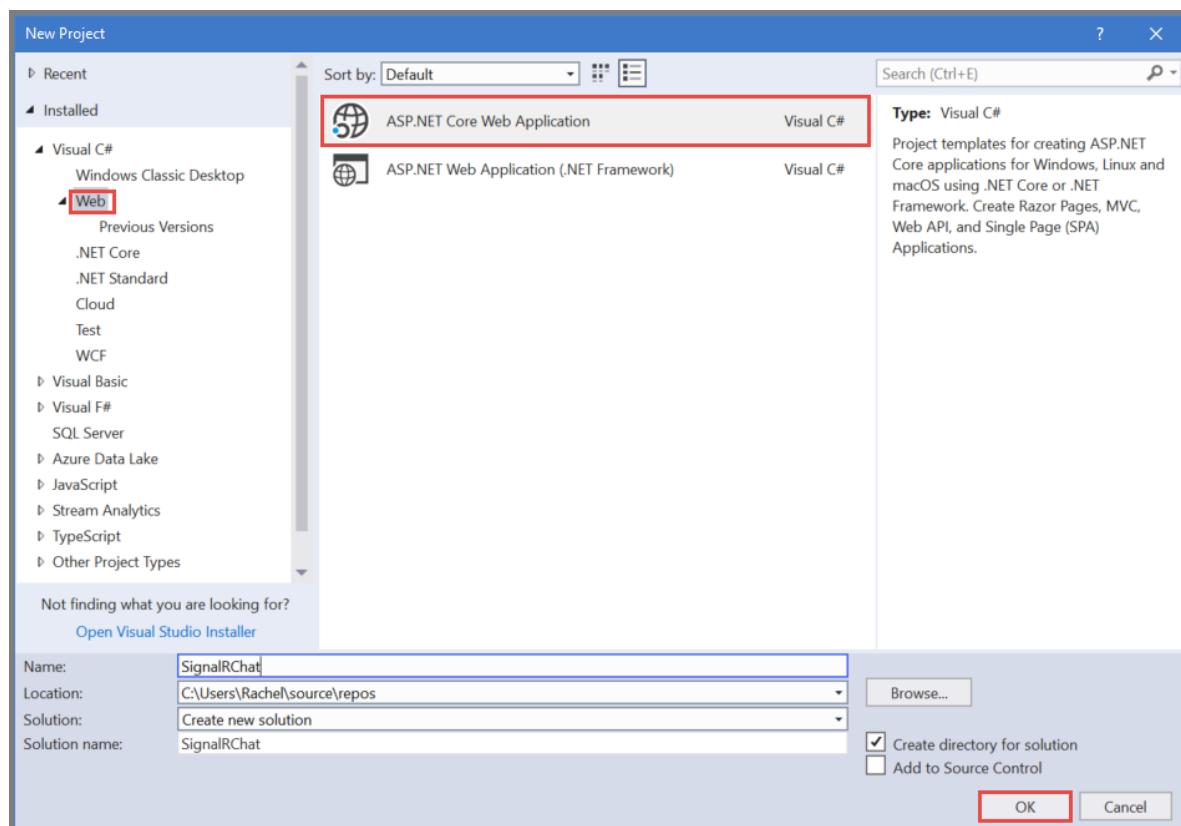
Install the following software:

- [Visual Studio](#)
- [Visual Studio Code](#)
- [.NET Core SDK 2.1 or later](#)
- [Visual Studio 2017](#) version 15.7.3 or later with the **ASP.NET and web development** workload
- [npm](#)

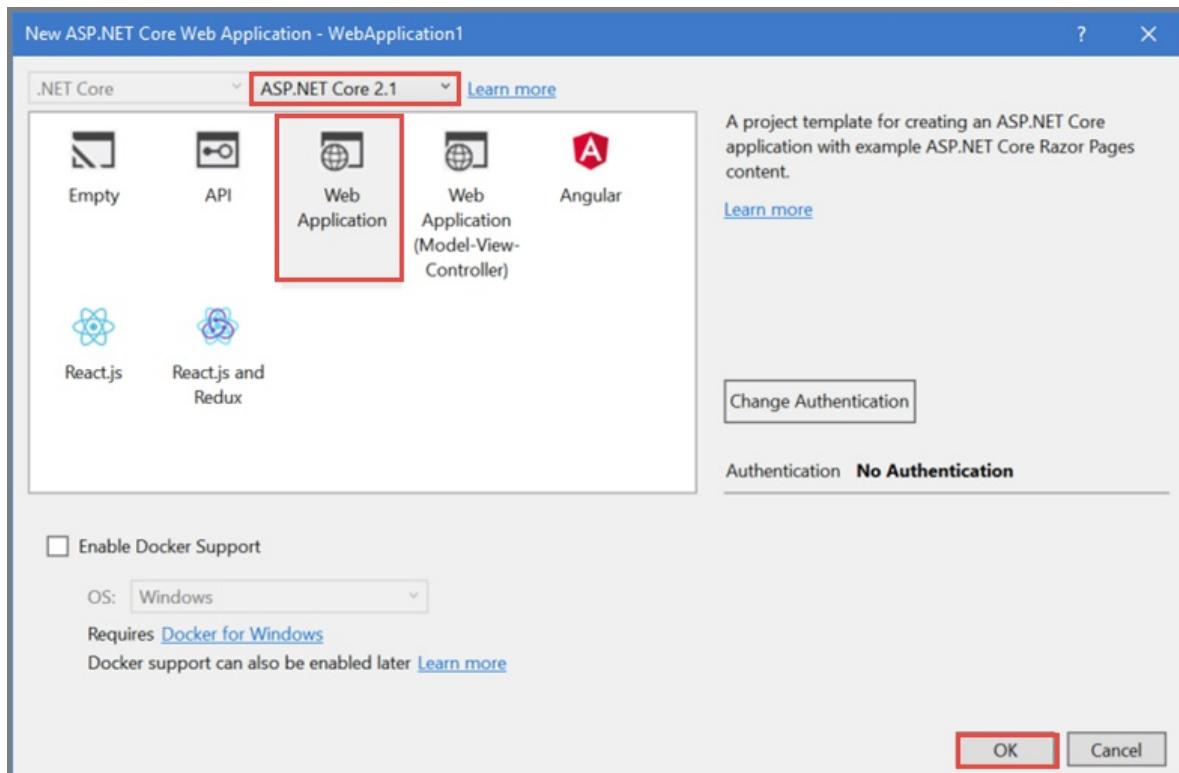
## Create an ASP.NET Core project that hosts SignalR client and server

- [Visual Studio](#)
- [Visual Studio Code](#)

1. Use the **File > New Project** menu option and choose **ASP.NET Core Web Application**. Name the project *SignalRChat*.



2. Select **Web Application** to create a project using Razor Pages. Then select **OK**. Be sure that **ASP.NET Core 2.1** is selected from the framework selector, though SignalR runs on older versions of .NET.



Visual Studio includes the `Microsoft.AspNetCore.SignalR` package containing its server libraries as part of its **ASP.NET Core Web Application** template. However, the JavaScript client library for SignalR must be installed using *npm*.

3. Run the following commands in the **Package Manager Console** window, from the project root:

```
npm init -y
npm install @aspnet/signalr
```

4. Create a new folder named "signalr" inside the *lib* folder in your project. Copy the *signalr.js* file from *node\_modules\@aspnet\signalr\dist\browser* to this folder.

## Create the SignalR Hub

A hub is a class that serves as a high-level pipeline that allows the client and server to call methods on each other.

- [Visual Studio](#)
- [Visual Studio Code](#)

1. Add a class to the project by choosing **File > New > File** and selecting **Visual C# Class**. Name the class `ChatHub` and the file `ChatHub.cs`.
2. Inherit from `Microsoft.AspNetCore.SignalR.Hub`. The `Hub` class contains properties and events for managing connections and groups, as well as sending and receiving data.
3. Create the `sendMessage` method that sends a message to all connected chat clients. Notice it returns a `Task`, because SignalR is asynchronous. Asynchronous code scales better.

```
using Microsoft.AspNetCore.SignalR;
using System.Threading.Tasks;

namespace SignalRChat.Hubs
{
    public class ChatHub : Hub
    {
        public async Task SendMessage(string user, string message)
        {
            await Clients.All.SendAsync("ReceiveMessage", user, message);
        }
    }
}
```

## Configure the project to use SignalR

The SignalR server must be configured so that it knows to pass requests to SignalR.

1. To configure a SignalR project, modify the project's `Startup.ConfigureServices` method.

`services.AddSignalR` makes the SignalR services available to the [dependency injection](#) system.

2. Configure routes to your hubs with `UseSignalR` in the `Configure` method. `app.UseSignalR` adds SignalR to the [middleware](#) pipeline.

```

using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.AspNetCore.Http;
using Microsoft.Extensions.Configuration;
using Microsoft.Extensions.DependencyInjection;
using SignalRChat.Hubs;

namespace SignalRChat
{
    public class Startup
    {
        public Startup(IConfiguration configuration)
        {
            Configuration = configuration;
        }

        public IConfiguration Configuration { get; }

        public void ConfigureServices(IServiceCollection services)
        {
            services.Configure<CookiePolicyOptions>(options =>
            {
                options.CheckConsentNeeded = context => true;
                options.MinimumSameSitePolicy = SameSiteMode.None;
            });

            services.AddMvc();

            services.AddCors(options => options.AddPolicy("CorsPolicy",
builder =>
{
    builder.AllowAnyMethod().AllowAnyHeader()
        .WithOrigins("http://localhost:55830")
        .AllowCredentials();
}));

            services.AddSignalR();
        }

        public void Configure(IApplicationBuilder app, IHostingEnvironment env)
        {
            if (env.IsDevelopment())
            {

                app.UseDeveloperExceptionPage();
            }
            else
            {
                app.UseExceptionHandler("/Error");
                app.UseHsts();
            }

            app.UseHttpsRedirection();
            app.UseStaticFiles();
            app.UseCookiePolicy();
            app.UseCors("CorsPolicy");
            app.UseSignalR(routes =>
            {
                routes.MapHub<ChatHub>("/chatHub");
            });
            app.UseMvc();
        }
    }
}

```

## Create the SignalR client code

1. Add a JavaScript file, named *chat.js*, to the *wwwroot\js* folder. Add the following code to it:

```
// The following sample code uses modern ECMAScript 6 features
// that aren't supported in Internet Explorer 11.
// To convert the sample for environments that do not support ECMAScript 6,
// such as Internet Explorer 11, use a transpiler such as
// Babel at http://babeljs.io/.
//
// See Es5-chat.js for a Babel transpiled version of the following code:

const connection = new signalR.HubConnectionBuilder()
    .withUrl("/chatHub")
    .build();

connection.on("ReceiveMessage", (user, message) => {
    const msg = message.replace(/&/g, "&").replace(/</g, "<").replace(/>/g, ">");
    const encodedMsg = user + " says " + msg;
    const li = document.createElement("li");
    li.textContent = encodedMsg;
    document.getElementById("messagesList").appendChild(li);
});

connection.start().catch(err => console.error(err.toString()));

document.getElementById("sendButton").addEventListener("click", event => {
    const user = document.getElementById("userInput").value;
    const message = document.getElementById("messageInput").value;
    connection.invoke("SendMessage", user, message).catch(err => console.error(err.toString()));
    event.preventDefault();
});
```

2. Replace the content in *Pages\Index.cshtml* with the following code:

```
@page


<div class="row">&nbsp;</div>
<div class="row">
    <div class="col-6">&nbsp;</div>
    <div class="col-6">
        User.....<input type="text" id="userInput" />
        <br />
        Message...<input type="text" id="messageInput" />
        <input type="button" id="sendButton" value="Send Message" />
    </div>
</div>
<div class="row">
    <div class="col-12">
        <hr />
    </div>
</div>
<div class="row">
    <div class="col-6">&nbsp;</div>
    <div class="col-6">
        <ul id="messagesList"></ul>
    </div>
</div>
</div>
<script src="~/lib/signalr/signalr.js"></script>
<script src="~/js/chat.js"></script>
@*<script src="~/js/es5-chat.js"></script>*@

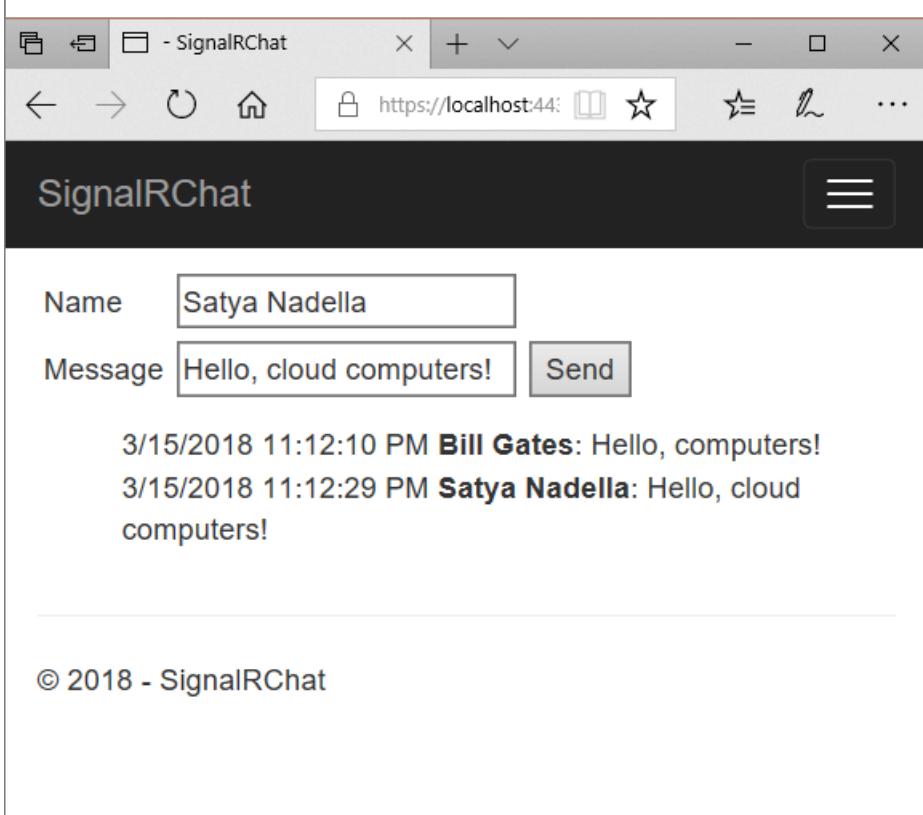
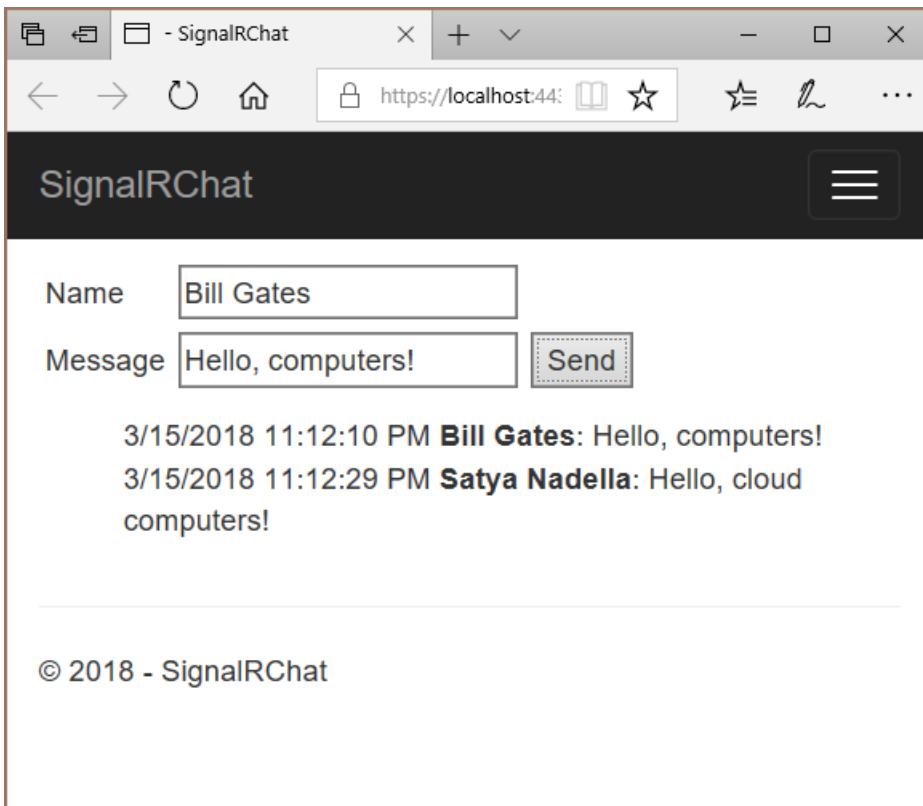

```

The preceding HTML displays name and message fields, and a submit button. Notice the script references at the bottom: a reference to SignalR and *chat.js*.

## Run the app

- [Visual Studio](#)
- [Visual Studio Code](#)

1. Select **Debug > Start without debugging** to launch a browser and load the website locally. Copy the URL from the address bar.
2. Open another browser instance (any browser) and paste the URL in the address bar.
3. Choose either browser, enter a name and message, and click the **Send** button. The name and message are displayed on both pages instantly.



## Related resources

[Introduction to ASP.NET Core SignalR](#)

# Use hubs in SignalR for ASP.NET Core

6/21/2018 • 3 minutes to read • [Edit Online](#)

By [Rachel Appel](#) and [Kevin Griffin](#)

[View or download sample code](#) ([how to download](#))

## What is a SignalR hub

The SignalR Hubs API enables you to call methods on connected clients from the server. In the server code, you define methods that are called by client. In the client code, you define methods that are called from the server. SignalR takes care of everything behind the scenes that makes real-time client-to-server and server-to-client communications possible.

## Configure SignalR hubs

The SignalR middleware requires some services, which are configured by calling `services.AddSignalR`.

```
services.AddSignalR();
```

When adding SignalR functionality to an ASP.NET Core app, setup SignalR routes by calling `app.UseSignalR` in the `Startup.Configure` method.

```
app.UseSignalR(route =>
{
    route.MapHub<ChatHub>("/chathub");
});
```

## Create and use hubs

Create a hub by declaring a class that inherits from `Hub`, and add public methods to it. Clients can call methods that are defined as `public`.

```

public class ChatHub : Hub
{
    public async Task SendMessage(string user, string message)
    {
        await Clients.All.SendAsync("ReceiveMessage", user, message);
    }

    public Task SendMessageToCaller(string message)
    {
        return Clients.Caller.SendAsync("ReceiveMessage", message);
    }

    public Task SendMessageToGroups(string message)
    {
        List<string> groups = new List<string>() { "SignalR Users" };
        return Clients.Groups(groups).SendAsync("ReceiveMessage", message);
    }

    public override async Task OnConnectedAsync()
    {
        await Groups.AddToGroupAsync(Context.ConnectionId, "SignalR Users");
        await base.OnConnectedAsync();
    }

    public override async Task OnDisconnectedAsync(Exception exception)
    {
        await Groups.RemoveFromGroupAsync(Context.ConnectionId, "SignalR Users");
        await base.OnDisconnectedAsync(exception);
    }
}

```

You can specify a return type and parameters, including complex types and arrays, as you would in any C# method. SignalR handles the serialization and deserialization of complex objects and arrays in your parameters and return values.

## The Clients object

Each instance of the `Hub` class has a property named `Clients` that contains the following members for communication between server and client:

PROPERTY	DESCRIPTION
<code>All</code>	Calls a method on all connected clients
<code>Caller</code>	Calls a method on the client that invoked the hub method
<code>Others</code>	Calls a method on all connected clients except the client that invoked the method

Additionally, `Hub.Clients` contains the following methods:

METHOD	DESCRIPTION
<code>AllExcept</code>	Calls a method on all connected clients except for the specified connections
<code>Client</code>	Calls a method on a specific connected client

METHOD	DESCRIPTION
Clients	Calls a method on specific connected clients
Group	Calls a method to all connections in the specified group
GroupExcept	Calls a method to all connections in the specified group, except the specified connections
Groups	Calls a method to multiple groups of connections
OthersInGroup	Calls a method to a group of connections, excluding the client that invoked the hub method
User	Calls a method to all connections associated with a specific user
Users	Calls a method to all connections associated with the specified users

Each property or method in the preceding tables returns an object with a `SendAsync` method. The `SendAsync` method allows you to supply the name and parameters of the client method to call.

## Send messages to clients

To make calls to specific clients, use the properties of the `Clients` object. In the following example, the `SendMessageToCaller` method demonstrates sending a message to the connection that invoked the hub method. The `SendMessageToGroups` method sends a message to the groups stored in a `List` named `groups`.

```
public Task SendMessageToCaller(string message)
{
    return Clients.Caller.SendAsync("ReceiveMessage", message);
}

public Task SendMessageToGroups(string message)
{
    List<string> groups = new List<string>() { "SignalR Users" };
    return Clients.Groups(groups).SendAsync("ReceiveMessage", message);
}
```

## Handle events for a connection

The SignalR Hubs API provides the `OnConnectedAsync` and `OnDisconnectedAsync` virtual methods to manage and track connections. Override the `OnConnectedAsync` virtual method to perform actions when a client connects to the Hub, such as adding it to a group.

```
public override async Task OnConnectedAsync()
{
    await Groups.AddToGroupAsync(Context.ConnectionId, "SignalR Users");
    await base.OnConnectedAsync();
}

public override async Task OnDisconnectedAsync(Exception exception)
{
    await Groups.RemoveFromGroupAsync(Context.ConnectionId, "SignalR Users");
    await base.OnDisconnectedAsync(exception);
}
```

## Handle errors

Exceptions thrown in your hub methods are sent to the client that invoked the method. On the JavaScript client, the `invoke` method returns a [JavaScript Promise](#). When the client receives an error with a handler attached to the promise using `catch`, it's invoked and passed as a JavaScript `Error` object.

```
connection.invoke("SendMessage", user, message).catch(err => console.error(err));
```

## Related resources

- [Intro to ASP.NET Core SignalR](#)
- [JavaScript client](#)
- [Publish to Azure](#)

# ASP.NET Core SignalR supported platforms

7/10/2018 • 2 minutes to read • [Edit Online](#)

## Server system requirements

SignalR for ASP.NET Core supports any server platform ASP.NET Core supports.

## Client system requirements

### Browser support

The SignalR for ASP.NET Core JavaScript client supports the following browsers:

BROWSER	VERSION
Microsoft Internet Explorer	11
Microsoft Edge	current
Mozilla Firefox	current
Google Chrome; includes Android	current
Safari; includes iOS	current

### .NET Client support

Any server platform supported by ASP.NET Core. When using IIS, the WebSockets transport requires IIS 8.0 or higher, on Windows Server 2012 or higher. Other transports are supported on all platforms.

# Use hubs in SignalR for ASP.NET Core

6/21/2018 • 3 minutes to read • [Edit Online](#)

By [Rachel Appel](#) and [Kevin Griffin](#)

[View or download sample code \(how to download\)](#)

## What is a SignalR hub

The SignalR Hubs API enables you to call methods on connected clients from the server. In the server code, you define methods that are called by client. In the client code, you define methods that are called from the server. SignalR takes care of everything behind the scenes that makes real-time client-to-server and server-to-client communications possible.

## Configure SignalR hubs

The SignalR middleware requires some services, which are configured by calling `services.AddSignalR()`.

```
services.AddSignalR();
```

When adding SignalR functionality to an ASP.NET Core app, setup SignalR routes by calling `app.UseSignalR` in the `Startup.Configure` method.

```
app.UseSignalR(route =>
{
    route.MapHub<ChatHub>("/chathub");
});
```

## Create and use hubs

Create a hub by declaring a class that inherits from `Hub`, and add public methods to it. Clients can call methods that are defined as `public`.

```

public class ChatHub : Hub
{
    public async Task SendMessage(string user, string message)
    {
        await Clients.All.SendAsync("ReceiveMessage", user, message);
    }

    public Task SendMessageToCaller(string message)
    {
        return Clients.Caller.SendAsync("ReceiveMessage", message);
    }

    public Task SendMessageToGroups(string message)
    {
        List<string> groups = new List<string>() { "SignalR Users" };
        return Clients.Groups(groups).SendAsync("ReceiveMessage", message);
    }

    public override async Task OnConnectedAsync()
    {
        await Groups.AddToGroupAsync(Context.ConnectionId, "SignalR Users");
        await base.OnConnectedAsync();
    }

    public override async Task OnDisconnectedAsync(Exception exception)
    {
        await Groups.RemoveFromGroupAsync(Context.ConnectionId, "SignalR Users");
        await base.OnDisconnectedAsync(exception);
    }
}

```

You can specify a return type and parameters, including complex types and arrays, as you would in any C# method. SignalR handles the serialization and deserialization of complex objects and arrays in your parameters and return values.

## The Clients object

Each instance of the `Hub` class has a property named `Clients` that contains the following members for communication between server and client:

PROPERTY	DESCRIPTION
<code>All</code>	Calls a method on all connected clients
<code>Caller</code>	Calls a method on the client that invoked the hub method
<code>Others</code>	Calls a method on all connected clients except the client that invoked the method

Additionally, `Hub.Clients` contains the following methods:

METHOD	DESCRIPTION
<code>AllExcept</code>	Calls a method on all connected clients except for the specified connections
<code>Client</code>	Calls a method on a specific connected client

METHOD	DESCRIPTION
Clients	Calls a method on specific connected clients
Group	Calls a method to all connections in the specified group
GroupExcept	Calls a method to all connections in the specified group, except the specified connections
Groups	Calls a method to multiple groups of connections
OthersInGroup	Calls a method to a group of connections, excluding the client that invoked the hub method
User	Calls a method to all connections associated with a specific user
Users	Calls a method to all connections associated with the specified users

Each property or method in the preceding tables returns an object with a `SendAsync` method. The `SendAsync` method allows you to supply the name and parameters of the client method to call.

## Send messages to clients

To make calls to specific clients, use the properties of the `Clients` object. In the following example, the `SendMessageToCaller` method demonstrates sending a message to the connection that invoked the hub method. The `SendMessageToGroups` method sends a message to the groups stored in a `List` named `groups`.

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    return Clients.Groups(groups).SendAsync("ReceiveMessage", message);
}
```

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The SignalR Hubs API provides the `OnConnectedAsync` and `OnDisconnectedAsync` virtual methods to manage and track connections. Override the `OnConnectedAsync` virtual method to perform actions when a client connects to the Hub, such as adding it to a group.

```
public override async Task OnConnectedAsync()
{
    await Groups.AddToGroupAsync(Context.ConnectionId, "SignalR Users");
    await base.OnConnectedAsync();
}

public override async Task OnDisconnectedAsync(Exception exception)
{
    await Groups.RemoveFromGroupAsync(Context.ConnectionId, "SignalR Users");
    await base.OnDisconnectedAsync(exception);
}
```

## Handle errors

Exceptions thrown in your hub methods are sent to the client that invoked the method. On the JavaScript client, the `invoke` method returns a [JavaScript Promise](#). When the client receives an error with a handler attached to the promise using `catch`, it's invoked and passed as a JavaScript `Error` object.

```
connection.invoke("SendMessage", user, message).catch(err => console.error(err));
```

## Related resources

- [Intro to ASP.NET Core SignalR](#)
- [JavaScript client](#)
- [Publish to Azure](#)

# Send messages from outside a hub

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Mikael Mengistu](#)

The SignalR hub is the core abstraction for sending messages to clients connected to the SignalR server. It's also possible to send messages from other places in your app using the `IHubContext` service. This article explains how to access a SignalR `IHubContext` to send notifications to clients from outside a hub.

[View or download sample code \(how to download\)](#)

## Get an instance of `IHubContext`

In ASP.NET Core SignalR, you can access an instance of `IHubContext` via dependency injection. You can inject an instance of `IHubContext` into a controller, middleware, or other DI service. Use the instance to send messages to clients.

### NOTE

This differs from ASP.NET SignalR which used `GlobalHost` to provide access to the `IHubContext`. ASP.NET Core has a dependency injection framework that removes the need for this global singleton.

### Inject an instance of `IHubContext` in a controller

You can inject an instance of `IHubContext` into a controller by adding it to your constructor:

```
public class HomeController : Controller
{
    private readonly IHubContext<NotificationHub> _hubContext;

    public HomeController(IHubContext<NotificationHub> hubContext)
    {
        _hubContext = hubContext;
    }
}
```

Now, with access to an instance of `IHubContext`, you can call hub methods as if you were in the hub itself.

```
public async Task<IActionResult> Index()
{
    await _hubContext.Clients.All.SendAsync("Notify", $"Home page loaded at: {DateTime.Now}");
    return View();
}
```

### Get an instance of `IHubContext` in middleware

Access the `IHubContext` within the middleware pipeline like so:

```
app.Use(next => (context) =>
{
    var hubContext = (IHubContext<MyHub>)context
        .RequestServices
        .GetServices<IHubContext<MyHub>>();
    //...
});
```

#### NOTE

When hub methods are called from outside of the `Hub` class, there's no caller associated with the invocation. Therefore, there's no access to the `ConnectionId`, `Caller`, and `Others` properties.

## Related resources

- [Get started](#)
- [Hubs](#)
- [Publish to Azure](#)

# Manage users and groups in SignalR

7/3/2018 • 2 minutes to read • [Edit Online](#)

By [Brennan Conroy](#)

SignalR allows messages to be sent to all connections associated with a specific user, as well as to named groups of connections.

[View or download sample code \(how to download\)](#)

## Users in SignalR

SignalR allows you to send messages to all connections associated with a specific user. By default, SignalR uses the `ClaimTypes.NameIdentifier` from the `ClaimsPrincipal` associated with the connection as the user identifier. A single user can have multiple connections to a SignalR app. For example, a user could be connected on their desktop as well as their phone. Each device has a separate SignalR connection, but they're all associated with the same user. If a message is sent to the user, all of the connections associated with that user receive the message. The user identifier for a connection can be accessed by the `Context.UserIdentifier` property in your hub.

Send a message to a specific user by passing the user identifier to the `User` function in your hub method as shown in the following example:

### NOTE

The user identifier is case-sensitive.

```
public Task SendPrivateMessage(string user, string message)
{
    return Clients.User(user).SendAsync("ReceiveMessage", message);
}
```

The user identifier can be customized by creating an `IUserIdProvider`, and registering it in `ConfigureServices`.

```
public class CustomUserIdProvider : IUserIdProvider
{
    public virtual string GetUserId(HubConnectionContext connection)
    {
        return connection.User?.FindFirst(ClaimTypes.Email)?.Value;
    }
}
```

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddSignalR();

    services.AddSingleton<IUserIdProvider, CustomUserIdProvider>();
}
```

**NOTE**

AddSignalR must be called before registering your custom SignalR services.

## Groups in SignalR

A group is a collection of connections associated with a name. Messages can be sent to all connections in a group. Groups are the recommended way to send to a connection or multiple connections because the groups are managed by the application. A connection can be a member of multiple groups. This makes groups ideal for something like a chat application, where each room can be represented as a group. Connections can be added to or removed from groups via the `AddToGroupAsync` and `RemoveFromGroupAsync` methods.

```
public async Task AddToGroup(string groupName)
{
    await Groups.AddToGroupAsync(Context.ConnectionId, groupName);

    await Clients.Group(groupName).SendAsync("Send", $"{Context.ConnectionId} has joined the group {groupName}.");
}

public async Task RemoveFromGroup(string groupName)
{
    await Groups.RemoveFromGroupAsync(Context.ConnectionId, groupName);

    await Clients.Group(groupName).SendAsync("Send", $"{Context.ConnectionId} has left the group {groupName}.");
}
```

Group membership isn't preserved when a connection reconnects. The connection needs to rejoin the group when it's re-established. It's not possible to count the members of a group, since this information is not available if the application is scaled to multiple servers.

**NOTE**

Group names are case-sensitive.

## Related resources

- [Get started](#)
- [Hubs](#)
- [Publish to Azure](#)

# Publish an ASP.NET Core SignalR app to an Azure Web App

6/21/2018 • 2 minutes to read • [Edit Online](#)

Azure Web App is a [Microsoft cloud computing](#) platform service for hosting web apps, including ASP.NET Core.

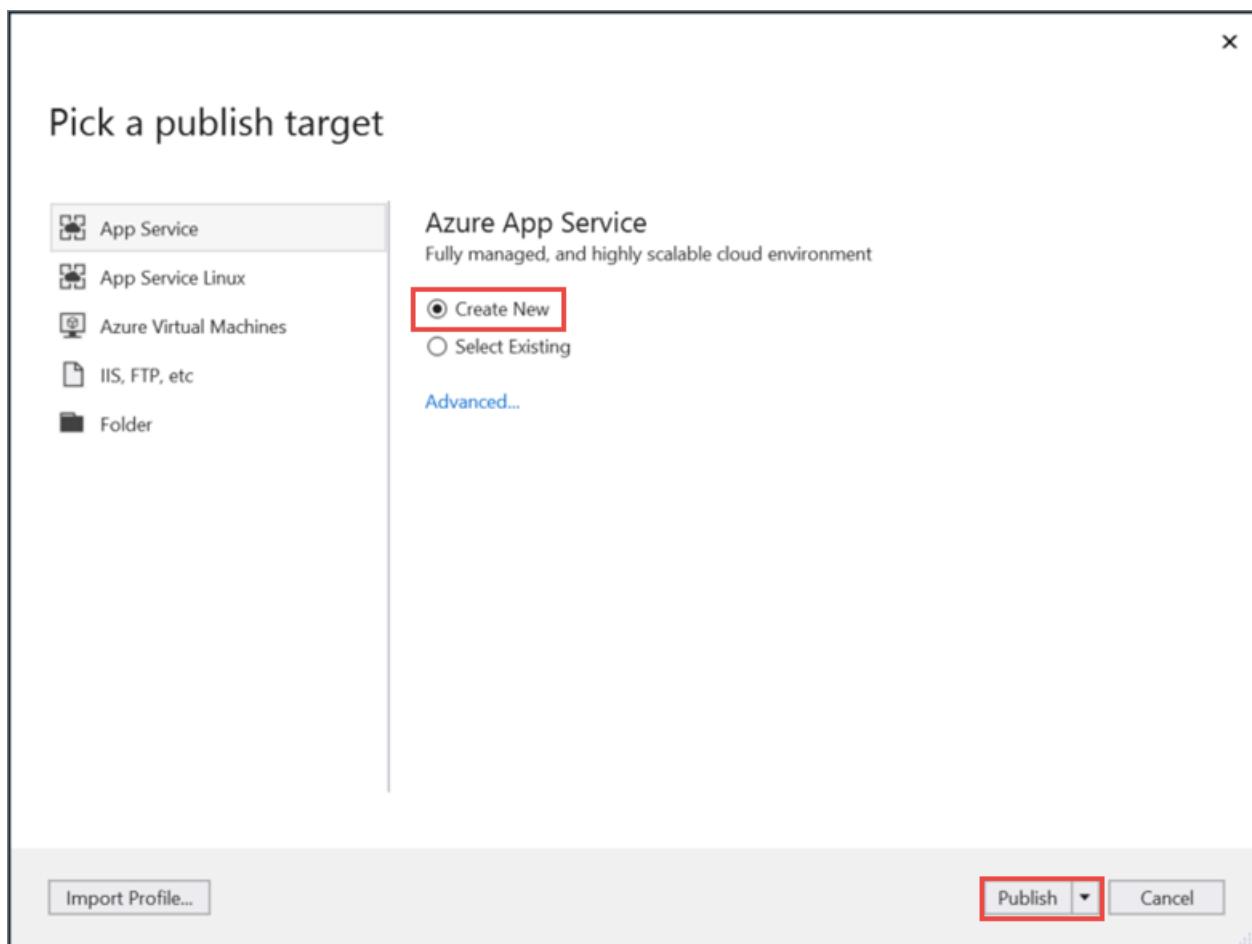
## NOTE

This article refers to publishing an ASP.NET Core SignalR app from Visual Studio. Visit [SignalR service for Azure](#) for more information about using SignalR on Azure.

## Publish the app

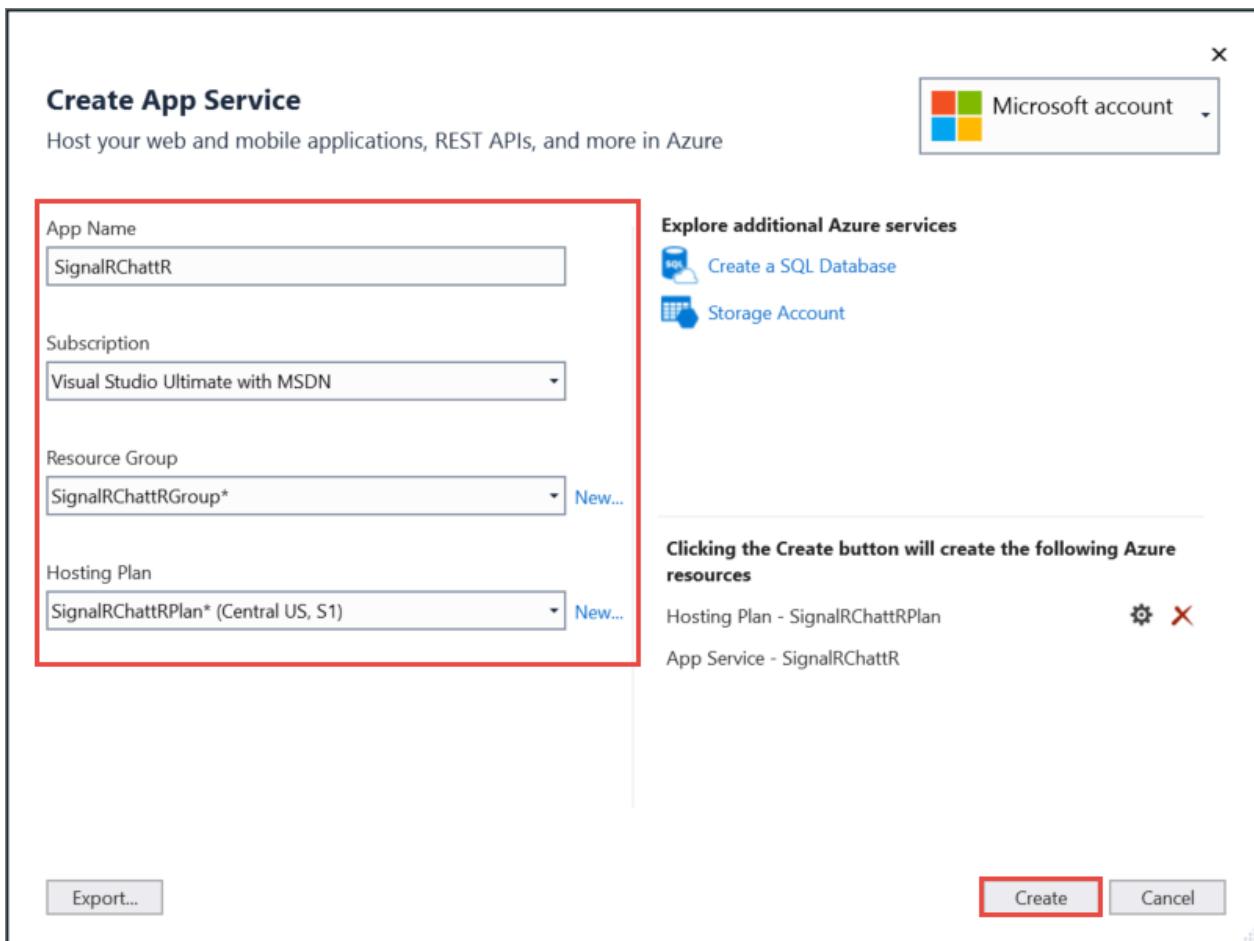
Visual Studio provides built-in tools for publishing to an Azure Web App. Visual Studio Code user can use [Azure CLI](#) commands to publish apps to Azure. This article covers publishing using the tools in Visual Studio. To publish an app using Azure CLI, see [Publish an ASP.NET Core app to Azure with command line tools](#).

Right-click on the project in **Solution Explorer** and select **Publish**. Confirm that **Create new** is checked in the **Pick a publish target** dialog, and select **Publish**.



Enter the following information in the **Create App Service** dialog and select **Create**.

ITEM	DESCRIPTION
<b>App name</b>	A unique name of the app.
<b>Subscription</b>	The Azure subscription that the app uses.
<b>Resource Group</b>	The group of related resources to which the app belongs.
<b>Hosting Plan</b>	The pricing plan for the web app.



Visual Studio completes the following tasks:

- Creates a Publish Profile containing publish settings.
- Creates or uses an existing *Azure Web App* with the provided details.
- Publishes the app.
- Launches a browser, with the published web app loaded.

Notice the format of the URL for the app is `{app name}.azurewebsites.net`. For example, an app named

`SignalRChattR` has a URL that looks like `https://signalrchattr.azurewebsites.net`.

If an HTTP 502.2 error occurs, see [Deploy ASP.NET Core preview release to Azure App Service](#) to resolve it.

## Configure SignalR web app

ASP.NET Core SignalR apps that are published as an Azure Web App must have [ARR Affinity](#) enabled. [WebSockets](#) should be enabled, to allow the WebSockets transport to function.

In the Azure portal, navigate to **App Settings** for your web app. Set **WebSockets** to **On**, and verify **ARR Affinity** is **On**.

SignalRChattR - Application settings

App Service

Search (Ctrl+ /)

Save Discard

General settings

SETTINGS

- Application settings **Selected**
- Authentication / Authorization
- Managed service identity
- Backups
- Custom domains
- SSL certificates
- Networking
- Scale up (App Service plan)
- Scale out (App Service plan)
- WebJobs
- Push
- MySQL In App
- Properties
- Locks
- Automation script

APP SERVICE PLAN

- App Service plan
- Quotas
- Change App Service plan

.NET Framework version v4.7

PHP version 5.6

Python version Off

Java version Off

Java minor version

Java web container

Platform 32-bit **Selected** 64-bit

Web sockets Off **Selected** On

Always On Off On

Managed Pipeline Version Integrated **Selected** Classic

You can improve the performance of your stateless applications by turning off the Affinity Cookie, stateful applications should keep the Affinity Cookie turned on for increased compatibility. Click to learn more.

ARR Affinity Off **Selected** On

Auto swap destinations cannot be configured from production slot

Auto Swap Off On

Auto Swap Slot

The screenshot shows the 'General settings' section of the Azure App Service configuration. It includes fields for .NET Framework version (v4.7), PHP version (5.6), Python version (Off), Java version (Off), Java minor version, Java web container, Platform (32-bit selected), Managed Pipeline Version (Integrated selected), and ARR Affinity (On). A note about affinity cookies is present. The 'Web sockets' section is highlighted with a red box, and the 'ARR Affinity' section is also highlighted with a red box.

WebSockets and other transports [are limited based on the App Service Plan](#).

## Related resources

- [Publish an ASP.NET Core app to Azure with command line tools](#)
- [Publish an ASP.NET Core app to Azure with Visual Studio](#)
- [Host and deploy ASP.NET Core Preview apps on Azure](#)

# ASP.NET Core SignalR JavaScript client

7/10/2018 • 3 minutes to read • [Edit Online](#)

By [Rachel Appel](#)

The ASP.NET Core SignalR JavaScript client library enables developers to call server-side hub code.

[View or download sample code \(how to download\)](#)

## Install the SignalR client package

The SignalR JavaScript client library is delivered as an [npm](#) package. If you're using Visual Studio, run `npm install` from the **Package Manager Console** while in the root folder. For Visual Studio Code, run the command from the **Integrated Terminal**.

```
npm init -y
npm install @aspnet/signalr
```

Npm installs the package contents in the `node_modules\@aspnet\signalr\dist\browser` folder. Create a new folder named `signalr` under the `wwwroot\lib` folder. Copy the `signalr.js` file to the `wwwroot\lib\signalr` folder.

## Use the SignalR JavaScript client

Reference the SignalR JavaScript client in the `<script>` element.

```
<script src="~/lib/signalr/signalr.js"></script>
```

## Connect to a hub

The following code creates and starts a connection. The hub's name is case insensitive.

```
const connection = new signalR.HubConnectionBuilder()
    .withUrl("/chatHub")
    .configureLogging(signalR.LogLevel.Information)
    .build();
connection.start().catch(err => console.error(err.toString()));
```

### Cross-origin connections

Typically, browsers load connections from the same domain as the requested page. However, there are occasions when a connection to another domain is required.

To prevent a malicious site from reading sensitive data from another site, [cross-origin connections](#) are disabled by default. To allow a cross-origin request, enable it in the `Startup` class.

```
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.AspNetCore.Http;
using Microsoft.Extensions.Configuration;
using Microsoft.Extensions.DependencyInjection;
using SignalRChat.Hubs;

namespace SignalRChat
{
    public class Startup
    {
        public Startup(IConfiguration configuration)
        {
            Configuration = configuration;
        }

        public IConfiguration Configuration { get; }

        public void ConfigureServices(IServiceCollection services)
        {
            services.Configure<CookiePolicyOptions>(options =>
            {
                options.CheckConsentNeeded = context => true;
                options.MinimumSameSitePolicy = SameSiteMode.None;
            });

            services.AddMvc();

            services.AddCors(options => options.AddPolicy("CorsPolicy",
                builder =>
                {
                    builder.AllowAnyMethod().AllowAnyHeader()
                        .WithOrigins("http://localhost:55830")
                        .AllowCredentials();
                }));
        }

        services.AddSignalR();
    }

    public void Configure(IApplicationBuilder app, IHostingEnvironment env)
    {
        if (env.IsDevelopment())
        {
            app.UseBrowserLink();
            app.UseDeveloperExceptionPage();
        }
        else
        {
            app.UseExceptionHandler("/Error");
            app.UseHsts();
        }

        app.UseHttpsRedirection();
        app.UseStaticFiles();
        app.UseCookiePolicy();
        app.UseCors("CorsPolicy");
        app.UseSignalR(routes =>
        {
            routes.MapHub<ChatHub>("/chathub");
        });
        app.UseMvc();
    }
}
```

## Call hub methods from client

JavaScript clients call public methods on hubs by using `connection.invoke`. The `invoke` method accepts two arguments:

- The name of the hub method. In the following example, the hub name is `SendMessage`.
- Any arguments defined in the hub method. In the following example, the argument name is `message`.

```
connection.invoke("SendMessage", user, message).catch(err => console.error(err.toString()));
```

## Call client methods from hub

To receive messages from the hub, define a method using the `connection.on` method.

- The name of the JavaScript client method. In the following example, the method name is `ReceiveMessage`.
- Arguments the hub passes to the method. In the following example, the argument value is `message`.

```
connection.on("ReceiveMessage", (user, message) => {
    const encodedMsg = user + " says " + message;
    const li = document.createElement("li");
    li.textContent = encodedMsg;
    document.getElementById("messagesList").appendChild(li);
});
```

The preceding code in `connection.on` runs when server-side code calls it using the `SendAsync` method.

```
public async Task SendMessage(string user, string message)
{
    await Clients.All.SendAsync("ReceiveMessage", user, message);
}
```

SignalR determines which client method to call by matching the method name and arguments defined in `SendAsync` and `connection.on`.

### NOTE

As a best practice, call `connection.start` after `connection.on` so your handlers are registered before any messages are received.

## Error handling and logging

Chain a `catch` method to the end of the `connection.start` method to handle client-side errors. Use `console.error` to output errors to the browser's console.

```
connection.start().catch(err => console.error(err.toString()));
```

Setup client-side log tracing by passing a logger and type of event to log when the connection is made. Messages are logged with the specified log level and higher. Available log levels are as follows:

- `signalR.LogLevel.Error` : Error messages. Logs `Error` messages only.
- `signalR.LogLevel.Warning` : Warning messages about potential errors. Logs `Warning`, and `Error` messages.
- `signalR.LogLevel.Information` : Status messages without errors. Logs `Information`, `Warning`, and `Error`

messages.

- `signalR.LogLevel.Trace` : Trace messages. Logs everything, including data transported between hub and client.

Use the `configureLogging` method on `HubConnectionBuilder` to configure the log level. Messages are logged to the browser console.

```
const connection = new signalR.HubConnectionBuilder()
    .withUrl("/chatHub")
    .configureLogging(signalR.LogLevel.Information)
    .build();
```

## Related resources

- [Hubs](#)
- [.NET client](#)
- [Publish to Azure](#)
- [Enable Cross-Origin Requests \(CORS\) in ASP.NET Core](#)

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using Microsoft.AspNetCore.Http;
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using Microsoft.Extensions.DependencyInjection;
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{
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    {
        public Startup(IConfiguration configuration)
        {
            Configuration = configuration;
        }

        public IConfiguration Configuration { get; }

        public void ConfigureServices(IServiceCollection services)
        {
            services.Configure<CookiePolicyOptions>(options =>
            {
                options.CheckConsentNeeded = context => true;
                options.MinimumSameSitePolicy = SameSiteMode.None;
            });

            services.AddMvc();

            services.AddCors(options => options.AddPolicy("CorsPolicy",
                builder =>
                {
                    builder.AllowAnyMethod().AllowAnyHeader()
                        .WithOrigins("http://localhost:55830")
                        .AllowCredentials();
                }));
        }

        public void AddSignalR();
    }

    public void Configure(IApplicationBuilder app, IHostingEnvironment env)
    {
        if (env.IsDevelopment())
        {
            app.UseBrowserLink();
            app.UseDeveloperExceptionPage();
        }
        else
        {
            app.UseExceptionHandler("/Error");
            app.UseHsts();
        }

        app.UseHttpsRedirection();
        app.UseStaticFiles();
        app.UseCookiePolicy();
        app.UseCors("CorsPolicy");
        app.UseSignalR(routes =>
        {
            routes.MapHub<ChatHub>("/chathub");
        });
        app.UseMvc();
    }
}
```

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- The name of the hub method. In the following example, the hub name is `SendMessage`.
- Any arguments defined in the hub method. In the following example, the argument name is `message`.

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- Arguments the hub passes to the method. In the following example, the argument value is `message`.

```
connection.on("ReceiveMessage", (user, message) => {
    const encodedMsg = user + " says " + message;
    const li = document.createElement("li");
    li.textContent = encodedMsg;
    document.getElementById("messagesList").appendChild(li);
});
```

The preceding code in `connection.on` runs when server-side code calls it using the `SendAsync` method.

```
public async Task SendMessage(string user, string message)
{
    await Clients.All.SendAsync("ReceiveMessage", user, message);
}
```

SignalR determines which client method to call by matching the method name and arguments defined in `SendAsync` and `connection.on`.

### NOTE

As a best practice, call `connection.start` after `connection.on` so your handlers are registered before any messages are received.

## Error handling and logging

Chain a `catch` method to the end of the `connection.start` method to handle client-side errors. Use `console.error` to output errors to the browser's console.

```
connection.start().catch(err => console.error(err.toString()));
```

Setup client-side log tracing by passing a logger and type of event to log when the connection is made. Messages are logged with the specified log level and higher. Available log levels are as follows:

- `signalR.LogLevel.Error` : Error messages. Logs `Error` messages only.
- `signalR.LogLevel.Warning` : Warning messages about potential errors. Logs `Warning`, and `Error` messages.
- `signalR.LogLevel.Information` : Status messages without errors. Logs `Information`, `Warning`, and `Error`

messages.

- `signalR.LogLevel.Trace` : Trace messages. Logs everything, including data transported between hub and client.

Use the `configureLogging` method on `HubConnectionBuilder` to configure the log level. Messages are logged to the browser console.

```
const connection = new signalR.HubConnectionBuilder()
    .withUrl("/chatHub")
    .configureLogging(signalR.LogLevel.Information)
    .build();
```

## Related resources

- [Hubs](#)
- [.NET client](#)
- [Publish to Azure](#)
- [Enable Cross-Origin Requests \(CORS\) in ASP.NET Core](#)

# ASP.NET Core SignalR .NET Client

7/10/2018 • 2 minutes to read • [Edit Online](#)

By [Rachel Appel](#)

The ASP.NET Core SignalR .NET client can be used by Xamarin, WPF, Windows Forms, Console, and .NET Core apps. Like the [JavaScript client](#), the .NET client enables you to receive and send and receive messages to a hub in real time.

[View or download sample code \(how to download\)](#)

The code sample in this article is a WPF app that uses the ASP.NET Core SignalR .NET client.

## Install the SignalR .NET client package

The `Microsoft.AspNetCore.SignalR.Client` package is needed for .NET clients to connect to SignalR hubs. To install the client library, run the following command in the **Package Manager Console** window:

```
Install-Package Microsoft.AspNetCore.SignalR.Client
```

## Connect to a hub

To establish a connection, create a `HubConnectionBuilder` and call `Build`. The hub URL, protocol, transport type, log level, headers, and other options can be configured while building a connection. Configure any required options by inserting any of the `HubConnectionBuilder` methods into `Build`. Start the connection with `StartAsync`.

```

using Microsoft.AspNetCore.SignalR.Client;
using Microsoft.Extensions.Logging;
using System;
using System.Windows;

namespace SignalRChatClient
{
    public partial class MainWindow : Window
    {
        HubConnection connection;
        public MainWindow()
        {
            InitializeComponent();

            connection = new HubConnectionBuilder()
                .WithUrl("https://localhost:44317/ChatHub")
                .Build();
        }

        private async void connectButton_Click(object sender, RoutedEventArgs e)
        {
            connection.On<string, string>("ReceiveMessage", (user, message) =>
            {
                this.Dispatcher.Invoke(() =>
                {
                    var newMessage = $"{user}: {message}";
                    messagesList.Items.Add(newMessage);
                });
            });

            try
            {
                await connection.StartAsync();
                messagesList.Items.Add("Connection started");
                connectButton.IsEnabled = false;
                sendButton.IsEnabled = true;
            }
            catch (Exception ex)
            {
                messagesList.Items.Add(ex.Message);
            }
        }

        private async void sendButton_Click(object sender, RoutedEventArgs e)
        {
            try
            {
                await connection.InvokeAsync("SendMessage",
                    userTextBox.Text, messageTextBox.Text);
            }
            catch (Exception ex)
            {
                messagesList.Items.Add(ex.Message);
            }
        }
    }
}

```

## Call hub methods from client

`InvokeAsync` calls methods on the hub. Pass the hub method name and any arguments defined in the hub method to `InvokeAsync`. SignalR is asynchronous, so use `async` and `await` when making the calls.

```
await connection.InvokeAsync("SendMessage",
    userTextBox.Text, messageTextBox.Text);
```

## Call client methods from hub

Define methods the hub calls using `connection.On` after building, but before starting the connection.

```
connection.On<string, string>("ReceiveMessage", (user, message) =>
{
    this.Dispatcher.Invoke(() =>
    {
        var newMessage = $"{user}: {message}";
        messagesList.Items.Add(newMessage);
    });
});
```

The preceding code in `connection.On` runs when server-side code calls it using the `SendAsync` method.

```
public async Task SendMessage(string user, string message)
{
    await Clients.All.SendAsync("ReceiveMessage", user, message);
}
```

## Error handling and logging

Handle errors with a try-catch statement. Inspect the `Exception` object to determine the proper action to take after an error occurs.

```
try
{
    await connection.InvokeAsync("SendMessage",
        userTextBox.Text, messageTextBox.Text);
}
catch (Exception ex)
{
    messagesList.Items.Add(ex.Message);
}
```

## Additional resources

- [Hubs](#)
- [JavaScript client](#)
- [Publish to Azure](#)

# Use ASP.NET Core SignalR with TypeScript and Webpack

7/10/2018 • 10 minutes to read • [Edit Online](#)

By [Sébastien Sougnez](#) and [Scott Addie](#)

[Webpack](#) enables developers to bundle and build the client-side resources of a web app. This tutorial demonstrates using Webpack in an ASP.NET Core SignalR web app whose client is written in [TypeScript](#).

In this tutorial, you learn how to:

- Scaffold a starter ASP.NET Core SignalR app
- Configure the SignalR TypeScript client
- Configure a build pipeline using Webpack
- Configure the SignalR server
- Enable communication between client and server

[View or download sample code \(how to download\)](#)

## Prerequisites

Install the following software:

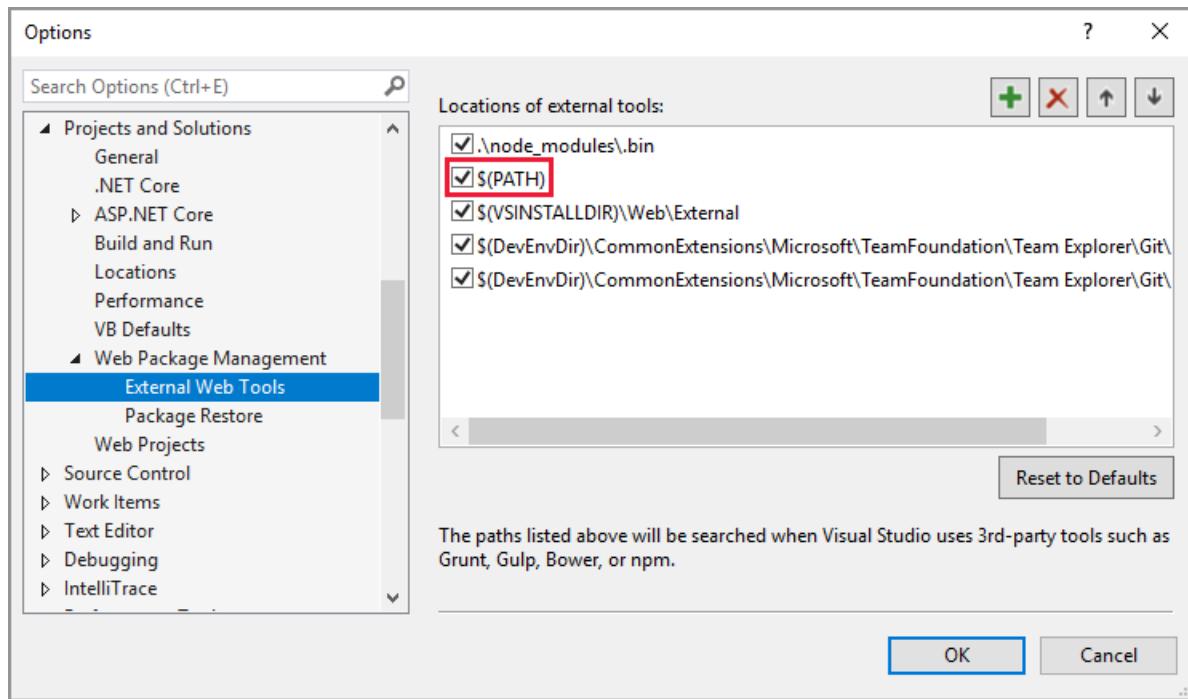
- [Visual Studio](#)
- [.NET Core CLI](#)
- [.NET Core SDK 2.1 or later](#)
- [Node.js](#) with [npm](#)
- [Visual Studio 2017](#) version 15.7.3 or later with the **ASP.NET and web development** workload

## Create the ASP.NET Core web app

- [Visual Studio](#)
- [.NET Core CLI](#)

Configure Visual Studio to look for npm in the *PATH* environment variable. By default, Visual Studio uses the version of npm found in its installation directory. Follow these instructions in Visual Studio:

1. Navigate to **Tools > Options > Projects and solutions > Web Package Management > External Web Tools**.
2. Select the `$(PATH)` entry from the list. Click the up arrow to move the entry to the second position in the list. As an aside, the first entry refers to the project's local packages.



Visual Studio configuration is completed. It's time to create the project.

1. Use the **File > New > Project** menu option and choose the **ASP.NET Core Web Application** template.
2. Name the project *SignalRWebPack*, and click the **OK** button.
3. Select *.NET Core* from the target framework drop-down, and select *ASP.NET Core 2.1* from the framework selector drop-down. Select the **Empty** template, and click the **OK** button.

## Configure Webpack and TypeScript

The following steps configure the conversion of TypeScript to JavaScript and the bundling of client-side resources.

1. Execute the following command in the project root to create a *package.json* file:

```
npm init -y
```

2. Add the highlighted property to the *package.json* file:

```
{
  "name": "SignalRWebPack",
  "version": "1.0.0",
  "private": true,
  "description": "",
  "main": "index.js",
  "scripts": {
    "test": "echo \\\"Error: no test specified\\\" && exit 1"
  },
  "keywords": [],
  "author": "",
  "license": "ISC"
}
```

Setting the `private` property to `true` prevents package installation warnings in the next step.

3. Install the required npm packages. Execute the following command from the project root:

```
npm install -D -E clean-webpack-plugin@0.1.19 css-loader@0.28.11 html-webpack-plugin@3.2.0 mini-css-extract-plugin@0.4.0 ts-loader@4.4.1 typescript@2.9.2 webpack@4.12.0 webpack-cli@3.0.6
```

Some command details to note:

- A version number follows the `@` sign for each package name. npm installs those specific package versions.
- The `-E` option disables npm's default behavior of writing [semantic versioning](#) range operators to `package.json`. For example, `"webpack": "4.12.0"` is used instead of `"webpack": "^4.12.0"`. This option prevents unintended upgrades to newer package versions.

See the official [npm-install](#) docs for more detail.

4. Replace the `scripts` property of the `package.json` file with the following snippet:

```
"scripts": {  
  "build": "webpack --mode=development --watch",  
  "release": "webpack --mode=production",  
  "publish": "npm run release && dotnet publish -c Release"  
},
```

Some explanation of the scripts:

- `build` : Bundles your client-side resources in development mode and watches for file changes. The file watcher causes the bundle to regenerate each time a project file changes. The `mode` option disables production optimizations, such as tree shaking and minification. Only use `build` in development.
- `release` : Bundles your client-side resources in production mode.
- `publish` : Runs the `release` script to bundle the client-side resources in production mode. It calls the .NET Core CLI's `publish` command to publish the app.

5. Create a file named `webpack.config.js`, in the project root, with the following content:

```

const path = require("path");
const HtmlWebpackPlugin = require("html-webpack-plugin");
const CleanWebpackPlugin = require("clean-webpack-plugin");
const MiniCssExtractPlugin = require("mini-css-extract-plugin");

module.exports = {
  entry: "./src/index.ts",
  output: {
    path: path.resolve(__dirname, "wwwroot"),
    filename: "[name].[chunkhash].js",
    publicPath: "/"
  },
  resolve: {
    extensions: [".js", ".ts"]
  },
  module: {
    rules: [
      {
        test: /\.ts$/,
        use: "ts-loader"
      },
      {
        test: /\.css$/,
        use: [MiniCssExtractPlugin.loader, "css-loader"]
      }
    ]
  },
  plugins: [
    new CleanWebpackPlugin(["wwwroot/*"]),
    new HtmlWebpackPlugin({
      template: "./src/index.html"
    }),
    new MiniCssExtractPlugin({
      filename: "css/[name].[chunkhash].css"
    })
  ]
};

```

The preceding file configures the Webpack compilation. Some configuration details to note:

- The `output` property overrides the default value of `dist`. The bundle is instead emitted in the `wwwroot` directory.
  - The `resolve.extensions` array includes `.js` to import the SignalR client JavaScript.
6. Create a new `src` directory in the project root. Its purpose is to store the project's client-side assets.
  7. Create `src/index.html` with the following content.

```

<!DOCTYPE html>
<html>
<head>
  <meta charset="utf-8" />
  <title>ASP.NET Core SignalR</title>
</head>
<body>
  <div id="divMessages" class="messages">
  </div>
  <div class="input-zone">
    <label id="lblMessage" for="tbMessage">Message:</label>
    <input id="tbMessage" class="input-zone-input" type="text" />
    <button id="btnSend">Send</button>
  </div>
</body>
</html>

```

The preceding HTML defines the homepage's boilerplate markup.

8. Create a new `src/css` directory. Its purpose is to store the project's `.css` files.

9. Create `src/css/main.css` with the following content:

```
* { *::before, *::after {  
    box-sizing: border-box;  
}  
  
html, body {  
    margin: 0;  
    padding: 0;  
}  
  
.input-zone {  
    align-items: center;  
    display: flex;  
    flex-direction: row;  
    margin: 10px;  
}  
  
.input-zone-input {  
    flex: 1;  
    margin-right: 10px;  
}  
  
.message-author {  
    font-weight: bold;  
}  
  
.messages {  
    border: 1px solid #000;  
    margin: 10px;  
    max-height: 300px;  
    min-height: 300px;  
    overflow-y: auto;  
    padding: 5px;  
}
```

The preceding `main.css` file styles the app.

10. Create `src/tsconfig.json` with the following content:

```
{  
  "compilerOptions": {  
    "target": "es5"  
  }  
}
```

The preceding code configures the TypeScript compiler to produce [ECMAScript](#) 5-compatible JavaScript.

11. Create `src/index.ts` with the following content:

```

import "./css/main.css";

const divMessages: HTMLDivElement = document.querySelector("#divMessages");
const tbMessage: HTMLInputElement = document.querySelector("#tbMessage");
const btnSend: HTMLButtonElement = document.querySelector("#btnSend");
const username = new Date().getTime();

tbMessage.addEventListener("keyup", (e: KeyboardEvent) => {
    if (e.keyCode === 13) {
        send();
    }
});

btnSend.addEventListener("click", send);

function send() {
}

```

The preceding TypeScript retrieves references to DOM elements and attaches two event handlers:

- `keyup`: This event fires when the user types something in the textbox identified as `tbMessage`. The `send` function is called when the user presses the **Enter** key.
- `click`: This event fires when the user clicks the **Send** button. The `send` function is called.

## Configure the ASP.NET Core app

1. The code provided in the `Startup.Configure` method displays *Hello World!*. Replace the `app.Run` method call with calls to `UseDefaultFiles` and `UseStaticFiles`.

```

app.UseDefaultFiles();
app.UseStaticFiles();

```

The preceding code allows the server to locate and serve the *index.html* file, whether the user enters its full URL or the root URL of the web app.

2. Call `AddSignalR` in the `Startup.ConfigureServices` method. It adds the SignalR services to your project.

```

services.AddSignalR();

```

3. Map a `/hub` route to the `ChatHub` hub. Add the following lines at the end of the `Startup.Configure` method:

```

app.UseSignalR(options =>
{
    options.MapHub<ChatHub>("/hub");
});

```

4. Create a new directory, called *Hubs*, in the project root. Its purpose is to store the SignalR hub, which is created in the next step.
5. Create hub *Hubs/ChatHub.cs* with the following code:

```
using Microsoft.AspNetCore.SignalR;
using System.Threading.Tasks;

namespace SignalRWebPack.Hubs
{
    public class ChatHub : Hub
    {
    }
}
```

6. Add the following code at the top of the *Startup.cs* file to resolve the `ChatHub` reference:

```
using SignalRWebPack.Hubs;
```

## Enable client and server communication

The app currently displays a simple form to send messages. Nothing happens when you try to do so. The server is listening to a specific route but does nothing with sent messages.

1. Execute the following command at the project root:

```
npm install @aspnet/signalr
```

The preceding command installs the [SignalR TypeScript client](#), which allows the client to send messages to the server.

2. Add the highlighted code to the *src/index.ts* file:

```

import "./css/main.css";
import * as signalR from "@aspnet/signalr";

const divMessages: HTMLDivElement = document.querySelector("#divMessages");
const tbMessage: HTMLInputElement = document.querySelector("#tbMessage");
const btnSend: HTMLButtonElement = document.querySelector("#btnSend");
const username = new Date().getTime();

const connection = new signalR.HubConnectionBuilder()
    .withUrl("/hub")
    .build();

connection.start().catch(err => document.write(err));

connection.on("messageReceived", (username: string, message: string) => {
    let m = document.createElement("div");

    m.innerHTML =
        `<div class="message__author">${username}</div><div>${message}</div>`;

    divMessages.appendChild(m);
    divMessages.scrollTop = divMessages.scrollHeight;
});

tbMessage.addEventListener("keyup", (e: KeyboardEvent) => {
    if (e.keyCode === 13) {
        send();
    }
});

btnSend.addEventListener("click", send);

function send() {
}

```

The preceding code supports receiving messages from the server. The `HubConnectionBuilder` class creates a new builder for configuring the server connection. The `withUrl` function configures the hub URL.

SignalR enables the exchange of messages between a client and a server. Each message has a specific name. For example, you can have messages with the name `messageReceived` that execute the logic responsible for displaying the new message in the messages zone. Listening to a specific message can be done via the `on` function. You can listen to any number of message names. It's also possible to pass parameters to the message, such as the author's name and the content of the message received. Once the client receives a message, a new `div` element is created with the author's name and the message content in its `innerHTML` attribute. It's added to the main `div` element displaying the messages.

- Now that the client can receive a message, configure it to send messages. Add the highlighted code to the `src/index.ts` file:

```

import "./css/main.css";
import * as signalR from "@aspnet/signalr";

const divMessages: HTMLDivElement = document.querySelector("#divMessages");
const tbMessage: HTMLInputElement = document.querySelector("#tbMessage");
const btnSend: HTMLButtonElement = document.querySelector("#btnSend");
const username = new Date().getTime();

const connection = new signalR.HubConnectionBuilder()
    .withUrl("/hub")
    .build();

connection.start().catch(err => document.write(err));

connection.on("messageReceived", (username: string, message: string) => {
    let messageContainer = document.createElement("div");

    messageContainer.innerHTML =
        `<div class="message-author">${username}</div><div>${message}</div>`;

    divMessages.appendChild(messageContainer);
    divMessages.scrollTop = divMessages.scrollHeight;
});

tbMessage.addEventListener("keyup", (e: KeyboardEvent) => {
    if (e.keyCode === 13) {
        send();
    }
});

btnSend.addEventListener("click", send);

function send() {
    connection.send("newMessage", username, tbMessage.value)
        .then(() => tbMessage.value = "");
}

```

Sending a message through the WebSockets connection requires calling the `send` method. The method's first parameter is the message name. The message data inhabits the other parameters. In this example, a message identified as `newMessage` is sent to the server. The message consists of the username and the user input from a text box. If the send works, the text box value is cleared.

- Add the highlighted method to the `ChatHub` class:

```

using Microsoft.AspNetCore.SignalR;
using System.Threading.Tasks;

namespace SignalRWebPack.Hubs
{
    public class ChatHub : Hub
    {
        public async Task NewMessage(string username, string message)
        {
            await Clients.All.SendAsync("messageReceived", username, message);
        }
    }
}

```

The preceding code broadcasts received messages to all connected users once the server receives them. It's unnecessary to have a generic `on` method to receive all the messages. A method named after the message name suffices.

In this example, the TypeScript client sends a message identified as `newMessage`. The C# `NewMessage`

method expects the data sent by the client. A call is made to the `SendAsync` method on `Clients.All`. The received messages are sent to all clients connected to the hub.

## Test the app

Confirm that the app works with the following steps.

- [Visual Studio](#)
- [.NET Core CLI](#)

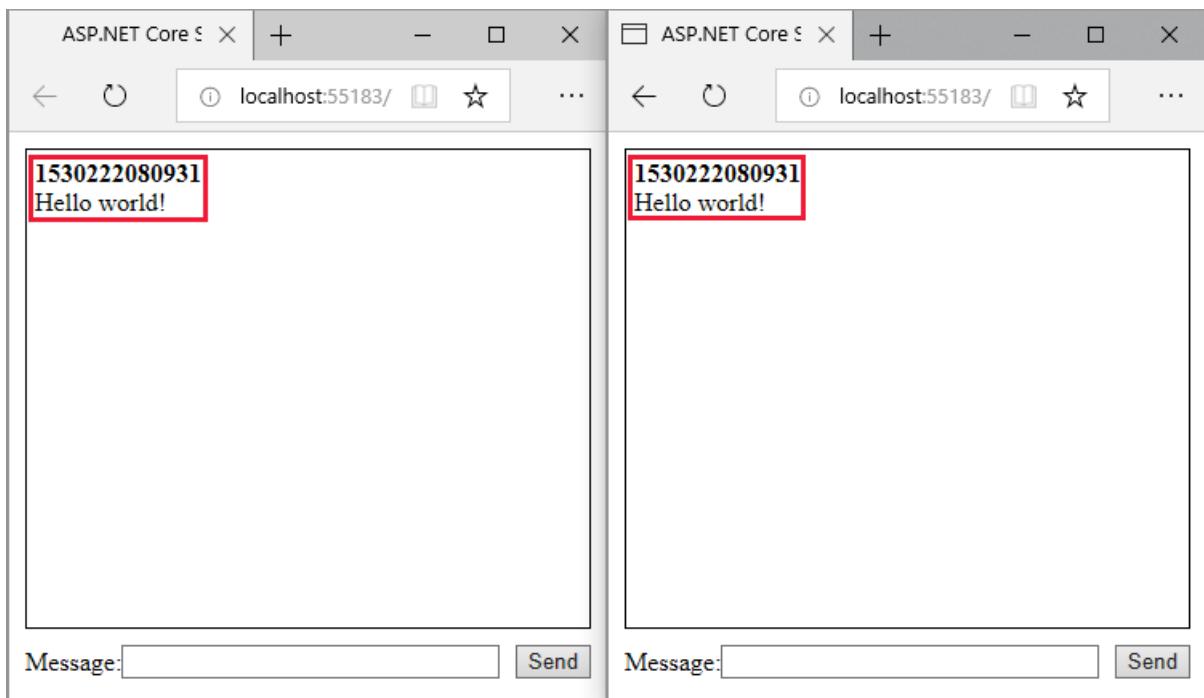
1. Run Webpack in *release* mode. Using the **Package Manager Console** window, execute the following command in the project root:

```
npm run release
```

This command yields the client-side assets to be served when running the app. The assets are placed in the `wwwroot` folder.

Webpack completed the following tasks:

- Purged the contents of the `wwwroot` directory.
  - Converted the TypeScript to JavaScript—a process known as *transpilation*.
  - Mangled the generated JavaScript to reduce file size—a process known as *minification*.
  - Copied the processed JavaScript, CSS, and HTML files from `src` to the `wwwroot` directory.
  - Injected the following elements into the `wwwroot/index.html` file:
    - A `<link>` tag, referencing the `wwwroot/main.<hash>.css` file. This tag is placed immediately before the closing `</head>` tag.
    - A `<script>` tag, referencing the minified `wwwroot/main.<hash>.js` file. This tag is placed immediately before the closing `</body>` tag.
2. Select **Debug > Start without debugging** to launch the app in a browser without attaching the debugger. The `wwwroot/index.html` file is served at `http://localhost:<port_number>`.
  3. Open another browser instance (any browser). Paste the URL in the address bar.
  4. Choose either browser, type something in the **Message** text box, and click the **Send** button. The unique user name and message are displayed on both pages instantly.



## Additional resources

- [ASP.NET Core SignalR JavaScript client](#)
- [Use hubs in ASP.NET Core SignalR](#)

# ASP.NET Core SignalR configuration

6/26/2018 • 8 minutes to read • [Edit Online](#)

## JSON/MessagePack serialization options

ASP.NET Core SignalR supports two protocols for encoding messages: [JSON](#) and [MessagePack](#). Each protocol has serialization configuration options.

JSON serialization can be configured on the server using the `AddJsonProtocol` extension method, which can be added after `AddSignalR` in your `Startup.ConfigureServices` method. The `AddJsonProtocol` method takes a delegate that receives an `options` object. The `PayloadSerializerSettings` property on that object is a [JSON.NET JsonSerializerSettings](#) object that can be used to configure serialization of arguments and return values. See the [JSON.NET Documentation](#) for more details.

As an example, to configure the serializer to use "PascalCase" property names, instead of the default "camelCase" names, use the following code:

```
services.AddSignalR()
    .AddJsonHubProtocol(options => {
        options.PayloadSerializerSettings.ContractResolver =
            new DefaultContractResolver();
    });
}
```

In the .NET client, the same `AddJsonHubProtocol` extension method exists on [HubConnectionBuilder](#). The `Microsoft.Extensions.DependencyInjection` namespace must be imported to resolve the extension method:

```
// At the top of the file:
using Microsoft.Extensions.DependencyInjection;

// When constructing your connection:
var connection = new HubConnectionBuilder()
    .AddJsonHubProtocol(options => {
        options.PayloadSerializerSettings.ContractResolver =
            new DefaultContractResolver();
    });
}
```

### NOTE

It's not possible to configure JSON serialization in the JavaScript client at this time.

## MessagePack serialization options

MessagePack serialization can be configured by providing a delegate to the `AddMessagePackProtocol` call. See [MessagePack in SignalR](#) for more details.

### NOTE

It's not possible to configure MessagePack serialization in the JavaScript client at this time.

## Configure server options

The following table describes options for configuring SignalR hubs:

OPTION	DESCRIPTION
<code>HandshakeTimeout</code>	If the client doesn't send an initial handshake message within this time interval, the connection is closed.
<code>KeepAliveInterval</code>	If the server hasn't sent a message within this interval, a ping message is sent automatically to keep the connection open.
<code>SupportedProtocols</code>	Protocols supported by this hub. By default, all protocols registered on the server are allowed, but protocols can be removed from this list to disable specific protocols for individual hubs.
<code>EnableDetailedErrors</code>	If <code>true</code> , detailed exception messages are returned to clients when an exception is thrown in a Hub method. The default is <code>false</code> , as these exception messages can contain sensitive information.

Options can be configured for all hubs by providing an options delegate to the `AddSignalR` call in

`Startup.ConfigureServices`.

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddSignalR(hubOptions =>
    {
        hubOptions.EnableDetailedErrors = true;
        hubOptions.KeepAliveInterval = TimeSpan.FromMinutes(1);
    })
}
```

Options for a single hub override the global options provided in `AddSignalR` and can be configured using

`AddHubOptions<T>`:

```
services.AddSignalR().AddHubOptions<MyHub>(options =>
{
    options.EnableDetailedErrors = true;
})
```

Use `HttpConnectionDispatcherOptions` to configure advanced settings related to transports and memory buffer management. These options are configured by passing a delegate to `MapHub<T>`.

OPTION	DESCRIPTION
<code>ApplicationMaxBufferSize</code>	The maximum number of bytes received from the client that the server buffers. Increasing this value allows the server to receive larger messages, but can negatively impact memory consumption. The default value is 32KB.
<code>AuthorizationData</code>	A list of <code>IAuthorizeData</code> objects used to determine if a client is authorized to connect to the hub. By default, this is populated with values from the <code>Authorize</code> attributes applied to the Hub class.

OPTION	DESCRIPTION
<code>TransportMaxBufferSize</code>	The maximum number of bytes sent by the app that the server buffers. Increasing this value allows the server to send larger messages, but can negatively impact memory consumption. The default value is 32KB.
<code>Transports</code>	A bitmask of <code>HttpTransportType</code> values that can restrict the transports a client can use to connect. All transports are enabled by default.
<code>LongPolling</code>	Additional options specific to the Long Polling transport.
<code>WebSockets</code>	Additional options specific to the WebSockets transport.

The Long Polling transport has additional options that can be configured using the `LongPolling` property:

OPTION	DESCRIPTION
<code>PollTimeout</code>	The maximum amount of time the server waits for a message to send to the client before terminating a single poll request. Decreasing this value causes the client to issue new poll requests more frequently. The default value is 90 seconds.

The WebSocket transport has additional options that can be configured using the `WebSockets` property:

OPTION	DESCRIPTION
<code>CloseTimeout</code>	After the server closes, if the client fails to close within this time interval, the connection is terminated.
<code>SubProtocolSelector</code>	A delegate that can be used to set the <code>Sec-WebSocket-Protocol</code> header to a custom value. The delegate receives the values requested by the client as input and is expected to return the desired value.

## Configure client options

Client options can be configured on the `HubConnectionBuilder` type (available in both .NET and JavaScript clients), as well as on the `HubConnection` itself.

### Configure logging

Logging is configured in the .NET Client using the `ConfigureLogging` method. Logging providers and filters can be registered in the same way as they are on the server. See the [Logging in ASP.NET Core](#) documentation for more information.

#### NOTE

In order to register Logging providers, you must install the necessary packages. See the [Built-in logging providers](#) section of the docs for a full list.

For example, to enable Console logging, install the `Microsoft.Extensions.Logging.Console` NuGet package. Call the `AddConsole` extension method:

```

var connection = new HubConnectionBuilder()
    .WithUrl("https://example.com/myhub")
    .ConfigureLogging(logging => {
        logging.SetMinimumLevel(LogLevel.Information);
        logging.AddConsole();
    })
    .Build();

```

In the JavaScript client, a similar `configureLogging` method exists. Provide a `LogLevel` value indicating the minimum level of log messages to produce. Logs are written to the browser console window.

```

let connection = new signalR.HubConnectionBuilder()
    .withUrl("/myhub")
    .configureLogging(signalR.LogLevel.Information)
    .build();

```

#### NOTE

To disable logging entirely, specify `signalR.LogLevel.None` in the `configureLogging` method.

Log levels available to the JavaScript client are listed below. Setting the log level to one of these values enables logging of messages at **or above** that level.

LEVEL	DESCRIPTION
<code>None</code>	No messages are logged.
<code>Critical</code>	Messages that indicate a failure in the entire app.
<code>Error</code>	Messages that indicate a failure in the current operation.
<code>Warning</code>	Messages that indicate a non-fatal problem.
<code>Information</code>	Informational messages.
<code>Debug</code>	Diagnostic messages useful for debugging.
<code>Trace</code>	Very detailed diagnostic messages designed for diagnosing specific issues.

#### Configure allowed transports

The transports used by SignalR can be configured in the `WithUrl` call (`withUrl` in JavaScript). A bitwise-OR of the values of `HttpTransportType` can be used to restrict the client to only use the specified transports. All transports are enabled by default.

For example, to disable the Server-Sent Events transport, but allow WebSockets and Long Polling connections:

```

var connection = new HubConnectionBuilder()
    .WithUrl("https://example.com/myhub", HttpTransportType.WebSockets | HttpTransportType.LongPolling)
    .Build();

```

In the JavaScript client, transports are configured by setting the `transport` field on the options object provided to

```
withUrl :
```

```
let connection = new signalR.HubConnectionBuilder()
    .withUrl("/myhub", { transport: signalR.HttpTransportType.WebSockets |
    signalR.HttpTransportType.LongPolling })
    .build();
```

## Configure bearer authentication

To provide authentication data along with SignalR requests, use the `AccessTokenProvider` option (`accessTokenFactory` in JavaScript) to specify a function that returns the desired access token. In the .NET Client, this access token is passed in as an HTTP "Bearer Authentication" token (Using the `Authorization` header with a type of `Bearer`). In the JavaScript client, the access token is used as a Bearer token, **except** in a few cases where browser APIs restrict the ability to apply headers (specifically, in Server-Sent Events and WebSockets requests). In these cases, the access token is provided as a query string value `access_token`.

In the .NET client, the `AccessTokenProvider` option can be specified using the options delegate in `WithUrl`:

```
var connection = new HubConnectionBuilder()
    .WithUrl("https://example.com/myhub", options => {
        options.AccessTokenProvider = async () => {
            // Get and return the access token.
        }
    })
    .Build();
```

In the JavaScript client, the access token is configured by setting the `accessTokenFactory` field on the options object in `withUrl`:

```
let connection = new signalR.HubConnectionBuilder()
    .withUrl("/myhub", {
        accessTokenFactory: () => {
            // Get and return the access token.
            // This function can return a JavaScript Promise if asynchronous
            // logic is required to retrieve the access token.
        }
    })
    .build();
```

## Configure timeout and keep-alive options

Additional options for configuring timeout and keep-alive behavior are available on the `HubConnection` object itself:

.NET OPTION	JAVASCRIPT OPTION	DESCRIPTION
<code>ServerTimeout</code>	<code>serverTimeoutInMilliseconds</code>	Timeout for server activity. If the server hasn't sent any message in this interval, the client considers the server disconnected and trigger the <code>Closed</code> event ( <code>onclose</code> in JavaScript).
<code>HandshakeTimeout</code>	Not configurable	Timeout for initial server handshake. If the server doesn't send a handshake response in this interval, the client cancels the handshake and trigger the <code>Closed</code> event ( <code>onclose</code> in JavaScript).

In the .NET Client, timeout values are specified as `TimeSpan` values. In the JavaScript client, timeout values are specified as numbers. The numbers represent time values in milliseconds.

## Configure additional options

Additional options can be configured in the `WithUrl` (`withUrl` in JavaScript) method on `HubConnectionBuilder`:

.NET OPTION	JAVASCRIPT OPTION	DESCRIPTION
<code>AccessTokenProvider</code>	<code>accessTokenFactory</code>	A function returning a string that is provided as a Bearer authentication token in HTTP requests.
<code>SkipNegotiation</code>	<code>skipNegotiation</code>	Set this to <code>true</code> to skip the negotiation step. <b>Only supported when the WebSockets transport is the only enabled transport.</b> This setting can't be enabled when using the Azure SignalR Service.
<code>ClientCertificates</code>	Not configurable *	A collection of TLS certificates to send to authenticate requests.
<code>Cookies</code>	Not configurable *	A collection of HTTP cookies to send with every HTTP request.
<code>Credentials</code>	Not configurable *	Credentials to send with every HTTP request.
<code>CloseTimeout</code>	Not configurable *	WebSockets only. The maximum amount of time the client waits after closing for the server to acknowledge the close request. If the server doesn't acknowledge the close within this time, the client disconnects.
<code>Headers</code>	Not configurable *	A dictionary of additional HTTP headers to send with every HTTP request.
<code>HttpMessageHandlerFactory</code>	Not configurable *	A delegate that can be used to configure or replace the <code>HttpMessageHandler</code> used to send HTTP requests. Not used for WebSocket connections. This delegate must return a non-null value, and it receives the default value as a parameter. Either modify settings on that default value and return it, or return a completely new <code>HttpMessageHandler</code> instance.
<code>Proxy</code>	Not configurable *	An HTTP proxy to use when sending HTTP requests.
<code>UseDefaultCredentials</code>	Not configurable *	Set this boolean to send the default credentials for HTTP and WebSockets requests. This enables the use of Windows authentication.

.NET OPTION	JAVASCRIPT OPTION	DESCRIPTION
WebSocketConfiguration	Not configurable *	A delegate that can be used to configure additional WebSocket options. Receives an instance of <a href="#">ClientWebSocketOptions</a> that can be used to configure the options.

Options marked with an asterisk (\*) aren't configurable in the JavaScript client, due to limitations in browser APIs.

In the .NET Client, these options can be modified by the options delegate provided to `WithUrl` :

```
var connection = new HubConnectionBuilder()
    .WithUrl("https://example.com/myhub", options => {
        options.Headers["Foo"] = "Bar";
        options.Cookies.Add(new Cookie(/* ... */));
        options.ClientCertificates.Add(/* ... */);
    })
    .Build();
```

In the JavaScript Client, these options can be provided in a JavaScript object provided to `withUrl` :

```
let connection = new signalR.HubConnectionBuilder()
    .withUrl("/myhub", {
        skipNegotiation: true,
        transport: signalR.HttpTransportType.WebSockets
    });
    .build();
```

## Additional resources

- [Get started with SignalR on ASP.NET Core](#)
- [Use hubs in ASP.NET Core SignalR](#)
- [ASP.NET Core SignalR JavaScript client](#)
- [ASP.NET Core SignalR .NET Client](#)
- [Use MessagePack Hub Protocol in SignalR for ASP.NET Core](#)
- [ASP.NET Core SignalR supported platforms](#)

# Authentication and authorization in ASP.NET Core SignalR

7/12/2018 • 4 minutes to read • [Edit Online](#)

By [Andrew Stanton-Nurse](#)

[View or download sample code](#) ([how to download](#))

## Authenticate users connecting to a SignalR hub

SignalR can be used with [ASP.NET Core Authentication](#) to associate a user with each connection. In a hub, authentication data can be accessed from the `HubConnectionContext.User` property. Authentication allows the hub to call methods on all connections associated with a user (See [Manage users and groups in SignalR](#) for more information). Multiple connections may be associated with a single user.

### Cookie authentication

In a browser-based app, cookie authentication allows your existing user credentials to automatically flow to SignalR connections. When using the browser client, no additional configuration is needed. If the user is logged in to your app, the SignalR connection automatically inherits this authentication.

Cookie authentication isn't recommended unless the app only needs to authenticate users from the browser client. When using the [.NET Client](#), the `Cookies` property can be configured in the `.WithUrl` call in order to provide a cookie. However, using cookie authentication from the .NET Client requires the app to provide an API to exchange authentication data for a cookie.

### Bearer token authentication

Bearer token authentication is the recommended approach when using clients other than the browser client. In this approach, the client provides an access token that the server validates and uses to identify the user. The details of bearer token authentication are beyond the scope of this document. On the server, bearer token authentication is configured using the [JWT Bearer middleware](#).

In the JavaScript client, the token can be provided using the `accessTokenFactory` option.

```
this.connection = new signalR.HubConnectionBuilder()
    .withUrl("/hubs/chat", { accessTokenFactory: () => this.loginToken })
    .build();
```

In the .NET client, there is a similar `AccessTokenProvider` property that can be used to configure the token:

```
var connection = new HubConnectionBuilder()
    .WithUrl("https://example.com/myhub", options =>
{
    options.AccessTokenProvider = () => _myAccessToken;
})
.Build();
```

## NOTE

The access token function you provide is called before **every** HTTP request made by SignalR. If you need to renew the token in order to keep the connection active (because it may expire during the connection), do so from within this function and return the updated token.

In standard web APIs, bearer tokens are sent in an HTTP header. However, SignalR is unable to set these headers in browsers when using some transports. When using WebSockets and Server-Sent Events, the token is transmitted as a query string parameter. In order to support this on the server, additional configuration is required:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddAuthentication(options =>
    {
        // Identity made Cookie authentication the default.
        // However, we want JWT Bearer Auth to be the default.
        options.DefaultAuthenticateScheme = JwtBearerDefaults.AuthenticationScheme;
        options.DefaultChallengeScheme = JwtBearerDefaults.AuthenticationScheme;
    })
    .AddJwtBearer(options =>
    {
        // Configure JWT Bearer Auth to expect our security key
        options.TokenValidationParameters =
            new TokenValidationParameters
            {
                LifetimeValidator = (before, expires, token, param) =>
                {
                    return expires > DateTime.UtcNow
                },
                ValidateAudience = false,
                ValidateIssuer = false,
                ValidateActor = false,
                ValidateLifetime = true,
                IssuerSigningKey = SecurityKey
            };

        // We have to hook the OnMessageReceived event in order to
        // allow the JWT authentication handler to read the access
        // token from the query string when a WebSocket or
        // Server-Sent Events request comes in.
        options.Events = new JwtBearerEvents
        {
            OnMessageReceived = context =>
            {
                var accessToken = context.Request.Query["access_token"];

                // If the request is for our hub...
                var path = context.HttpContext.Request.Path;
                if (!string.IsNullOrEmpty(accessToken) &&
                    (path.StartsWithSegments("/hubs/chat")))
                {

```

## Windows authentication

If [Windows authentication](#) is configured in your app, SignalR can use that identity to secure hubs. However, in order to send messages to individual users, you need to add a custom User ID provider. This is because the Windows authentication system doesn't provide the "Name Identifier" claim that SignalR uses to determine the user name.

Add a new class that implements `IUserIdProvider` and retrieve one of the claims from the user to use as the identifier. For example, to use the "Name" claim (which is the Windows username in the form `[Domain]\[Username]`

), create the following class:

```
public class NameUserIdProvider : IUserIdProvider
{
    public string GetUserId(HubConnectionContext connection)
    {
        return connection.User?.FindFirst(ClaimTypes.Name)?.Value;
    }
}
```

Rather than `ClaimTypes.Name`, you can use any value from the `User` (such as the Windows SID identifier, etc.).

#### NOTE

The value you choose must be unique among all the users in your system. Otherwise, a message intended for one user could end up going to a different user.

Register this component in your `Startup.ConfigureServices` method **after** the call to `.AddSignalR`

```
public void ConfigureServices(IServiceCollection services)
{
    // ... other services ...

    services.AddSignalR();
    services.AddSingleton<IUserIdProvider, NameUserIdProvider>();
}
```

## Authorize users to access hubs and hub methods

By default, all methods in a hub can be called by an unauthenticated user. In order to require authentication, apply the [Authorize](#) attribute to the hub:

```
[Authorize]
public class ChatHub: Hub
{}
```

You can use the constructor arguments and properties of the `[Authorize]` attribute to restrict access to only users matching specific [authorization policies](#). For example, if you have a custom authorization policy called `MyAuthorizationPolicy` you can ensure that only users matching that policy can access the hub using the following code:

```
[Authorize("MyAuthorizationPolicy")]
public class ChatHub: Hub
{}
```

Individual hub methods can have the `[Authorize]` attribute applied as well. If the current user doesn't match the policy applied to the method, an error is returned to the caller:

```
[Authorize]
public class ChatHub: Hub
{
    public async Task Send(string message)
    {
        // ... send a message to all users ...
    }

    [Authorize("Administrators")]
    public void BanUser(string userName)
    {
        // ... ban a user from the chat room (something only Administrators can do) ...
    }
}
```

# Security considerations in ASP.NET Core SignalR

7/12/2018 • 3 minutes to read • [Edit Online](#)

By [Andrew Stanton-Nurse](#)

## Overview

SignalR provides a number of security protections by default. It's important to understand how to configure these protections.

### Cross-origin resource sharing

[Cross-origin resource sharing \(CORS\)](#) can be used to allow cross-origin SignalR connections in the browser. If your JavaScript code is hosted on a different domain name from your SignalR app, you have to enable the [ASP.NET Core CORS middleware](#) in order to allow the connection. In general, allow cross-origin requests only from domains you control. For example, if your site is hosted on `http://www.example.com` and your SignalR app is hosted on `http://signalr.example.com`, you should configure CORS in your SignalR app to only allow the origin `www.example.com`.

For more information on configuring CORS, see [the documentation on ASP.NET Core CORS](#). SignalR requires the following CORS policies in order to operate correctly:

- The policy must allow the specific origins you expect, or allow any origin (not recommended).
- HTTP methods `GET` and `POST` must be allowed.
- Credentials must be enabled, even when you aren't using authentication.

For example, the following CORS policy allows a SignalR browser client hosted on `http://example.com` to access your SignalR app:

```
public void Configure(IApplicationBuilder app)
{
    // ... other middleware ...

    // Make sure the CORS middleware is ahead of SignalR.
    app.UseCors(builder => {
        builder.WithOrigins("http://example.com")
            .AllowAnyHeader()
            .WithMethods("GET", "POST")
            .AllowCredentials();
    });

    // ... other middleware ...

    app.UseSignalR();

    // ... other middleware ...
}
```

#### NOTE

SignalR is not compatible with the built-in CORS feature in Azure App Service.

### Access token logging

When using WebSockets or Server-Sent Events, the browser client sends the access token in the query string. This

is generally as secure as using the standard `Authorization` header, however many web servers log the URL for each request, including the query string. This means the access token may be included in logs. Consider reviewing the web server's logging settings to avoid logging this information.

## Exceptions

Exception messages are generally considered sensitive data that shouldn't be revealed to a client. By default, SignalR doesn't send the details of an exception thrown by a hub method to the client. Instead, the client receives a generic message indicating an error occurred. You can override this behavior by setting the `EnableDetailedErrors` setting.

## Buffer management

SignalR uses per-connection buffers in order to manage incoming and outgoing messages. By default, SignalR limits these buffers to 32KB. This means the largest possible message a client or server can send is 32KB. This also means the maximum amount of memory consumed by a connection for messages is 32KB. If you know your messages are always smaller than this limit, you can reduce this size to prevent a client from being able to send a larger message and force the server to allocate memory to accept it. Similarly, if you know your messages are larger than this limit, you can increase it. However, be aware that increasing this limit means that the client is able to cause the server to allocate additional memory and may reduce the number of concurrent connections your app can handle.

There are separate limits for incoming and outgoing messages, both can be configured on the

`HttpConnectionDispatcherOptions` object configured in `MapHub`:

- `ApplicationMaxBufferSize` represents the maximum number of bytes from the client that the server buffers. If the client attempts to send a message larger than this limit, the connection may be closed.
- `TransportMaxBufferSize` represents the maximum number of bytes the server can send. If the server attempts to send a message (includes return values from hub methods) larger than this limit, an exception will be thrown.

Setting the limit to `0` disables the limit entirely. However, this should be done with extreme caution. Removing the limit allows a client to send a message of any size. This could be used by a malicious client to cause excess memory to be allocated, which could dramatically reduce the number of concurrent connections your app can support.

# Use MessagePack Hub Protocol in SignalR for ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Brennan Conroy](#)

This article assumes the reader is familiar with the topics covered in [Get Started](#).

## What is MessagePack?

[MessagePack](#) is a binary serialization format that is fast and compact. It's useful when performance and bandwidth are a concern because it creates smaller messages compared to [JSON](#). Because it's a binary format, messages are unreadable when looking at network traces and logs unless the bytes are passed through a MessagePack parser. SignalR has built-in support for the MessagePack format, and provides APIs for the client and server to use.

## Configure MessagePack on the server

To enable the MessagePack Hub Protocol on the server, install the

`Microsoft.AspNetCore.SignalR.Protocols.MessagePack` package in your app. In the `Startup.cs` file add `AddMessagePackProtocol` to the `AddSignalR` call to enable MessagePack support on the server.

### NOTE

JSON is enabled by default. Adding MessagePack enables support for both JSON and MessagePack clients.

```
services.AddSignalR()
    .AddMessagePackProtocol();
```

To customize how MessagePack will format your data, `AddMessagePackProtocol` takes a delegate for configuring options. In that delegate, the `FormatterResolvers` property can be used to configure MessagePack serialization options. For more information on how the resolvers work, visit the MessagePack library at [MessagePack-CSharp](#). Attributes can be used on the objects you want to serialize to define how they should be handled.

```
services.AddSignalR()
    .AddMessagePackProtocol(options =>
{
    options.FormatterResolvers = new List<MessagePack.IFormatterResolver>()
    {
        MessagePack.Resolvers.StandardResolver.Instance
    };
});
```

## Configure MessagePack on the client

### .NET client

To enable MessagePack in the .NET Client, install the `Microsoft.AspNetCore.SignalR.Protocols.MessagePack` package and call `AddMessagePackProtocol` on `HubConnectionBuilder`.

```
var hubConnection = new HubConnectionBuilder()
    .WithUrl("/chatHub")
    .AddMessagePackProtocol()
    .Build();
```

#### NOTE

This `AddMessagePackProtocol` call takes a delegate for configuring options just like the server.

### JavaScript client

MessagePack support for the Javascript client is provided by the `@aspnet/signalr-protocol-msgpack` NPM package.

```
npm install @aspnet/signalr-protocol-msgpack
```

After installing the npm package, the module can be used directly via a JavaScript module loader or imported into the browser by referencing the `node_modules\@aspnet\signalr-protocol-msgpack\dist\browser\signalr-protocol-msgpack.js` file. In a browser the `msgpack5` library must also be referenced. Use a `<script>` tag to create a reference. The library can be found at `node_modules\msgpack5\dist\msgpack5.js`.

#### NOTE

When using the `<script>` element, the order is important. If `signalr-protocol-msgpack.js` is referenced before `msgpack5.js`, an error occurs when trying to connect with MessagePack. `signalr.js` is also required before `signalr-protocol-msgpack.js`.

```
<script src="~/lib/signalr/signalr.js"></script>
<script src="~/lib/msgpack5/msgpack5.js"></script>
<script src="~/lib/signalr/signalr-protocol-msgpack.js"></script>
```

Adding `.withHubProtocol(new signalR.protocols.msgpack.MessagePackHubProtocol())` to the `HubConnectionBuilder` will configure the client to use the MessagePack protocol when connecting to a server.

```
const connection = new signalR.HubConnectionBuilder()
    .withUrl("/chatHub")
    .withHubProtocol(new signalR.protocols.msgpack.MessagePackHubProtocol())
    .build();
```

#### NOTE

At this time, there are no configuration options for the MessagePack protocol on the JavaScript client.

## Related resources

- [Get Started](#)
- [.NET client](#)
- [JavaScript client](#)

# Use streaming in ASP.NET Core SignalR

6/22/2018 • 2 minutes to read • [Edit Online](#)

By [Brennan Conroy](#)

ASP.NET Core SignalR supports streaming return values of server methods. This is useful for scenarios where fragments of data will come in over time. When a return value is streamed to the client, each fragment is sent to the client as soon as it becomes available, rather than waiting for all the data to become available.

[View or download sample code \(how to download\)](#)

## Set up the hub

A hub method automatically becomes a streaming hub method when it returns a `ChannelReader<T>` or a `Task<ChannelReader<T>>`. Below is a sample that shows the basics of streaming data to the client. Whenever an object is written to the `ChannelReader` that object is immediately sent to the client. At the end, the `ChannelReader` is completed to tell the client the stream is closed.

### NOTE

Write to the `ChannelReader` on a background thread and return the `ChannelReader` as soon as possible. Other hub invocations will be blocked until a `ChannelReader` is returned.

```
public class StreamHub : Hub
{
    public ChannelReader<int> Counter(int count, int delay)
    {
        var channel = Channel.CreateUnbounded<int>();

        // We don't want to await WriteItems, otherwise we'd end up waiting
        // for all the items to be written before returning the channel back to
        // the client.
        _ = WriteItems(channel.Writer, count, delay);

        return channel.Reader;
    }

    private async Task WriteItems(ChannelWriter<int> writer, int count, int delay)
    {
        for (var i = 0; i < count; i++)
        {
            await writer.WriteAsync(i);
            await Task.Delay(delay);
        }

        writer.TryComplete();
    }
}
```

## .NET client

The `StreamAsChannelAsync` method on `HubConnection` is used to invoke a streaming method. Pass the hub method name, and arguments defined in the hub method to `StreamAsChannelAsync`. The generic parameter on `StreamAsChannelAsync<T>` specifies the type of objects returned by the streaming method. A `ChannelReader<T>` is

returned from the stream invocation, and represents the stream on the client. To read data, a common pattern is to loop over `WaitToReadAsync` and call `TryRead` when data is available. The loop will end when the stream has been closed by the server, or the cancellation token passed to `StreamAsChannelAsync` is canceled.

```
var channel = await hubConnection.StreamAsChannelAsync<int>("Counter", 10, 500, CancellationToken.None);

// Wait asynchronously for data to become available
while (await channel.WaitToReadAsync())
{
    // Read all currently available data synchronously, before waiting for more data
    while (channel.TryRead(out var count))
    {
        Console.WriteLine($"{count}");
    }
}

Console.WriteLine("Streaming completed");
```

## JavaScript client

JavaScript clients call streaming methods on hubs by using `connection.stream`. The `stream` method accepts two arguments:

- The name of the hub method. In the following example, the hub method name is `Counter`.
- Arguments defined in the hub method. In the following example, the arguments are: a count for the number of stream items to receive, and the delay between stream items.

`connection.stream` returns an `IStreamResult` which contains a `subscribe` method. Pass an `IStreamSubscriber` to `subscribe` and set the `next`, `error`, and `complete` callbacks to get notifications from the `stream` invocation.

```
connection.stream("Counter", 10, 500)
    .subscribe({
        next: (item) => {
            var li = document.createElement("li");
            li.textContent = item;
            document.getElementById("messagesList").appendChild(li);
        },
        complete: () => {
            var li = document.createElement("li");
            li.textContent = "Stream completed";
            document.getElementById("messagesList").appendChild(li);
        },
        error: (err) => {
            var li = document.createElement("li");
            li.textContent = err;
            document.getElementById("messagesList").appendChild(li);
        },
    });
});
```

To end the stream from the client call the `dispose` method on the `ISubscription` that is returned from the `subscribe` method.

## Related resources

- [Hubs](#)
- [.NET client](#)
- [JavaScript client](#)
- [Publish to Azure](#)

# Differences between SignalR and ASP.NET Core SignalR

6/28/2018 • 2 minutes to read • [Edit Online](#)

ASP.NET Core SignalR is not compatible with clients or servers for ASP.NET SignalR. This article details the features which have been removed or changed in the ASP.NET Core SignalR.

## Feature differences

### Automatic reconnects

Automatic reconnects are no longer supported. Previously, SignalR tried to reconnect to the server if the connection was dropped. Now, if the client is disconnected the user must explicitly start a new connection if they want to reconnect.

### Protocol support

ASP.NET Core SignalR supports JSON, as well as a new binary protocol based on [MessagePack](#). Additionally, custom protocols can be created.

## Differences on the server

The SignalR server-side libraries are included in the `Microsoft.AspNetCore.App` package that is part of the **ASP.NET Core Web Application** template for both Razor and MVC projects.

SignalR is an ASP.NET Core middleware, so it must be configured by calling `AddSignalR` in `Startup.ConfigureServices`.

```
services.AddSignalR();
```

To configure routing, map routes to hubs inside the `UseSignalR` method call in the `Startup.Configure` method.

```
app.UseSignalR(routes =>
{
    routes.MapHub<ChatHub>("/hub");
});
```

### Sticky sessions now required

Because of how scale-out worked in the previous versions of SignalR, clients could reconnect and send messages to any server in the farm. Due to changes to the scale-out model, as well as not supporting reconnects, this is no longer supported. Now, once the client connects to the server it needs to interact with the same server for the duration of the connection.

### Single hub per connection

In ASP.NET Core SignalR, the connection model has been simplified. Connections are made directly to a single hub, rather than a single connection being used to share access to multiple hubs.

### Streaming

SignalR now supports [streaming data](#) from the hub to the client.

### State

The ability to pass arbitrary state between clients and the hub (often called HubState) has been removed, as well as support for progress messages. There is no counterpart of hub proxies at the moment.

## Differences on the client

### TypeScript

The ASP.NET Core version of SignalR is written in [TypeScript](#). You can write in JavaScript or TypeScript when using the [JavaScript client](#).

### The JavaScript client is hosted at [npm](#)

In previous versions, the JavaScript client was obtained through a NuGet package in Visual Studio. For the Core versions, the [@aspnet/signalr npm package](#) contains the JavaScript libraries. This package isn't included in the **ASP.NET Core Web Application** template. Use npm to obtain and install the [@aspnet/signalr](#) npm package.

```
npm init -y
npm install @aspnet/signalr
```

### jQuery

The dependency on jQuery has been removed, however projects can still use jQuery.

### JavaScript client method syntax

The JavaScript syntax has changed from the previous version of SignalR. Rather than using the [\\$connection](#) object, create a connection using the [HubConnectionBuilder](#) API.

```
const connection = new signalR.HubConnectionBuilder()
    .withUrl("/hub")
    .build();
```

Use [connection.on](#) to specify client methods that the hub can call.

```
connection.on("ReceiveMessage", (user, message) => {
    const msg = message.replace(/&/g, "&").replace(/</g, "<").replace(/>/g, ">");
    const encodedMsg = user + " says " + msg;
    log(encodedMsg);
});
```

After creating the client method, start the hub connection. Chain a [catch](#) method to log or handle errors.

```
connection.start().catch(err => console.error(err.toString()));
```

### Hub proxies

Hub proxies are no longer automatically generated. Instead, the method name is passed into the [invoke](#) API as a string.

### .NET and other clients

The [Microsoft.AspNetCore.SignalR.Client](#) NuGet package contains the .NET client libraries for ASP.NET Core SignalR.

Use the [HubConnectionBuilder](#) to create and build an instance of a connection to a hub.

```
connection = new HubConnectionBuilder()
    .WithUrl("url")
    .Build();
```

## Additional resources

- [Hubs](#)
- [JavaScript client](#)
- [.NET client](#)
- [Supported platforms](#)

# Mobile development with ASP.NET Core

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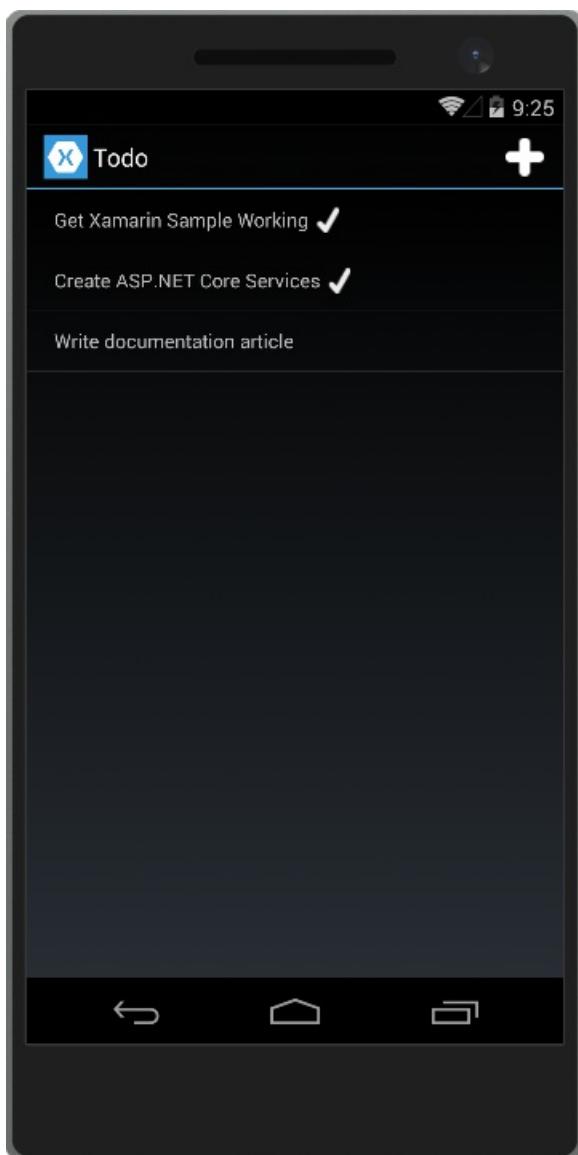
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[View or download sample backend services code](#)

## The Sample Native Mobile App

This tutorial demonstrates how to create backend services using ASP.NET Core MVC to support native mobile apps. It uses the [Xamarin Forms ToDoRest app](#) as its native client, which includes separate native clients for Android, iOS, Windows Universal, and Window Phone devices. You can follow the linked tutorial to create the native app (and install the necessary free Xamarin tools), as well as download the Xamarin sample solution. The Xamarin sample includes an ASP.NET Web API 2 services project, which this article's ASP.NET Core app replaces (with no changes required by the client).

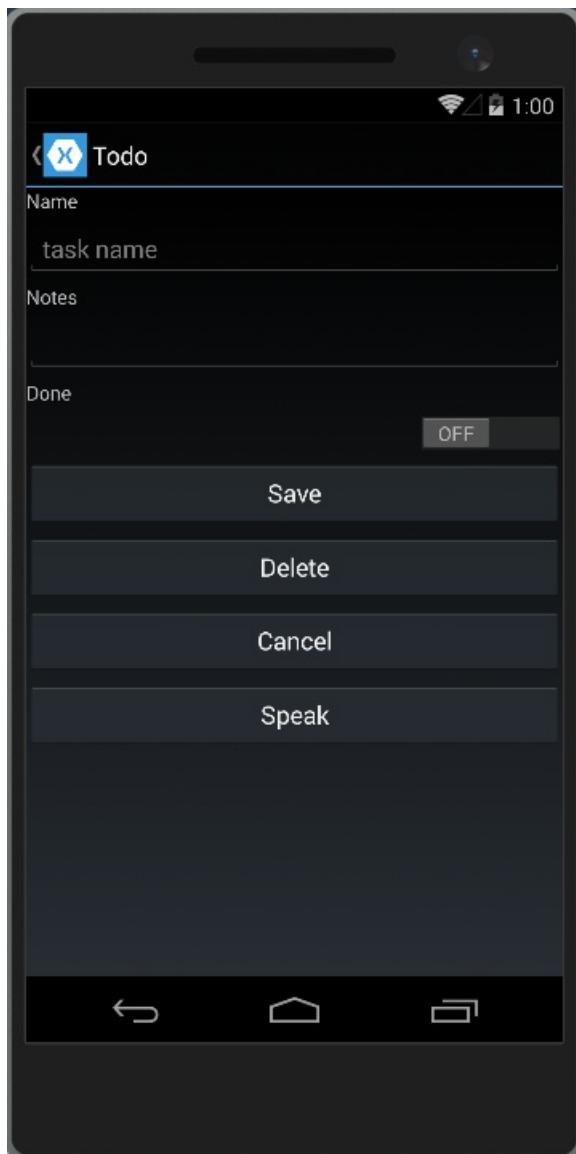


### Features

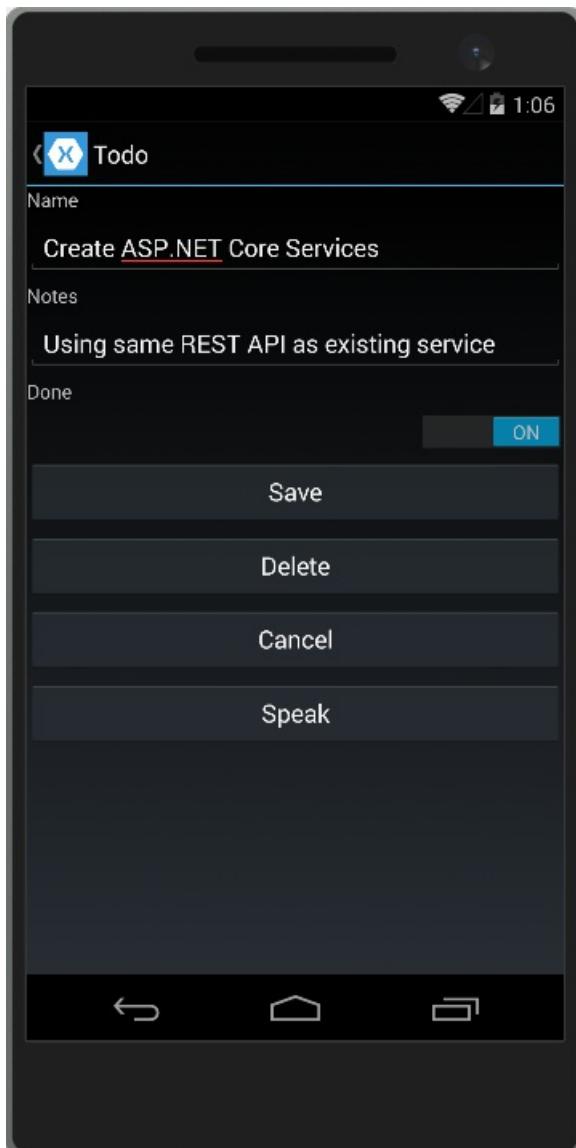
The ToDoRest app supports listing, adding, deleting, and updating To-Do items. Each item has an ID, a Name, Notes, and a property indicating whether it's been Done yet.

The main view of the items, as shown above, lists each item's name and indicates if it's done with a checkmark.

Tapping the  icon opens an add item dialog:



Tapping an item on the main list screen opens up an edit dialog where the item's Name, Notes, and Done settings can be modified, or the item can be deleted:



This sample is configured by default to use backend services hosted at developer.xamarin.com, which allow read-only operations. To test it out yourself against the ASP.NET Core app created in the next section running on your computer, you'll need to update the app's `RestUrl` constant. Navigate to the `ToDoREST` project and open the `Constants.cs` file. Replace the `RestUrl` with a URL that includes your machine's IP address (not localhost or 127.0.0.1, since this address is used from the device emulator, not from your machine). Include the port number as well (5000). In order to test that your services work with a device, ensure you don't have an active firewall blocking access to this port.

```
// URL of REST service (Xamarin ReadOnly Service)
//public static string RestUrl = "http://developer.xamarin.com:8081/api/todoitems{0}";

// use your machine's IP address
public static string RestUrl = "http://192.168.1.207:5000/api/todoitems{0}";
```

## Creating the ASP.NET Core Project

Create a new ASP.NET Core Web Application in Visual Studio. Choose the Web API template and No Authentication. Name the project `ToDoApi`.

Select a template:

**ASP.NET Core Templates**

Empty



Web API



Web Application

A project template for creating an ASP.NET Core application with an example Controller for a RESTful HTTP service. This template can also be used for ASP.NET MVC Views and Controllers.

[Learn more](#)[Change Authentication](#)Authentication: **No Authentication**

Microsoft Azure

 Host in the cloud

App Service ▾

[OK](#)[Cancel](#)

The application should respond to all requests made to port 5000. Update *Program.cs* to include

```
.UseUrls("http://*:5000")
```

 to achieve this:

```
var host = new WebHostBuilder()
    .UseKestrel()
    .UseUrls("http://*:5000")
    .UseContentRoot(Directory.GetCurrentDirectory())
    .UseIISIntegration()
    .UseStartup<Startup>()
    .Build();
```

**NOTE**

Make sure you run the application directly, rather than behind IIS Express, which ignores non-local requests by default. Run `dotnet run` from a command prompt, or choose the application name profile from the Debug Target dropdown in the Visual Studio toolbar.

Add a model class to represent To-Do items. Mark required fields using the `[Required]` attribute:

```

using System.ComponentModel.DataAnnotations;

namespace ToDoApi.Models
{
    public class ToDoItem
    {
        [Required]
        public string ID { get; set; }

        [Required]
        public string Name { get; set; }

        [Required]
        public string Notes { get; set; }

        public bool Done { get; set; }
    }
}

```

The API methods require some way to work with data. Use the same `IRepository` interface the original Xamarin sample uses:

```

using System.Collections.Generic;
using ToDoApi.Models;

namespace ToDoApi.Interfaces
{
    public interface IToDoRepository
    {
        bool DoesItemExist(string id);
        IEnumerable<ToDoItem> All { get; }
        ToDoItem Find(string id);
        void Insert(ToDoItem item);
        void Update(ToDoItem item);
        void Delete(string id);
    }
}

```

For this sample, the implementation just uses a private collection of items:

```

using System.Collections.Generic;
using System.Linq;
using ToDoApi.Interfaces;
using ToDoApi.Models;

namespace ToDoApi.Services
{
    public class ToDoRepository : IToDoRepository
    {
        private List<ToDoItem> _ToDoList;

        public ToDoRepository()
        {
            InitializeData();
        }

        public IEnumerable<ToDoItem> All
        {
            get { return _ToDoList; }
        }

        public bool DoesItemExist(string id)
        {
            return _ToDoList.Any(item => item.ID == id);
        }
    }
}

```

```

    }

    public ToDoItem Find(string id)
    {
        return _ToDoList.FirstOrDefault(item => item.ID == id);
    }

    public void Insert(ToDoItem item)
    {
        _ToDoList.Add(item);
    }

    public void Update(ToDoItem item)
    {
        var todoItem = this.Find(item.ID);
        var index = _ToDoList.IndexOf(todoItem);
        _ToDoList.RemoveAt(index);
        _ToDoList.Insert(index, item);
    }

    public void Delete(string id)
    {
        _ToDoList.Remove(this.Find(id));
    }

    private void InitializeData()
    {
        _ToDoList = new List<ToDoItem>();

        var todoItem1 = new ToDoItem
        {
            ID = "6bb8a868-dba1-4f1a-93b7-24ebce87e243",
            Name = "Learn app development",
            Notes = "Attend Xamarin University",
            Done = true
        };

        var todoItem2 = new ToDoItem
        {
            ID = "b94afb54-a1cb-4313-8af3-b7511551b33b",
            Name = "Develop apps",
            Notes = "Use Xamarin Studio/Visual Studio",
            Done = false
        };

        var todoItem3 = new ToDoItem
        {
            ID = "ecfa6f80-3671-4911-aabe-63cc442c1ecf",
            Name = "Publish apps",
            Notes = "All app stores",
            Done = false,
        };

        _ToDoList.Add(todoItem1);
        _ToDoList.Add(todoItem2);
        _ToDoList.Add(todoItem3);
    }
}

```

Configure the implementation in *Startup.cs*:

```
public void ConfigureServices(IServiceCollection services)
{
    // Add framework services.
    services.AddMvc();

    services.AddSingleton<IToDoRepository, ToDoRepository>();
}
```

At this point, you're ready to create the *ToDoItemsController*.

**TIP**

Learn more about creating web APIs in [Build your first Web API with ASP.NET Core MVC and Visual Studio](#).

## Creating the Controller

Add a new controller to the project, *ToDoItemsController*. It should inherit from `Microsoft.AspNetCore.Mvc.Controller`. Add a `[Route]` attribute to indicate that the controller will handle requests made to paths starting with `api/todoitems`. The `[controller]` token in the route is replaced by the name of the controller (omitting the `Controller` suffix), and is especially helpful for global routes. Learn more about [routing](#).

The controller requires an `IRepository` to function; request an instance of this type through the controller's constructor. At runtime, this instance will be provided using the framework's support for [dependency injection](#).

```
using System;
using Microsoft.AspNetCore.Http;
using Microsoft.AspNetCore.Mvc;
using ToDoApi.Interfaces;
using ToDoApi.Models;

namespace ToDoApi.Controllers
{
    [Route("api/[controller]")]
    public class ToDoItemsController : Controller
    {
        private readonly IToDoRepository _ToDoRepository;

        public ToDoItemsController(IToDoRepository ToDoRepository)
        {
            _ToDoRepository = ToDoRepository;
        }
    }
}
```

This API supports four different HTTP verbs to perform CRUD (Create, Read, Update, Delete) operations on the data source. The simplest of these is the Read operation, which corresponds to an HTTP GET request.

### Reading Items

Requesting a list of items is done with a GET request to the `List` method. The `[HttpGet]` attribute on the `List` method indicates that this action should only handle GET requests. The route for this action is the route specified on the controller. You don't necessarily need to use the action name as part of the route. You just need to ensure each action has a unique and unambiguous route. Routing attributes can be applied at both the controller and method levels to build up specific routes.

```
[HttpGet]
public IActionResult List()
{
    return Ok(_todoRepository.All);
}
```

The `List` method returns a 200 OK response code and all of the ToDo items, serialized as JSON.

You can test your new API method using a variety of tools, such as [Postman](#), shown here:

The screenshot shows the Postman application interface. At the top, there are tabs for 'Runner', 'Import', 'Builder' (which is selected), 'Team Library', and various status indicators. Below the tabs, the URL is set to `http://192.168.1.207:5000/a`. The main area shows a 'GET' request to `http://192.168.1.207:5000/api/todoitems`. The 'Headers' tab is selected, showing a key-value pair: 'key' and 'value'. Below the request details, the 'Body' tab is selected, showing the returned JSON data. The JSON response is:

```
1 [ ]
2 {
3     "id": "6bb8a868-dba1-4f1a-93b7-24ebce87e243",
4     "name": "Learn app development",
5     "notes": "Attend Xamarin University",
6     "done": true
7 },
8 [
9     {
10        "id": "b94afb54-a1cb-4313-8af3-b7511551b33b",
11        "name": "Develop apps",
12        "notes": "Use Xamarin Studio/Visual Studio",
13        "done": false
14 },
15     {
16        "id": "ecfa6f80-3671-4911-aabe-63cc442c1ecf",
17        "name": "Publish apps",
18        "notes": "All app stores",
19        "done": false
20 ]
```

## Creating Items

By convention, creating new data items is mapped to the HTTP POST verb. The `Create` method has an `[HttpPost]` attribute applied to it, and accepts a `ToDoItem` instance. Since the `item` argument will be passed in the body of the POST, this parameter is decorated with the `[FromBody]` attribute.

Inside the method, the item is checked for validity and prior existence in the data store, and if no issues occur, it's added using the repository. Checking `ModelState.IsValid` performs [model validation](#), and should be done in every API method that accepts user input.

```
[HttpPost]
public IActionResult Create([FromBody] ToDoItem item)
{
    try
    {
        if (item == null || !ModelState.IsValid)
        {
            return BadRequest(ErrorCode.TodoItemNameAndNotesRequired.ToString());
        }
        bool itemExists = _ToDoRepository.DoesItemExist(item.ID);
        if (itemExists)
        {
            return StatusCode(StatusCodes.Status409Conflict, ErrorCode.TodoItemIDInUse.ToString());
        }
        _ToDoRepository.Insert(item);
    }
    catch (Exception)
    {
        return BadRequest(ErrorCode.CouldNotCreateItem.ToString());
    }
    return Ok(item);
}
```

The sample uses an enum containing error codes that are passed to the mobile client:

```
public enum ErrorCode
{
    TodoItemNameAndNotesRequired,
    TodoItemIDInUse,
    RecordNotFound,
    CouldNotCreateItem,
    CouldNotUpdateItem,
    CouldNotDeleteItem
}
```

Test adding new items using Postman by choosing the POST verb providing the new object in JSON format in the Body of the request. You should also add a request header specifying a Content-Type of application/json .

The screenshot shows the Postman application interface. At the top, there's a toolbar with icons for Runner, Import, Builder (which is selected), Team Library, and various status indicators like SYNC OFF and a bell icon.

The main area has a URL input field showing "http://192.168.1.207:5000/a" and a "No environment" dropdown. Below the URL is a request configuration panel:

- Method:** POST
- URL:** http://192.168.1.207:5000/api/todoitems
- Params:** None
- Send:** (blue button)
- Save:** (grey button)

The "Body" tab is active, showing a JSON payload:

```

1 {
2   "ID": "6bb8b868-dba1-4f1a-93b7-24ebce87243",
3   "Name": "A Test Item",
4   "Notes": "asdf",
5   "Done": false
6 }

```

Below the request panel is a response panel:

- Body:** (selected)
- Cookies:**
- Headers:** (4)
- Tests:**
- Status:** 200 OK
- Time:** 227 ms

The "Body" tab shows the response JSON:

```

1 {
2   "id": "6bb8b868-dba1-4f1a-93b7-24ebce87243",
3   "name": "A Test Item",
4   "notes": "asdf",
5   "done": false
6 }

```

The text "The method returns the newly created item in the response." is displayed below the response panel.

## Updating Items

Modifying records is done using HTTP PUT requests. Other than this change, the `Edit` method is almost identical to `Create`. Note that if the record isn't found, the `Edit` action will return a `NotFound` (404) response.

```

[HttpPut]
public IActionResult Edit([FromBody] ToDoItem item)
{
    try
    {
        if (item == null || !ModelState.IsValid)
        {
            return BadRequest(ErrorCode.TodoItemNameAndNotesRequired.ToString());
        }
        var existingItem = _ToDoRepository.Find(item.ID);
        if (existingItem == null)
        {
            return NotFound(ErrorCode.RecordNotFound.ToString());
        }
        _ToDoRepository.Update(item);
    }
    catch (Exception)
    {
        return BadRequest(ErrorCode.CouldNotUpdateItem.ToString());
    }
    return NoContent();
}

```

To test with Postman, change the verb to PUT. Specify the updated object data in the Body of the request.

The screenshot shows the Postman application interface. The top navigation bar includes 'Runner', 'Import', 'Builder' (which is highlighted), 'Team Library', and various status indicators. The main workspace shows a 'PUT' request to 'http://192.168.1.207:5000/api/todoitems'. The 'Body' tab is selected, showing a raw JSON payload:

```
1 {  
2     "ID": "6bb8b868-dba1-4f1a-93b7-24ebce87243",  
3     "Name": "An UPDATED Test Item",  
4     "Notes": "Some updated notes",  
5     "Done": true  
6 }
```

Below the request details, the 'Body' tab is active, showing the response status as '204 No Content' and time as '91 ms'. The response body is empty, indicated by a single digit '1'.

This method returns a `NoContent` (204) response when successful, for consistency with the pre-existing API.

## Deleting Items

Deleting records is accomplished by making DELETE requests to the service, and passing the ID of the item to be deleted. As with updates, requests for items that don't exist will receive `NotFound` responses. Otherwise, a successful request will get a `NoContent` (204) response.

```
[HttpDelete("{id}")]  
public IActionResult Delete(string id)  
{  
    try  
    {  
        var item = _todoRepository.Find(id);  
        if (item == null)  
        {  
            return NotFound(ErrorCode.RecordNotFound.ToString());  
        }  
        _todoRepository.Delete(id);  
    }  
    catch (Exception)  
    {  
        return BadRequest(ErrorCode.CouldNotDeleteItem.ToString());  
    }  
    return NoContent();  
}
```

Note that when testing the delete functionality, nothing is required in the Body of the request.

The screenshot shows the Postman application interface. At the top, there are tabs for Runner, Import, Builder (which is selected), Team Library, and various status indicators like SYNC OFF and a bell icon. Below the header, the URL `http://192.168.1.207:5000/a` is entered. The main area shows a **DELETE** request to `http://192.168.1.207:5000/api/todoitems/6bb8b8`. The **Body** tab is selected, showing options for form-data, x-www-form-urlencoded, raw, binary, and JSON (application/json). The **raw** option is selected, and the body content area contains the number `1`. Other tabs include Headers (2), Pre-request Script, Tests, and Generate Code. Below the request details, the response section shows **Body**, Cookies, and Headers (2). The Headers section lists `Content-Type: application/json`. The response status is **204 No Content** and the time taken is **91 ms**. The response body is empty, showing only the number `1`.

## Common Web API Conventions

As you develop the backend services for your app, you will want to come up with a consistent set of conventions or policies for handling cross-cutting concerns. For example, in the service shown above, requests for specific records that weren't found received a `NotFound` response, rather than a `BadRequest` response. Similarly, commands made to this service that passed in model bound types always checked `ModelState.IsValid` and returned a `BadRequest` for invalid model types.

Once you've identified a common policy for your APIs, you can usually encapsulate it in a [filter](#). Learn more about [how to encapsulate common API policies in ASP.NET Core MVC applications](#).

# Host and deploy ASP.NET Core

6/21/2018 • 3 minutes to read • [Edit Online](#)

In general, to deploy an ASP.NET Core app to a hosting environment:

- Publish the app to a folder on the hosting server.
- Set up a process manager that starts the app when requests arrive and restarts the app after it crashes or the server reboots.
- If configuration of a reverse proxy is desired, set up a reverse proxy that forwards requests to the app.

## Publish to a folder

The [dotnet publish](#) CLI command compiles app code and copies the files needed to run the app into a *publish* folder. When deploying from Visual Studio, the [dotnet publish](#) step happens automatically before the files are copied to the deployment destination.

### Folder contents

The *publish* folder contains *.exe* and *.dll* files for the app, its dependencies, and optionally the .NET runtime.

A .NET Core app can be published as *self-contained* or *framework-dependent* app. If the app is self-contained, the *.dll* files that contain the .NET runtime are included in the *publish* folder. If the app is framework-dependent, the .NET runtime files aren't included because the app has a reference to a version of .NET that's installed on the server. The default deployment model is framework-dependent. For more information, see [.NET Core application deployment](#).

In addition to *.exe* and *.dll* files, the *publish* folder for an ASP.NET Core app typically contains configuration files, static assets, and MVC views. For more information, see [Directory structure](#).

## Set up a process manager

An ASP.NET Core app is a console app that must be started when a server boots and restarted if it crashes. To automate starts and restarts, a process manager is required. The most common process managers for ASP.NET Core are:

- Linux
  - [Nginx](#)
  - [Apache](#)
- Windows
  - [IIS](#)
  - [Windows Service](#)

## Set up a reverse proxy

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

If the app uses the [Kestrel](#) web server, [Nginx](#), [Apache](#), or [IIS](#) can be used as a reverse proxy server. A reverse proxy server receives HTTP requests from the Internet and forwards them to Kestrel after some preliminary handling.

Either configuration—with or without a reverse proxy server—is a valid and supported hosting configuration for

ASP.NET Core 2.0 or later apps. For more information, see [When to use Kestrel with a reverse proxy](#).

## Proxy server and load balancer scenarios

Additional configuration might be required for apps hosted behind proxy servers and load balancers. Without additional configuration, an app might not have access to the scheme (HTTP/HTTPS) and the remote IP address where a request originated. For more information, see [Configure ASP.NET Core to work with proxy servers and load balancers](#).

## Using Visual Studio and MSBuild to automate deployment

Deployment often requires additional tasks besides copying the output from `dotnet publish` to a server. For example, extra files might be required or excluded from the *publish* folder. Visual Studio uses MSBuild for web deployment, and MSBuild can be customized to do many other tasks during deployment. For more information, see [Publish profiles in Visual Studio](#) and the [Using MSBuild and Team Foundation Build](#) book.

By using [the Publish Web feature](#) or [built-in Git support](#), apps can be deployed directly from Visual Studio to the Azure App Service. Visual Studio Team Services supports [continuous deployment to Azure App Service](#).

## Publishing to Azure

See [Publish an ASP.NET Core web app to Azure App Service using Visual Studio](#) for instructions on how to publish an app to Azure using Visual Studio. The app can also be published to Azure from the [command line](#).

## Additional resources

For information on using Docker as a hosting environment, see [Host ASP.NET Core apps in Docker](#).

# Host ASP.NET Core on Azure App Service

6/21/2018 • 5 minutes to read • [Edit Online](#)

Azure App Service is a Microsoft cloud computing platform service for hosting web apps, including ASP.NET Core.

## Useful resources

The Azure [Web Apps Documentation](#) is the home for Azure Apps documentation, tutorials, samples, how-to guides, and other resources. Two notable tutorials that pertain to hosting ASP.NET Core apps are:

### [Quickstart: Create an ASP.NET Core web app in Azure](#)

Use Visual Studio to create and deploy an ASP.NET Core web app to Azure App Service on Windows.

### [Quickstart: Create a .NET Core web app in App Service on Linux](#)

Use the command line to create and deploy an ASP.NET Core web app to Azure App Service on Linux.

The following articles are available in ASP.NET Core documentation:

#### [Publish to Azure with Visual Studio](#)

Learn how to publish an ASP.NET Core app to Azure App Service using Visual Studio.

#### [Publish to Azure with CLI tools](#)

Learn how to publish an ASP.NET Core app to Azure App Service using the Git command-line client.

#### [Continuous deployment to Azure with Visual Studio and Git](#)

Learn how to create an ASP.NET Core web app using Visual Studio and deploy it to Azure App Service using Git for continuous deployment.

#### [Continuous deployment to Azure with VSTS](#)

Set up a CI build for an ASP.NET Core app, then create a continuous deployment release to Azure App Service.

#### [Azure Web App sandbox](#)

Discover Azure App Service runtime execution limitations enforced by the Azure Apps platform.

## Application configuration

With ASP.NET Core 2.0 and later, three packages in the [Microsoft.AspNetCore.All metapackage](#) provide automatic logging features for apps deployed to Azure App Service:

- [Microsoft.AspNetCore.AzureAppServices.HostingStartup](#) uses [IHostingStartup](#) to provide ASP.NET Core lightup integration with Azure App Service. The added logging features are provided by the [Microsoft.AspNetCore.AzureAppServicesIntegration](#) package.
- [Microsoft.AspNetCore.AzureAppServicesIntegration](#) executes [AddAzureWebAppDiagnostics](#) to add Azure App Service diagnostics logging providers in the [Microsoft.Extensions.Logging.AzureAppServices](#) package.
- [Microsoft.Extensions.Logging.AzureAppServices](#) provides logger implementations to support Azure App Service diagnostics logs and log streaming features.

## Proxy server and load balancer scenarios

The IIS Integration Middleware, which configures Forwarded Headers Middleware, and the ASP.NET Core Module are configured to forward the scheme (HTTP/HTTPS) and the remote IP address where the request originated. Additional configuration might be required for apps hosted behind additional proxy servers and load balancers. For more information, see [Configure ASP.NET Core to work with proxy servers and load balancers](#).

# Monitoring and logging

For monitoring, logging, and troubleshooting information, see the following articles:

## [How to: Monitor Apps in Azure App Service](#)

Learn how to review quotas and metrics for apps and App Service plans.

## [Enable diagnostics logging for web apps in Azure App Service](#)

Discover how to enable and access diagnostic logging for HTTP status codes, failed requests, and web server activity.

## [Introduction to Error Handling in ASP.NET Core](#)

Understand common approaches to handling errors in ASP.NET Core apps.

## [Troubleshoot ASP.NET Core on Azure App Service](#)

Learn how to diagnose issues with Azure App Service deployments with ASP.NET Core apps.

## [Common errors reference for Azure App Service and IIS with ASP.NET Core](#)

See the common deployment configuration errors for apps hosted by Azure App Service/IIS with troubleshooting advice.

# Data Protection key ring and deployment slots

[Data Protection keys](#) are persisted to the `%HOME%\ASPNET\DataProtection-Keys` folder. This folder is backed by network storage and is synchronized across all machines hosting the app. Keys aren't protected at rest. This folder supplies the key ring to all instances of an app in a single deployment slot. Separate deployment slots, such as Staging and Production, don't share a key ring.

When swapping between deployment slots, any system using data protection won't be able to decrypt stored data using the key ring inside the previous slot. ASP.NET Cookie Middleware uses data protection to protect its cookies. This leads to users being signed out of an app that uses the standard ASP.NET Cookie Middleware. For a slot-independent key ring solution, use an external key ring provider, such as:

- Azure Blob Storage
- Azure Key Vault
- SQL store
- Redis cache

For more information, see [Key storage providers](#).

# Deploy ASP.NET Core preview release to Azure App Service

ASP.NET Core preview apps can be deployed to Azure App Service with the following approaches:

- [Install the preview site extension](#)
- [Deploy the app self-contained](#)
- [Use Docker with Web Apps for containers](#)

If a problem occurs using the preview site extension, open an issue on [GitHub](#).

## **Install the preview site extension**

1. From the Azure portal, navigate to the App Service blade.
2. Select the web app.
3. Enter "ex" in the search box or scroll down the list of management panes to **DEVELOPMENT TOOLS**.
4. Select **DEVELOPMENT TOOLS > Extensions**.

5. Select **Add**.

The screenshot shows the 'Extensions' blade in the Azure portal. On the left, there's a sidebar with 'DEVELOPMENT TOOLS' expanded, showing 'Resource explorer' and 'Extensions' (which is highlighted with a red box). A search bar at the top has 'ex' typed into it. In the center, there's a large 'Add' button with a plus sign, also highlighted with a red box. Below it, a message says 'Extensions add functionality to your App Service. Click add to see the list of available extensions.' A table below shows columns for NAME, VERSION, and UPDATE AVAILABLE, with a note: 'You don't have any extensions installed. Click ADD to get started.'

6. Select **ASP.NET Core Extensions**.

7. Select **OK** to accept the legal terms.

8. Select **OK** to install the extension.

When the add operations complete, the latest .NET Core preview is installed. Verify the installation by running `dotnet --info` in the console. From the **App Service** blade:

1. Enter "con" in the search box or scroll down the list of management panes to **DEVELOPMENT TOOLS**.
2. Select **DEVELOPMENT TOOLS > Console**.
3. Enter `dotnet --info` in the console.

If version `2.1.300-preview1-008174` is the latest preview release, the following output is obtained by running `dotnet --info` at the command prompt:

The screenshot shows the 'Console' blade in the Azure portal. On the left, there's a sidebar with 'DEVELOPMENT TOOLS' expanded, showing 'Console' selected (highlighted with a red box). A search bar at the top has 'con' typed into it. The right pane shows the output of the `dotnet --info` command. It includes sections for Product Information (Version: 2.1.300-preview1-008174, Commit SHA-1 hash: b8df89a54f), Runtime Environment (OS Name: Windows, OS Version: 10.0.14393, OS Platform: Windows, RID: win10-x86, Base Path: D:\home\SiteExtensions\AspNetCoreRuntime\sdk\2.1.300-preview1-008174\), and Microsoft .NET Core Shared Framework Host (Version: 2.1.0-preview1-26216-03, Build: f2c3216183d20416568a4bbf5bb7d153e826f153).

The version of ASP.NET Core shown in the preceding image, `2.1.300-preview1-008174`, is an example. The latest preview version of ASP.NET Core at the time the site extension is configured appears when you execute

```
dotnet --info.
```

The `dotnet --info` displays the path to the site extension where the Preview has been installed. It shows the app is running from the site extension instead of from the default *ProgramFiles* location. If you see *ProgramFiles*, restart the site and run `dotnet --info`.

## Use the preview site extension with an ARM template

If an ARM template is used to create and deploy apps, the `siteextensions` resource type can be used to add the site extension to a web app. For example:

```
{
  "type": "siteextensions",
  "name": "AspNetCoreRuntime",
  "apiVersion": "2015-04-01",
  "location": "[resourceGroup().location]",
  "properties": {
    "version": "[parameters('aspnetcoreVersion')]"
  },
  "dependsOn": [
    "[resourceId('Microsoft.Web/Sites', parameters('siteName'))]"
  ]
}
```

## Deploy the app self-contained

A [self-contained app](#) can be deployed that carries the preview runtime in the deployment. When deploying a self-contained app:

- The site doesn't need to be prepared.
- The app must be published differently than when publishing for a framework-dependent deployment with the shared runtime and host on the server.

Self-contained apps are an option for all ASP.NET Core apps.

## Use Docker with Web Apps for containers

The [Docker Hub](#) contains the latest preview Docker images. The images can be used as a base image. Use the image and deploy to Web Apps for Containers normally.

## Additional resources

- [Web Apps overview \(5-minute overview video\)](#)
- [Azure App Service: The Best Place to Host your .NET Apps \(55-minute overview video\)](#)
- [Azure Friday: Azure App Service Diagnostic and Troubleshooting Experience \(12-minute video\)](#)
- [Azure App Service diagnostics overview](#)

Azure App Service on Windows Server uses [Internet Information Services \(IIS\)](#). The following topics pertain to the underlying IIS technology:

- [Host ASP.NET Core on Windows with IIS](#)
- [Introduction to ASP.NET Core Module](#)
- [ASP.NET Core Module configuration reference](#)
- [IIS Modules with ASP.NET Core](#)
- [Microsoft TechNet Library: Windows Server](#)

# Publish an ASP.NET Core app to Azure with Visual Studio

6/21/2018 • 3 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [Cesar Blum Silveira](#), and [Rachel Appel](#)

## IMPORTANT

### ASP.NET Core preview releases with Azure App Service

ASP.NET Core preview releases aren't deployed to Azure App Service by default. To host an app that uses an ASP.NET Core preview release, see [Deploy ASP.NET Core preview release to Azure App Service](#).

See [Publish to Azure from Visual Studio for Mac](#) if you are working on macOS.

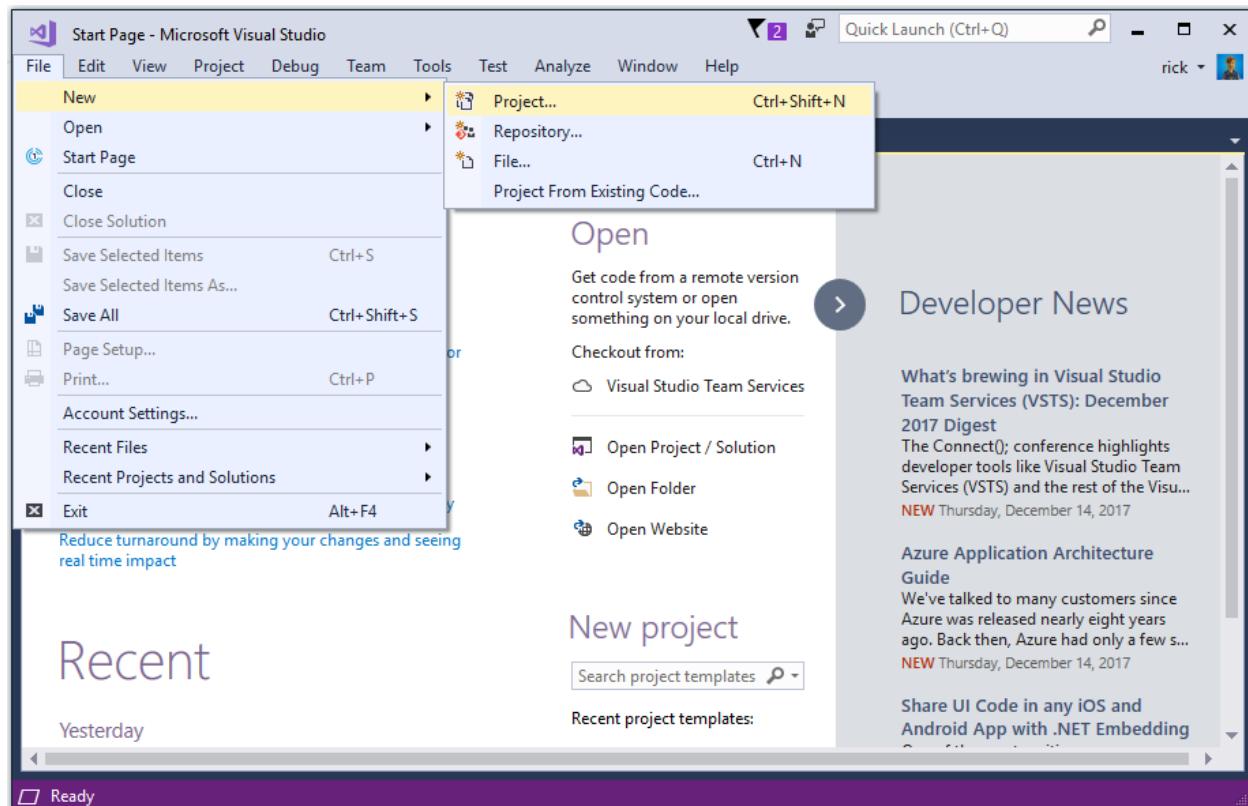
To troubleshoot an App Service deployment issue, see [Troubleshoot ASP.NET Core on Azure App Service](#).

## Set up

- Open a [free Azure account](#) if you don't have one.

## Create a web app

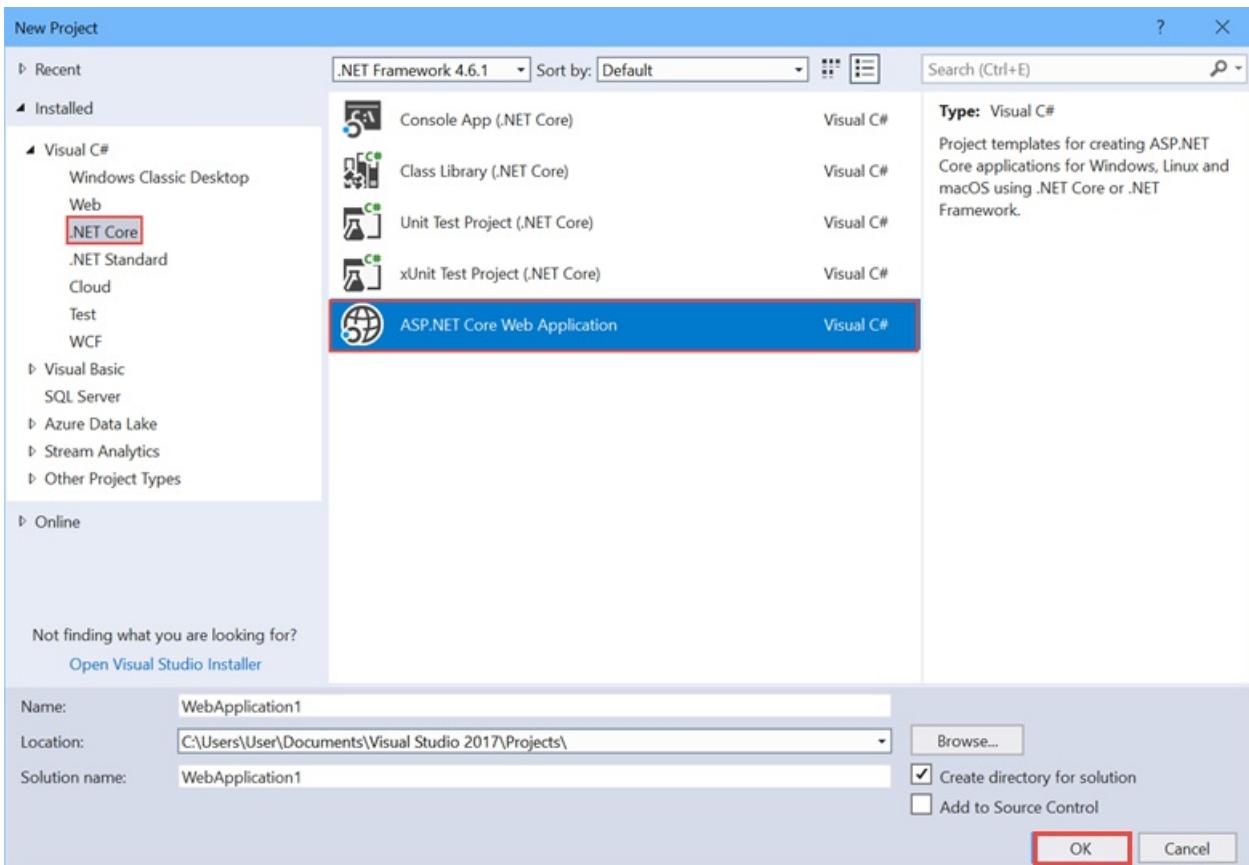
In the Visual Studio Start Page, select **File > New > Project...**



Complete the **New Project** dialog:

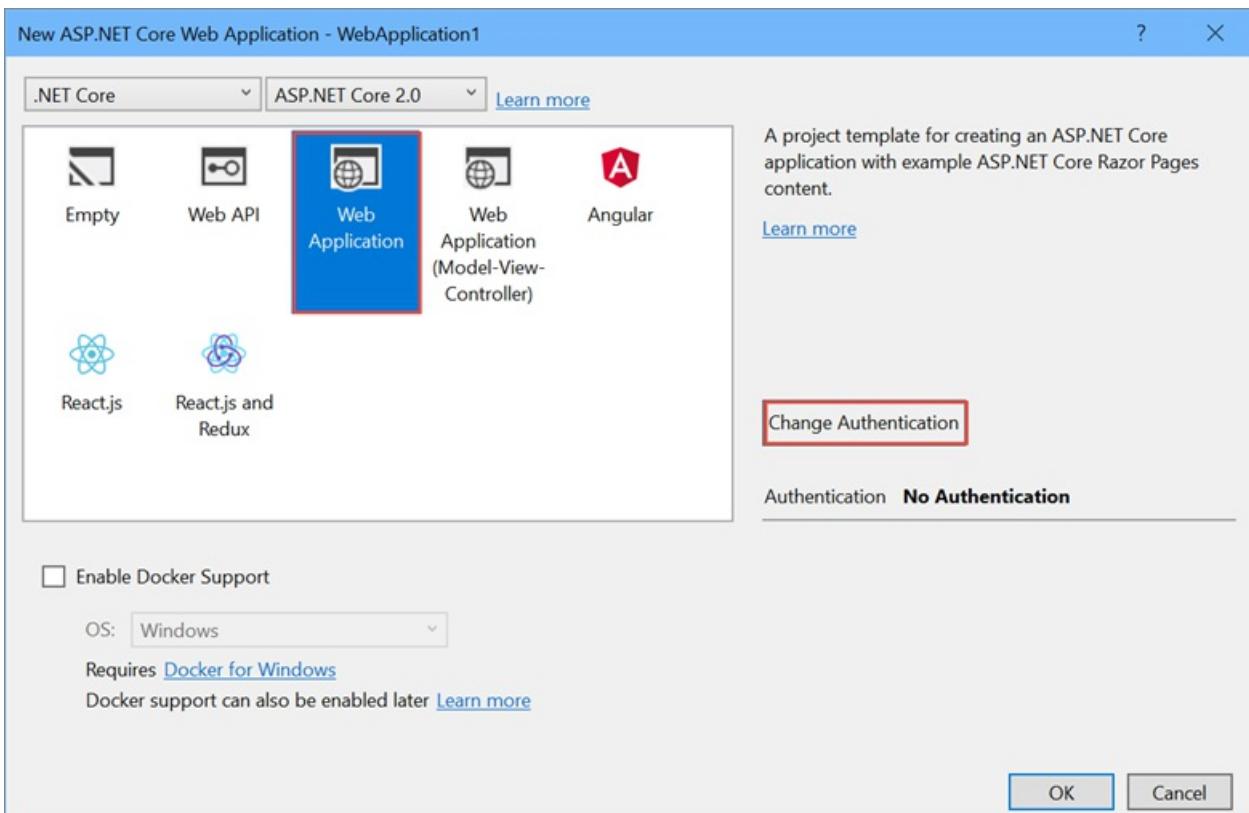
- In the left pane, select **.NET Core**.
- In the center pane, select **ASP.NET Core Web Application**.

- Select **OK**.



In the **New ASP.NET Core Web Application** dialog:

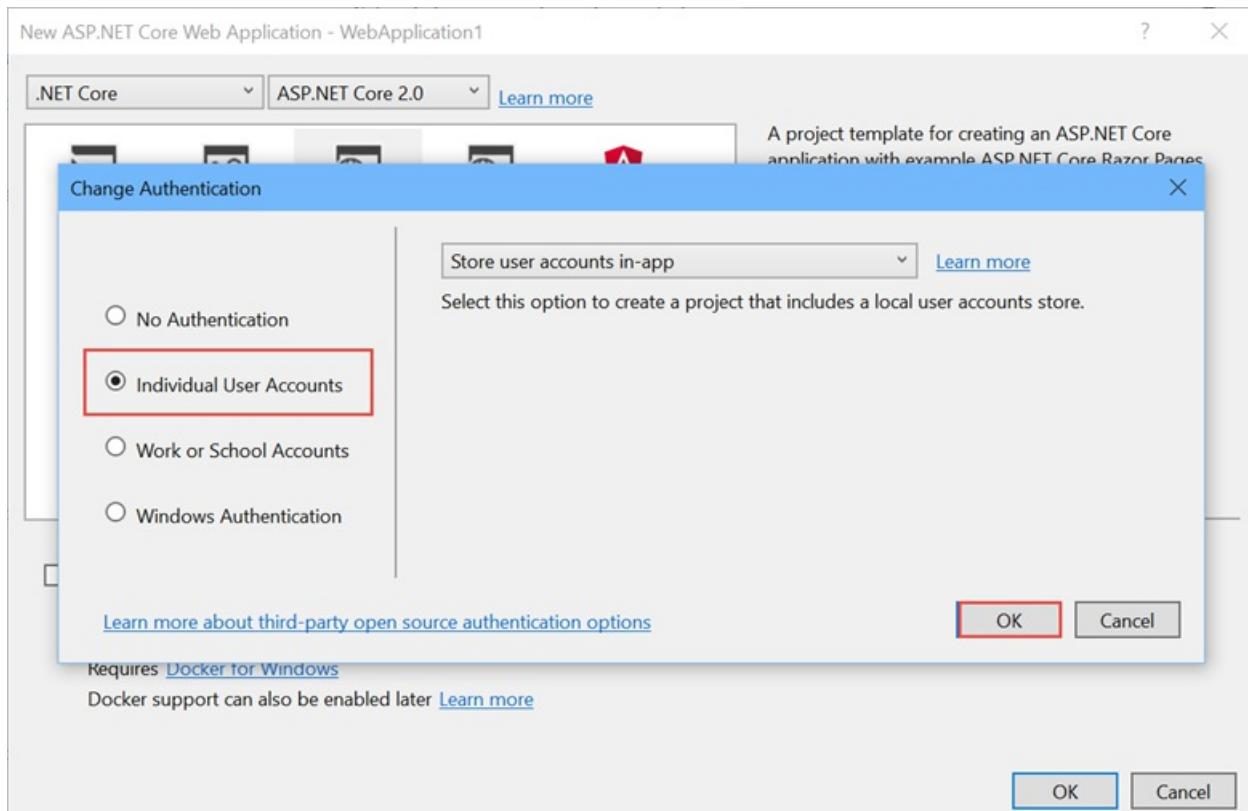
- Select **Web Application**.
- Select **Change Authentication**.



The **Change Authentication** dialog appears.

- Select **Individual User Accounts**.

- Select **OK** to return to the **New ASP.NET Core Web Application**, then select **OK** again.



Visual Studio creates the solution.

## Run the app

- Press CTRL+F5 to run the project.
- Test the **About** and **Contact** links.

The screenshot shows a web browser displaying the running ASP.NET Core application. The URL is localhost:44349. The page title is 'WebApplication1'. The navigation bar includes 'Home', 'About', 'Contact', 'Register' (which is highlighted with a yellow box), and 'Log in'. The main content area features the ASP.NET Core logo and links to Windows, Linux, and OSX. It also includes a 'Learn how to build ASP.NET apps that can run anywhere.' section with a 'Learn More' button. Below this are four circular icons. The footer is divided into four sections: 'Application uses', 'How to', 'Overview', and 'Run & Deploy', each containing a list of items.

Application uses	How to	Overview	Run & Deploy
<ul style="list-style-type: none"> <li>Sample pages using ASP.NET Core Razor Pages</li> <li>Bower for managing client-side libraries</li> <li>Theming using Bootstrap</li> </ul>	<ul style="list-style-type: none"> <li>Working with Razor Pages.</li> <li>Manage User Secrets using Secret Manager.</li> <li>Use logging to log a message.</li> <li>Add packages using NuGet.</li> <li>Add client packages using Bower.</li> <li>Target development, staging or production environment.</li> </ul>	<ul style="list-style-type: none"> <li>Conceptual overview of what is ASP.NET Core</li> <li>Fundamentals of ASP.NET Core such as Startup and middleware.</li> <li>Working with Data</li> <li>Security</li> <li>Client side development</li> <li>Develop on different platforms</li> <li>Read more on the documentation site</li> </ul>	<ul style="list-style-type: none"> <li>Run your app</li> <li>Run tools such as EF migrations and more</li> <li>Publish to Microsoft Azure App Service</li> </ul>

## Register a user

- Select **Register** and register a new user. You can use a fictitious email address. When you submit, the page displays the following error:

*"Internal Server Error: A database operation failed while processing the request. SQL exception: Cannot open the database. Applying existing migrations for Application DB context may resolve this issue."*
- Select **Apply Migrations** and, once the page updates, refresh the page.

The screenshot shows a browser window with the title "Internal Server Error". The URL in the address bar is "localhost:16841/Account/Register". The main content area displays the following text:

A database operation failed while processing the request.  
SqlException: Cannot open database "aspnet-WebApplication1-3caf68c5-2764-4579-a54b-15b98365379b" requested by the login. The login failed. Login failed for user 'D\user'.

Applying existing migrations for ApplicationDbContext may resolve this issue  
There are migrations for ApplicationDbContext that have not been applied to the database

- 0000000000000000\_CreatedIdentitySchema

**Apply Migrations**

In Visual Studio, you can use the Package Manager Console to apply pending migrations to the database:  
PM> Update-Database

Alternatively, you can apply pending migrations from a command prompt at your project directory:  
> dotnet ef database update

The app displays the email used to register the new user and a **Log out** link.

The screenshot shows a web browser window with the title "Home page - WebApplication1". The address bar indicates a secure connection to "https://localhost:44323". The page itself is titled "WebApplication1" and features a navigation menu with links for "Home", "About", and "Contact". A user session is shown with the greeting "Hello user@example.com!" and a "Log out" link. A yellow box highlights the user greeting. Below the menu, there is a large blue banner for Microsoft Azure, which includes the text "Microsoft Azure", "Learn how Microsoft's Azure cloud platform allows you to build, deploy, and scale web apps.", a "Learn More" button, and four small icons representing different Azure services: a person icon, a network icon, a database icon, and a calendar/icon icon. There are also navigation arrows and a progress bar consisting of three circles.

**Application uses**

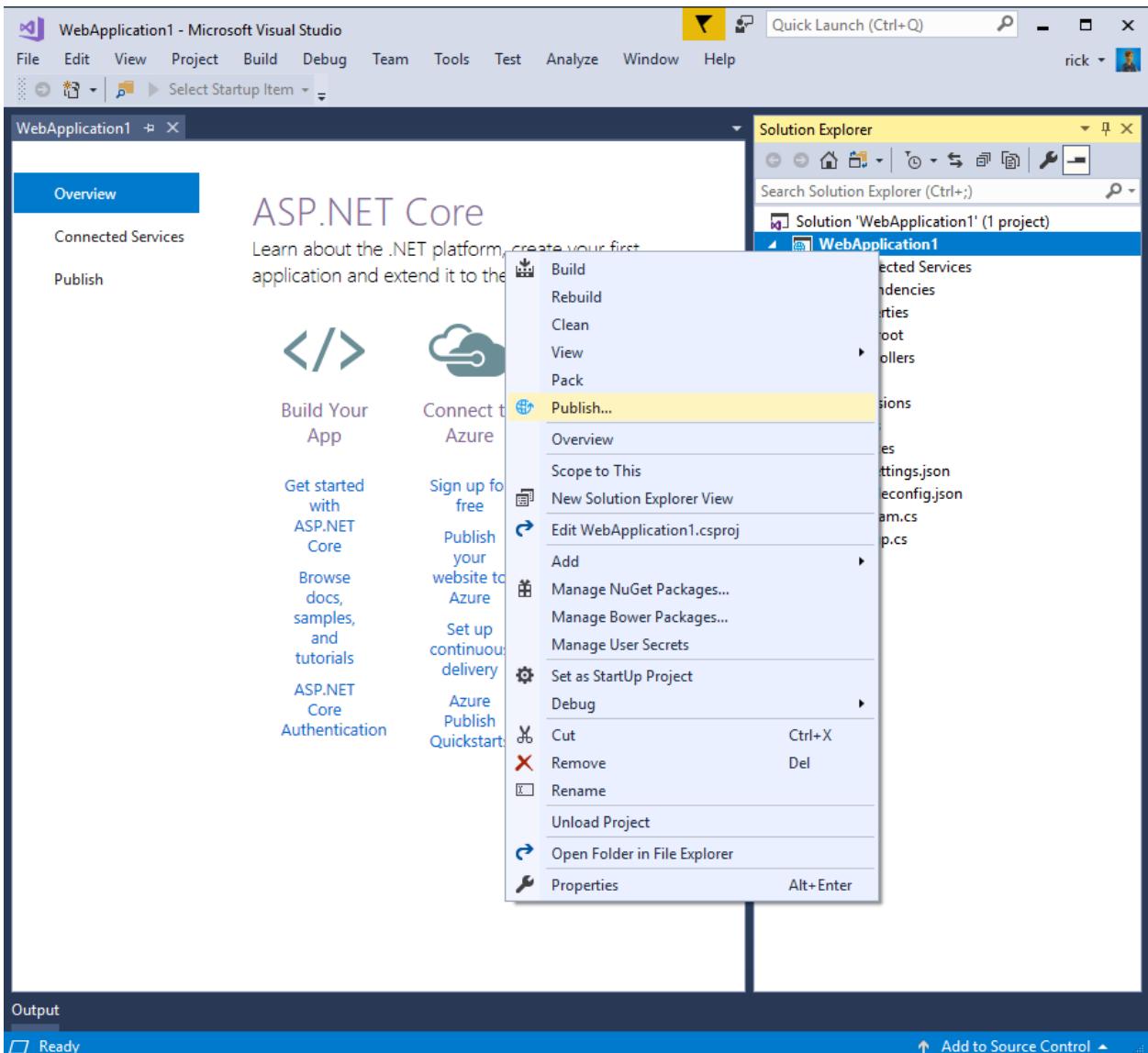
- Sample pages using ASP.NET Core Razor Pages
- Theming using Bootstrap

**How to**

- Working with Razor Pages.
- Manage User Secrets using Secret Manager.
- Use logging to log a message.
- Add packages using NuGet

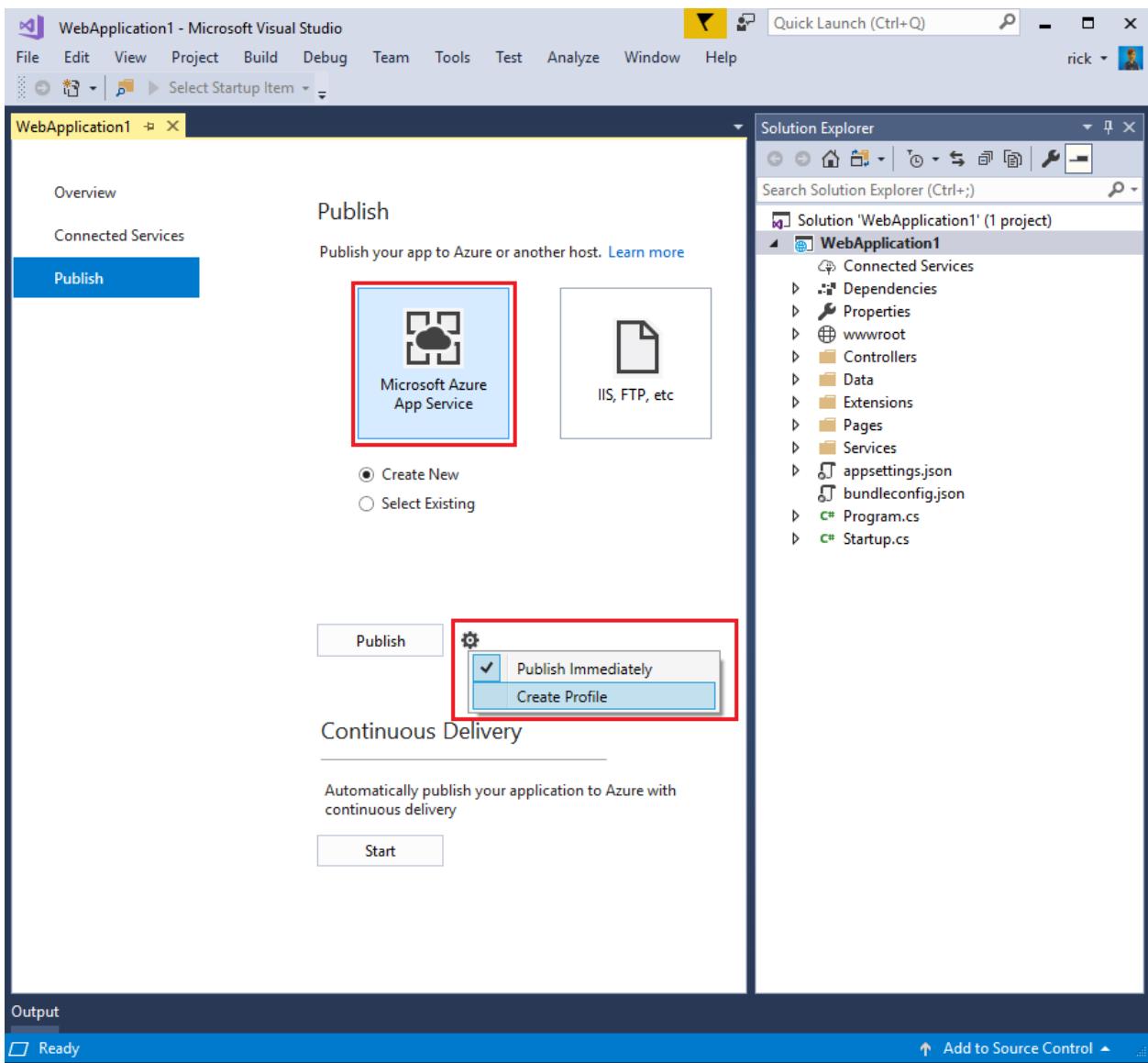
## Deploy the app to Azure

Right-click on the project in Solution Explorer and select **Publish....**



In the **Publish** dialog:

- Select **Microsoft Azure App Service**.
- Select the gear icon and then select **Create Profile**.
- Select **Create Profile**.



## Create Azure resources

The **Create App Service** dialog appears:

- Enter your subscription.
- The **App Name**, **Resource Group**, and **App Service Plan** entry fields are populated. You can keep these names or change them.

**Create App Service**

Host your web and mobile applications, REST APIs, and more in Azure

Microsoft account  
a.ricka00@gmail.com

**Hosting** Services

**App Name:** WebApplication120171215025005

**Change Type:** ▾

**Subscription:** MSDN

**Resource Group:** WebApplication120171215025005ResourceGroup\* New... i

**App Service Plan:** WebApplication120171215025005Plan\* New...

**Clicking the Create button will create the following Azure resources**

[Explore additional Azure services](#)

App Service - WebApplication120171215025005

App Service Plan - WebApplication120171215025005Plan

If you have removed your spending limit or you are using Pay as You Go, there may be monetary impact if you provision additional resources.

[Learn More](#)

Export... Create Cancel

- Select the **Services** tab to create a new database.
- Select the green + icon to create a new SQL Database

**Create App Service**

Host your web and mobile applications, REST APIs, and more in Azure

Microsoft account  
a.ricka00@gmail.com

**Hosting** Services

Select any additional Azure resources your app will need

Show: Recommended

**Resource Type**

SQL Database Scalable and managed database service for modern business-class apps +

Resources you've selected and configured

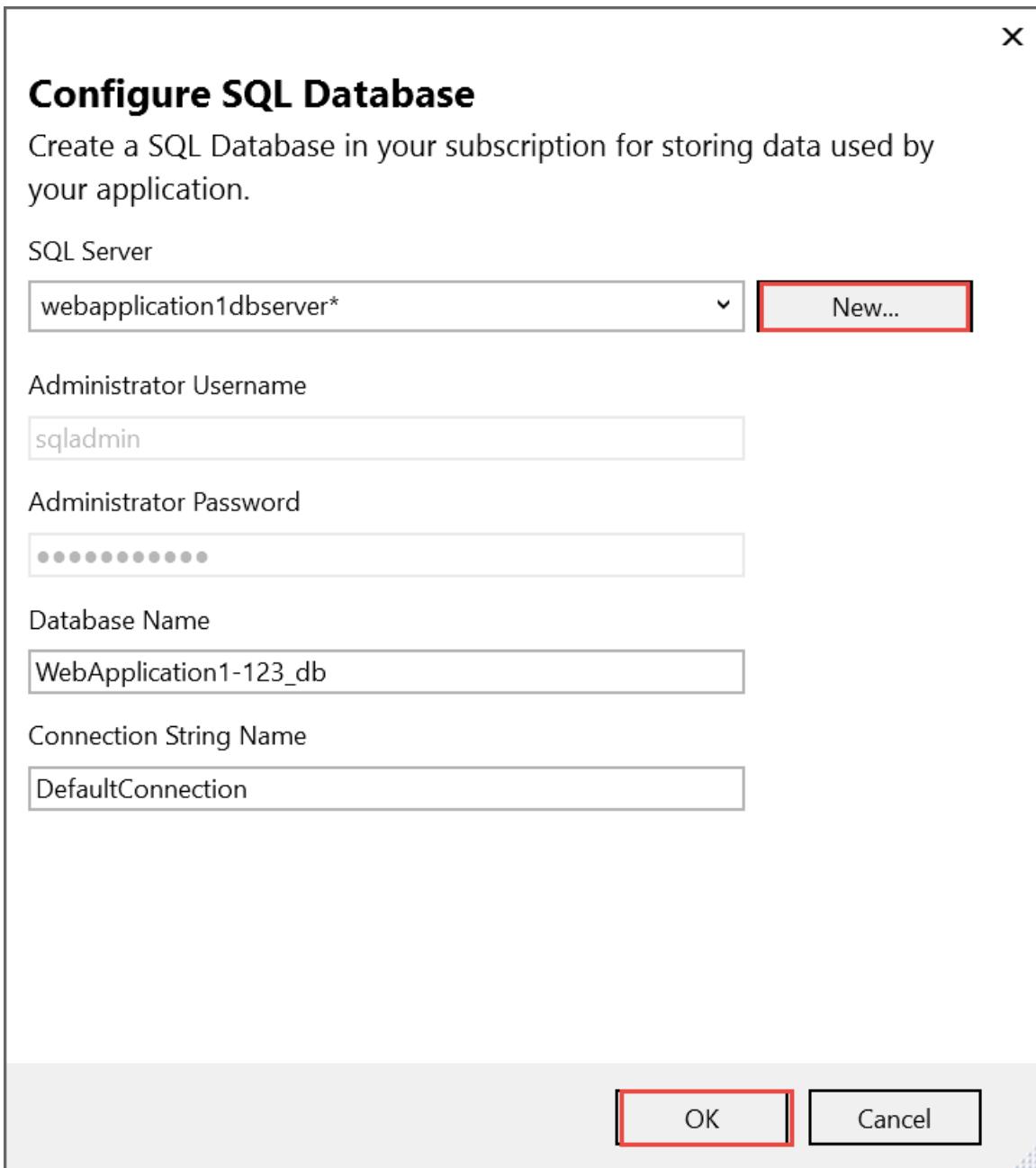
Resource Type	Actions
<span style="border: 1px solid red; padding: 2px;">WebApplication120171215025005Plan</span> App Service Plan	<span style="border: 1px solid red; border-radius: 50%; padding: 5px 10px; display: inline-block;">⚙️</span> <span style="border: 1px solid red; border-radius: 50%; padding: 5px 10px; display: inline-block;">✖️</span>

If you have removed your spending limit or you are using Pay as You Go, there may be monetary impact if you provision additional resources.

[Learn More](#)

Export... Create Cancel

- Select **New...** on the **Configure SQL Database** dialog to create a new database.

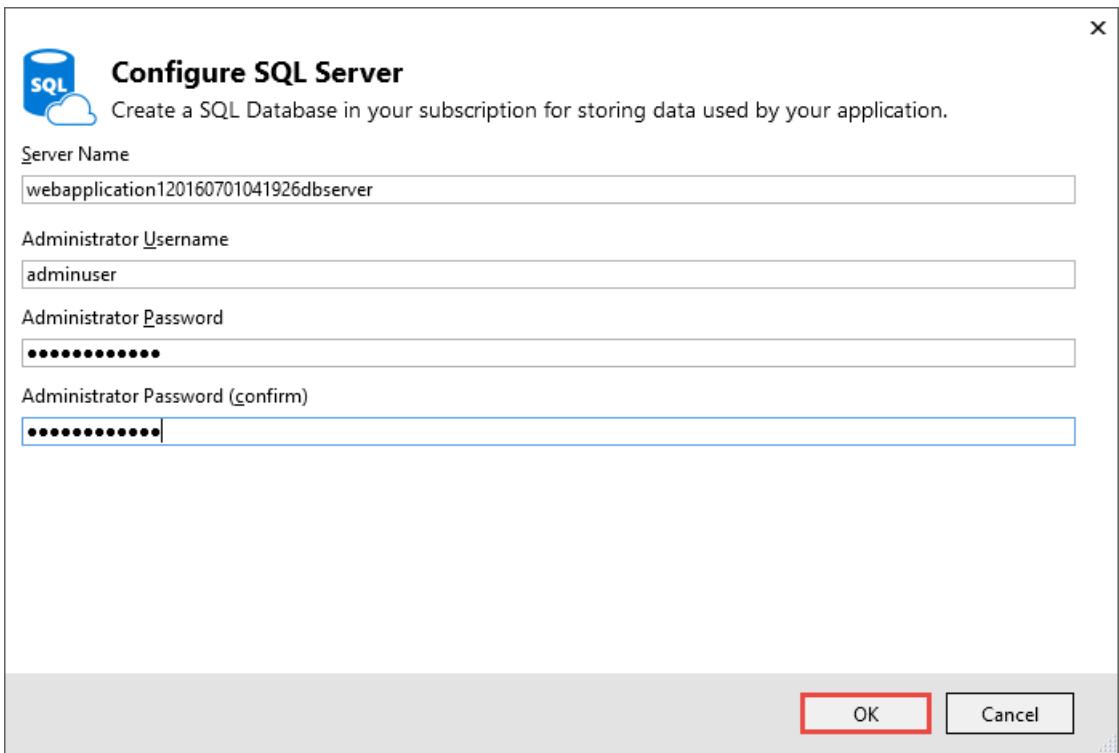


The **Configure SQL Server** dialog appears.

- Enter an administrator user name and password, and then select **OK**. You can keep the default **Server Name**.

**NOTE**

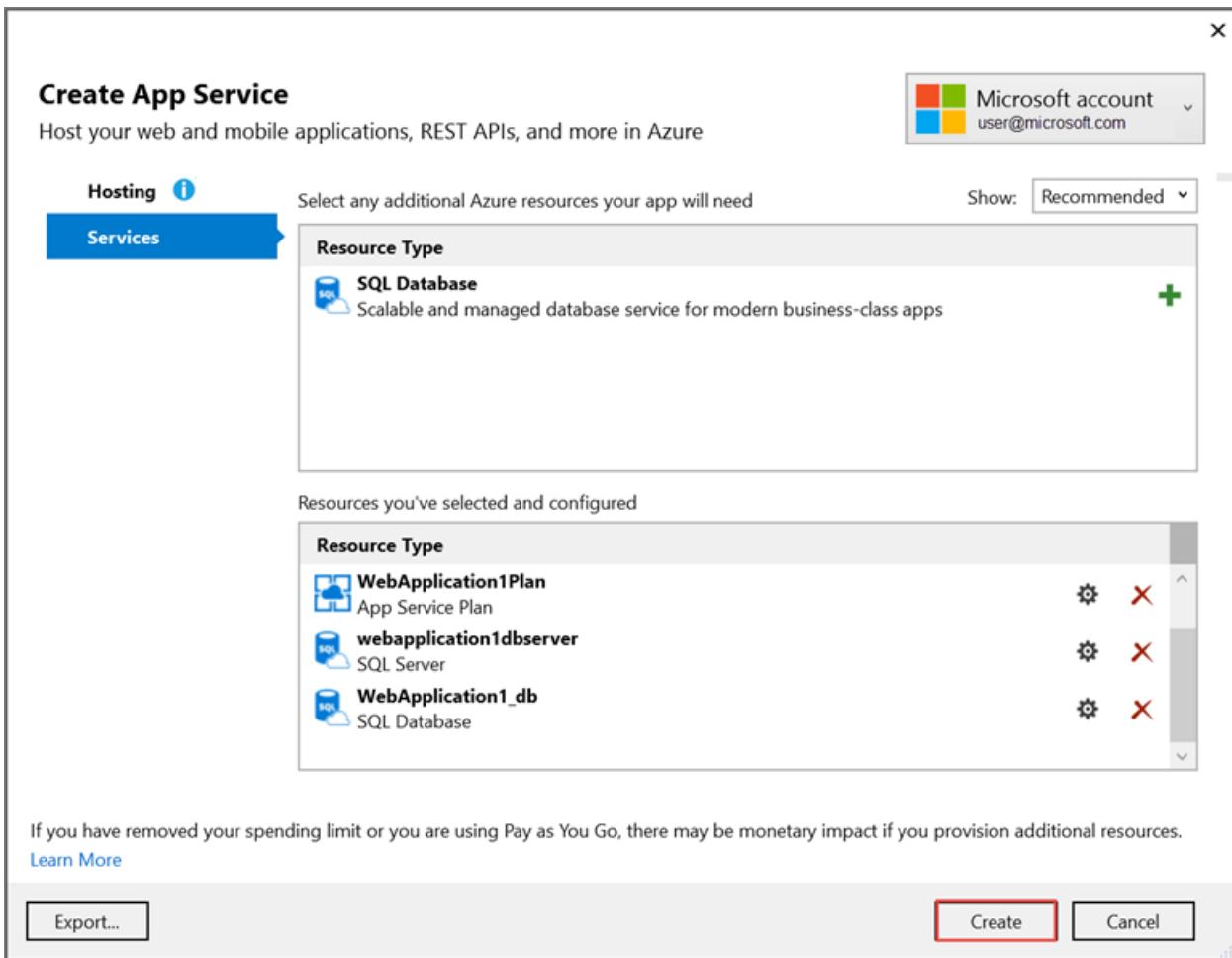
"admin" isn't allowed as the administrator user name.



- Select **OK**.

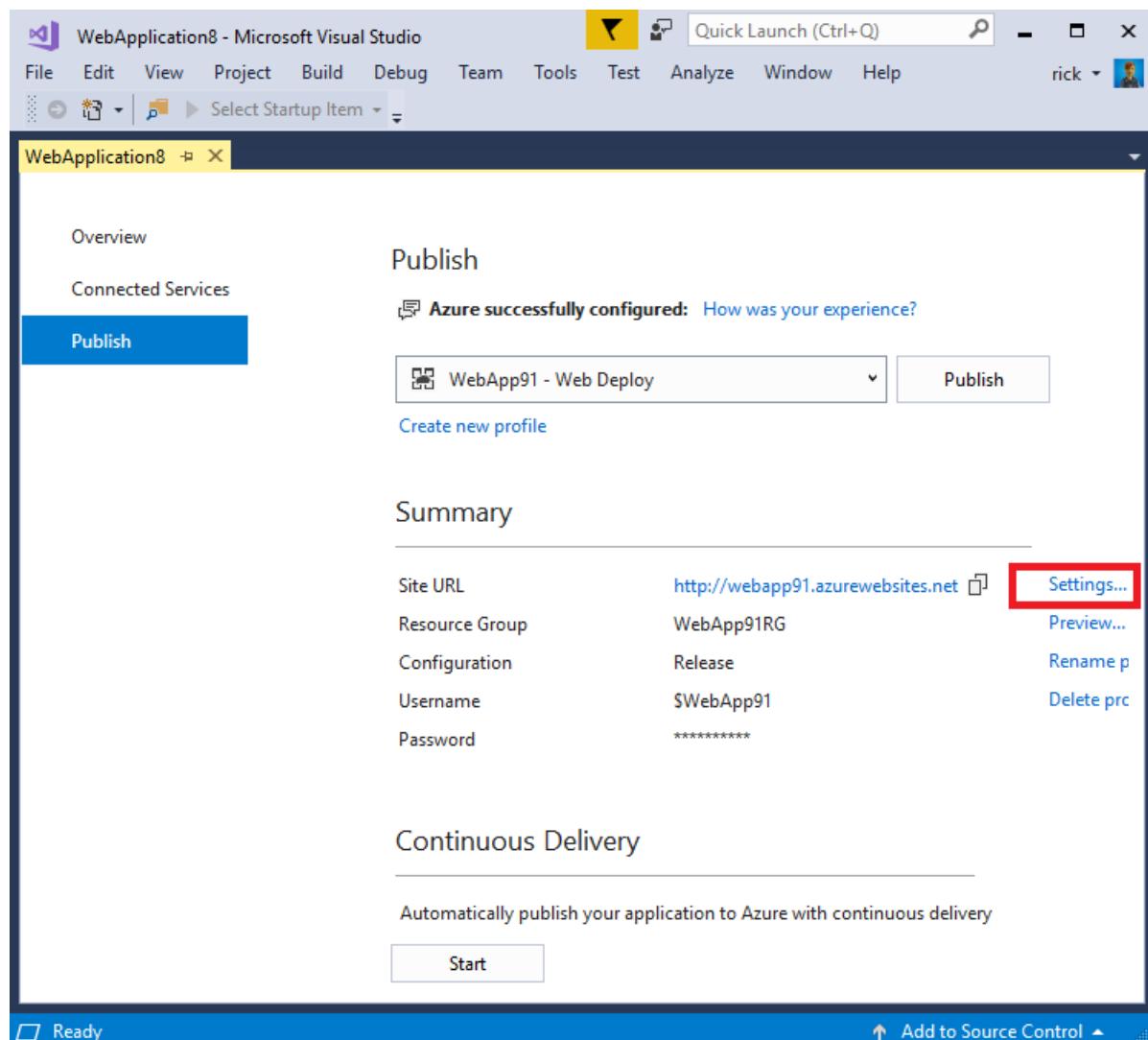
Visual Studio returns to the **Create App Service** dialog.

- Select **Create** on the **Create App Service** dialog.



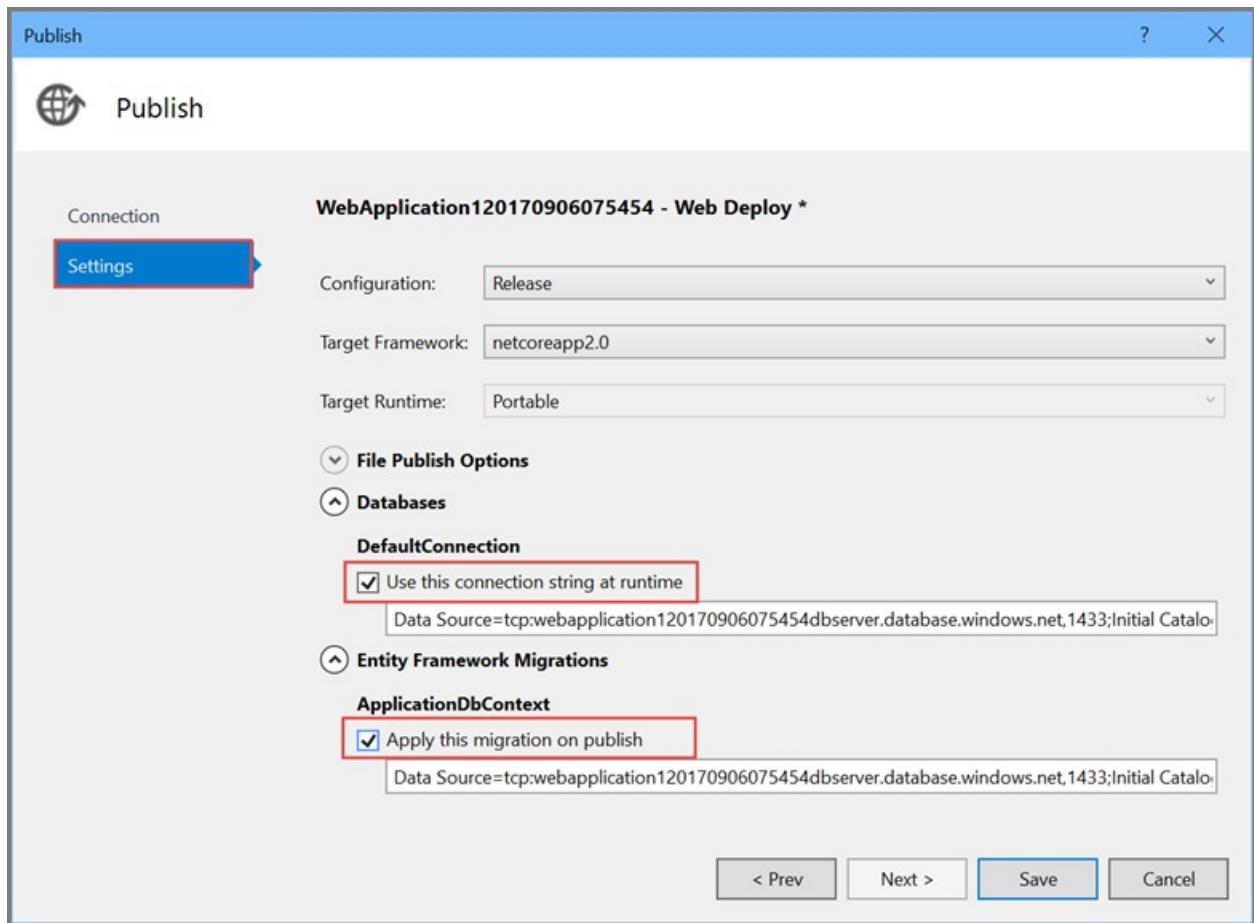
Visual Studio creates the Web app and SQL Server on Azure. This step can take a few minutes. For information on the resources created, see [Additional resources](#).

When deployment completes, select **Settings**:



On the **Settings** page of the **Publish** dialog:

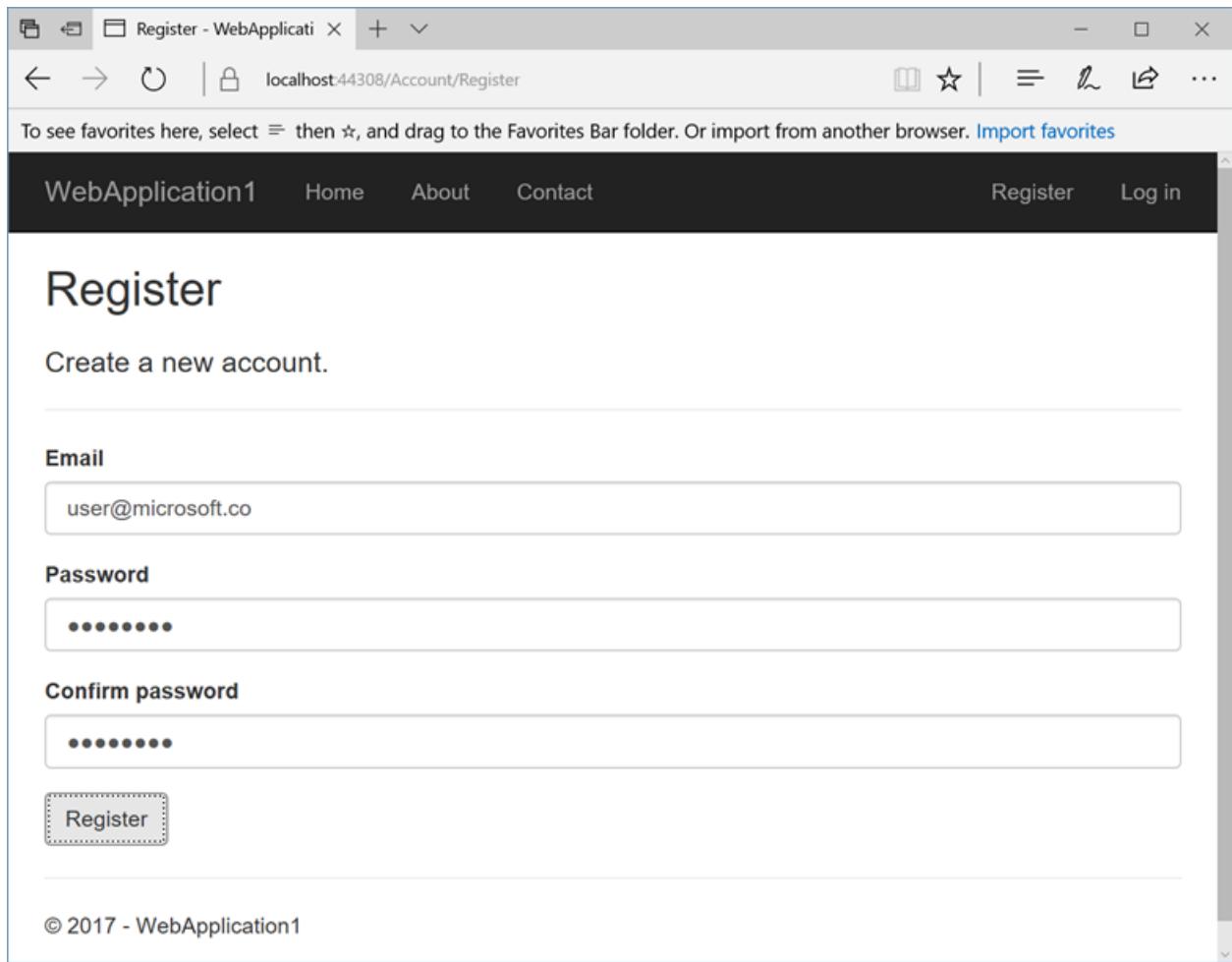
- Expand **Databases** and check **Use this connection string at runtime**.
- Expand **Entity Framework Migrations** and check **Apply this migration on publish**.
- Select **Save**. Visual Studio returns to the **Publish** dialog.



Click **Publish**. Visual Studio publishes your app to Azure. When the deployment completes, the app is opened in a browser.

#### Test your app in Azure

- Test the **About** and **Contact** links
- Register a new user



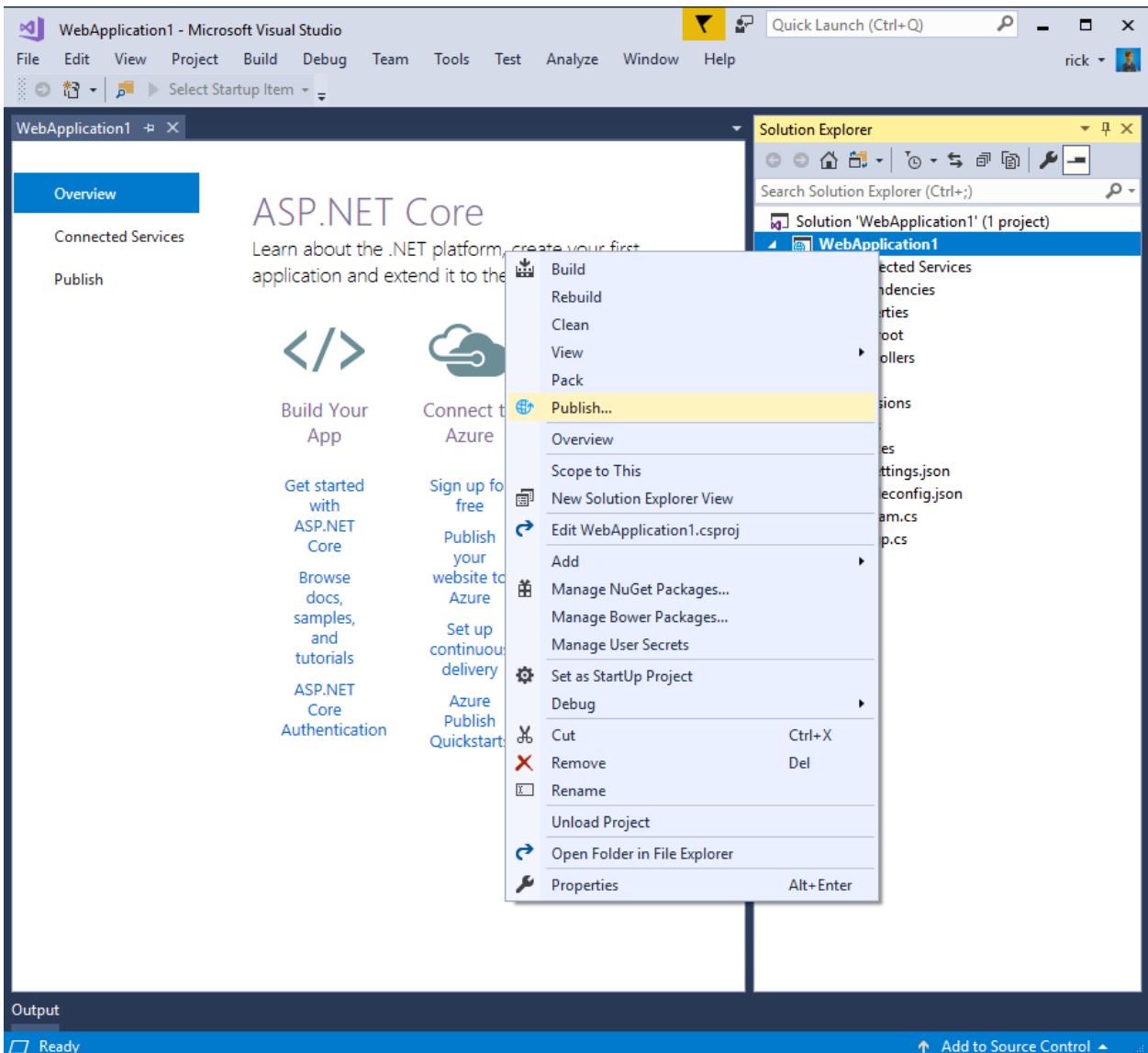
## Update the app

- Edit the *Pages/About.cshtml* Razor page and change its contents. For example, you can modify the paragraph to say "Hello ASP.NET Core!":

```
@page
@model AboutModel
 @{
    ViewData["Title"] = "About";
}
<h2>@ViewData["Title"]</h2>
<h3>@Model.Message</h3>

<p>Hello ASP.NET Core!</p>
```

- Right-click on the project and select **Publish...** again.



- After the app is published, verify the changes you made are available on Azure.

To see favorites here, select  $\equiv$  then  $\star$ , and drag to the Favorites Bar folder. Or import from another browser. [Import favorites](#)

WebApplication1 Home About Contact Register Log in

## About

Your application description page.

Hello ASP.NET Core!

© 2017 - WebApplication2

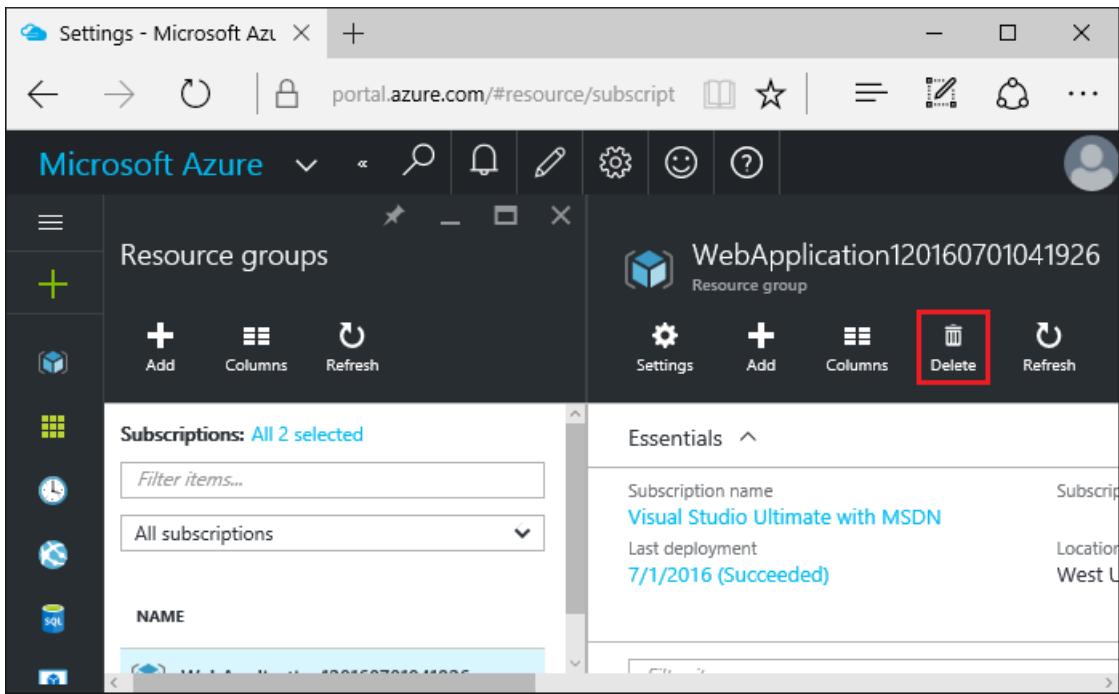
### Clean up

When you have finished testing the app, go to the [Azure portal](#) and delete the app.

- Select **Resource groups**, then select the resource group you created.

NAME
WebApplication120160701041926

- In the **Resource groups** page, select **Delete**.



- Enter the name of the resource group and select **Delete**. Your app and all other resources created in this tutorial are now deleted from Azure.

#### Next steps

- [Continuous Deployment to Azure with Visual Studio and Git](#)

## Additonal resources

- [Azure App Service](#)
- [Azure resource groups](#)
- [Azure SQL Database](#)
- [Troubleshoot ASP.NET Core on Azure App Service](#)

# Publish an ASP.NET Core app to Azure with command line tools

6/21/2018 • 4 minutes to read • [Edit Online](#)

By [Cam Soper](#)

## IMPORTANT

### ASP.NET Core preview releases with Azure App Service

ASP.NET Core preview releases aren't deployed to Azure App Service by default. To host an app that uses an ASP.NET Core preview release, see [Deploy ASP.NET Core preview release to Azure App Service](#).

This tutorial will show you how to build and deploy an ASP.NET Core app to Microsoft Azure App Service using command line tools. When finished, you'll have a Razor Pages web app built in ASP.NET Core hosted as an Azure App Service Web App. This tutorial is written using Windows command line tools, but can be applied to macOS and Linux environments, as well.

In this tutorial, you learn how to:

- Create an Azure App Service website using Azure CLI
- Deploy an ASP.NET Core app to Azure App Service using the Git command line tool

## Prerequisites

To complete this tutorial, you'll need:

- [A Microsoft Azure subscription](#)
- [.NET Core SDK 2.0 or later](#)
- [Git command line client](#)

## Create a web app

Create a new directory for the web app, create a new ASP.NET Core Razor Pages app, and then run the website locally.

- [Windows](#)
- [Other](#)

```
REM Create a new ASP.NET Core Razor Pages app
dotnet new webapp -o MyApplication

REM Change to the new directory that was just created
cd MyApplication

REM Run the app
dotnet run
```

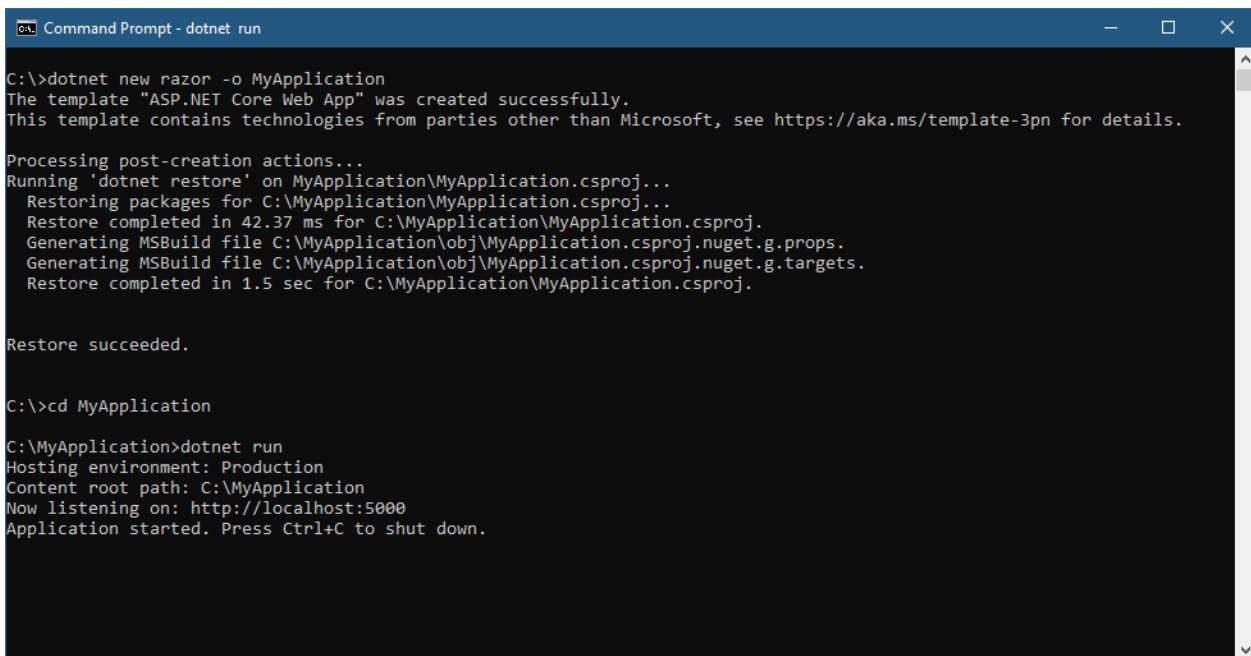
#### NOTE

In ASP.NET Core 2.1 or later, `webapp` is an alias of the `razor` argument. If the `dotnet new webapp <OPTIONS>` command loads the `dotnet new` command help instead of creating a new Razor Pages app, install the [.NET Core 2.1 SDK](#).

```
REM Create a new ASP.NET Core Razor Pages app  
dotnet new razor -o MyApplication
```

```
REM Change to the new directory that was just created  
cd MyApplication
```

```
REM Run the app  
dotnet run
```



```
C:\>dotnet new razor -o MyApplication  
The template "ASP.NET Core Web App" was created successfully.  
This template contains technologies from parties other than Microsoft, see https://aka.ms/template-3pn for details.  
Processing post-creation actions...  
Running 'dotnet restore' on MyApplication\MyApplication.csproj...  
Restoring packages for C:\MyApplication\MyApplication.csproj...  
Restore completed in 42.37 ms for C:\MyApplication\MyApplication.csproj.  
Generating MSBuild file C:\MyApplication\obj\MyApplication.csproj.nuget.g.props.  
Generating MSBuild file C:\MyApplication\obj\MyApplication.csproj.nuget.g.targets.  
Restore completed in 1.5 sec for C:\MyApplication\MyApplication.csproj.  
  
Restore succeeded.  
  
C:\>cd MyApplication  
C:\MyApplication>dotnet run  
Hosting environment: Production  
Content root path: C:\MyApplication  
Now listening on: http://localhost:5000  
Application started. Press Ctrl+C to shut down.
```

Test the app by browsing to <http://localhost:5000>.

ASP.NET Core | Windows | Linux | OSX

Learn how to build ASP.NET apps that can run anywhere. [Learn More](#)

●○○○

## Application uses

- Sample pages using ASP.NET Core MVC
- Bower for managing client-side libraries
- Theming using Bootstrap

## How to

- Add a Controller and View
- Manage User Secrets using Secret Manager.
- Use logging to log a message.
- Add packages using NuGet.
- Add client packages using Bower.
- Target development, staging or production environment.

## Overview

## Create the Azure App Service instance

Using the [Azure Cloud Shell](#), create a resource group, App Service plan, and an App Service web app.

```
# Generate a unique Web App name
let randomNum=$RANDOM*$RANDOM
webappname=tutorialApp$randomNum

# Create the DotNetAzureTutorial resource group
az group create --name DotNetAzureTutorial --location EastUS

# Create an App Service plan.
az appservice plan create --name $webappname --resource-group DotNetAzureTutorial --sku FREE

# Create the Web App
az webapp create --name $webappname --resource-group DotNetAzureTutorial --plan $webappname
```

Before deployment, set the account-level deployment credentials using the following command:

```
az webapp deployment user set --user-name <desired user name> --password <desired password>
```

A deployment URL is needed to deploy the app using Git. Retrieve the URL like this.

```
az webapp deployment source config-local-git -n $webappname -g DotNetAzureTutorial --query [url] -o tsv
```

Note the displayed URL ending in `.git`. It's used in the next step.

## Deploy the app using Git

You're ready to deploy from your local machine using Git.

### NOTE

It's safe to ignore any warnings from Git about line endings.

- [Windows](#)
- [Other](#)

```
REM Initialize the local Git repository
git init

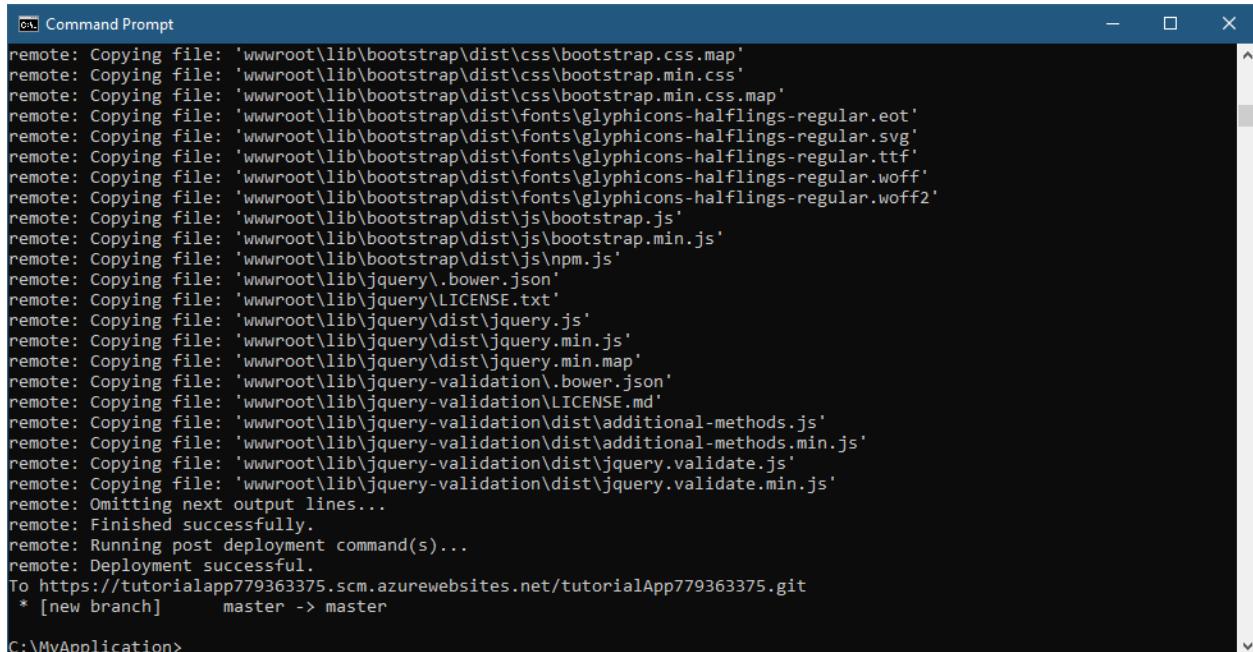
REM Add the contents of the working directory to the repo
git add --all

REM Commit the changes to the local repo
git commit -a -m "Initial commit"

REM Add the URL as a Git remote repository
git remote add azure <THE GIT URL YOU NOTED EARLIER>

REM Push the local repository to the remote
git push azure master
```

Git prompts for the deployment credentials that were set earlier. After authenticating, the app will be pushed to the remote location, built, and deployed.

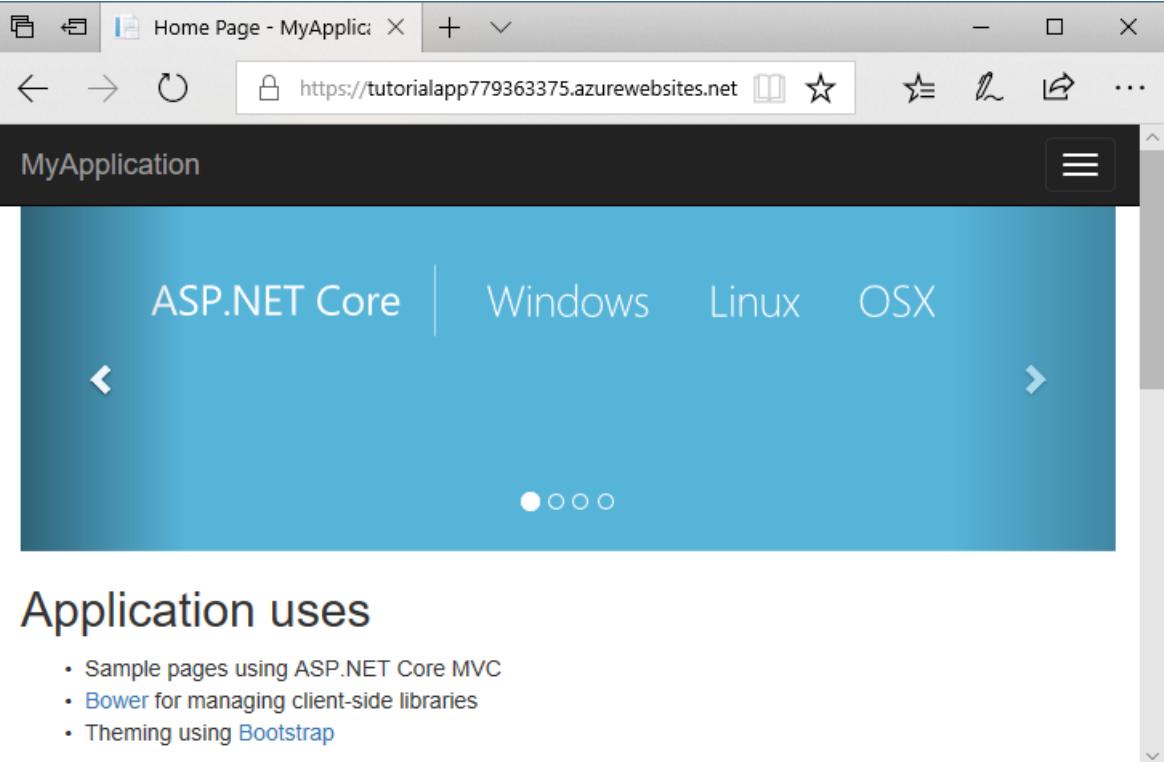


```
remote: Copying file: 'wwwroot\lib\bootstrap\dist\css\bootstrap.css.map'
remote: Copying file: 'wwwroot\lib\bootstrap\dist\css\bootstrap.min.css'
remote: Copying file: 'wwwroot\lib\bootstrap\dist\css\bootstrap.min.css.map'
remote: Copying file: 'wwwroot\lib\bootstrap\dist\fonts\glyphicon-halflings-regular.eot'
remote: Copying file: 'wwwroot\lib\bootstrap\dist\fonts\glyphicon-halflings-regular.svg'
remote: Copying file: 'wwwroot\lib\bootstrap\dist\fonts\glyphicon-halflings-regular.ttf'
remote: Copying file: 'wwwroot\lib\bootstrap\dist\fonts\glyphicon-halflings-regular.woff'
remote: Copying file: 'wwwroot\lib\bootstrap\dist\fonts\glyphicon-halflings-regular.woff2'
remote: Copying file: 'wwwroot\lib\bootstrap\dist\js\bootstrap.js'
remote: Copying file: 'wwwroot\lib\bootstrap\dist\js\bootstrap.min.js'
remote: Copying file: 'wwwroot\lib\bootstrap\dist\js\npm.js'
remote: Copying file: 'wwwroot\lib\jquery\.bower.json'
remote: Copying file: 'wwwroot\lib\jquery\LICENSE.txt'
remote: Copying file: 'wwwroot\lib\jquery\dist\jquery.js'
remote: Copying file: 'wwwroot\lib\jquery\dist\jquery.min.js'
remote: Copying file: 'wwwroot\lib\jquery\dist\jquery.min.map'
remote: Copying file: 'wwwroot\lib\jquery-validation\.bower.json'
remote: Copying file: 'wwwroot\lib\jquery-validation\LICENSE.md'
remote: Copying file: 'wwwroot\lib\jquery-validation\dist\additional-methods.js'
remote: Copying file: 'wwwroot\lib\jquery-validation\dist\additional-methods.min.js'
remote: Copying file: 'wwwroot\lib\jquery-validation\dist\jquery.validate.js'
remote: Copying file: 'wwwroot\lib\jquery-validation\dist\jquery.validate.min.js'
remote: Omitting next output lines...
remote: Finished successfully.
remote: Running post deployment command(s)...
remote: Deployment successful.
To https://tutorialapp779363375.scm.azurewebsites.net/tutorialApp779363375.git
 * [new branch]      master -> master
C:\MyApplication>
```

## Test the app

Test the app by browsing to `https://<web app name>.azurewebsites.net`. To display the address in the Cloud Shell (or Azure CLI), use the following:

```
az webapp show -n $webappName -g DotNetAzureTutorial --query defaultHostName -o tsv
```



The screenshot shows a Microsoft Edge browser window. The address bar displays the URL <https://tutorialapp779363375.azurewebsites.net>. The page content is titled "MyApplication". It features a large blue banner at the top with the text "ASP.NET Core" and icons for "Windows", "Linux", and "OSX". Below the banner, there is a section titled "Application uses" with a bulleted list:

- Sample pages using ASP.NET Core MVC
- Bower for managing client-side libraries
- Theming using Bootstrap

## Clean up

When finished testing the app and inspecting the code and resources, delete the web app and plan by deleting the resource group.

```
az group delete -n DotNetAzureTutorial
```

## Next steps

In this tutorial, you learned how to:

- Create an Azure App Service website using Azure CLI
- Deploy an ASP.NET Core app to Azure App Service using the Git command line tool

Next, learn to use the command line to deploy an existing web app that uses CosmosDB.

[Deploy to Azure from the command line with .NET Core](#)

# Continuous deployment to Azure with Visual Studio and Git with ASP.NET Core

6/21/2018 • 6 minutes to read • [Edit Online](#)

By Erik Reitan

## IMPORTANT

### ASP.NET Core preview releases with Azure App Service

ASP.NET Core preview releases aren't deployed to Azure App Service by default. To host an app that uses an ASP.NET Core preview release, see [Deploy ASP.NET Core preview release to Azure App Service](#).

This tutorial shows how to create an ASP.NET Core web app using Visual Studio and deploy it from Visual Studio to Azure App Service using continuous deployment.

See also [Use VSTS to Build and Publish to an Azure Web App with Continuous Deployment](#), which shows how to configure a continuous delivery (CD) workflow for [Azure App Service](#) using Visual Studio Team Services. Azure Continuous Delivery in Team Services simplifies setting up a robust deployment pipeline to publish updates for apps hosted in Azure App Service. The pipeline can be configured from the Azure portal to build, run tests, deploy to a staging slot, and then deploy to production.

## NOTE

To complete this tutorial, a Microsoft Azure account is required. To obtain an account, [activate MSDN subscriber benefits](#) or [sign up for a free trial](#).

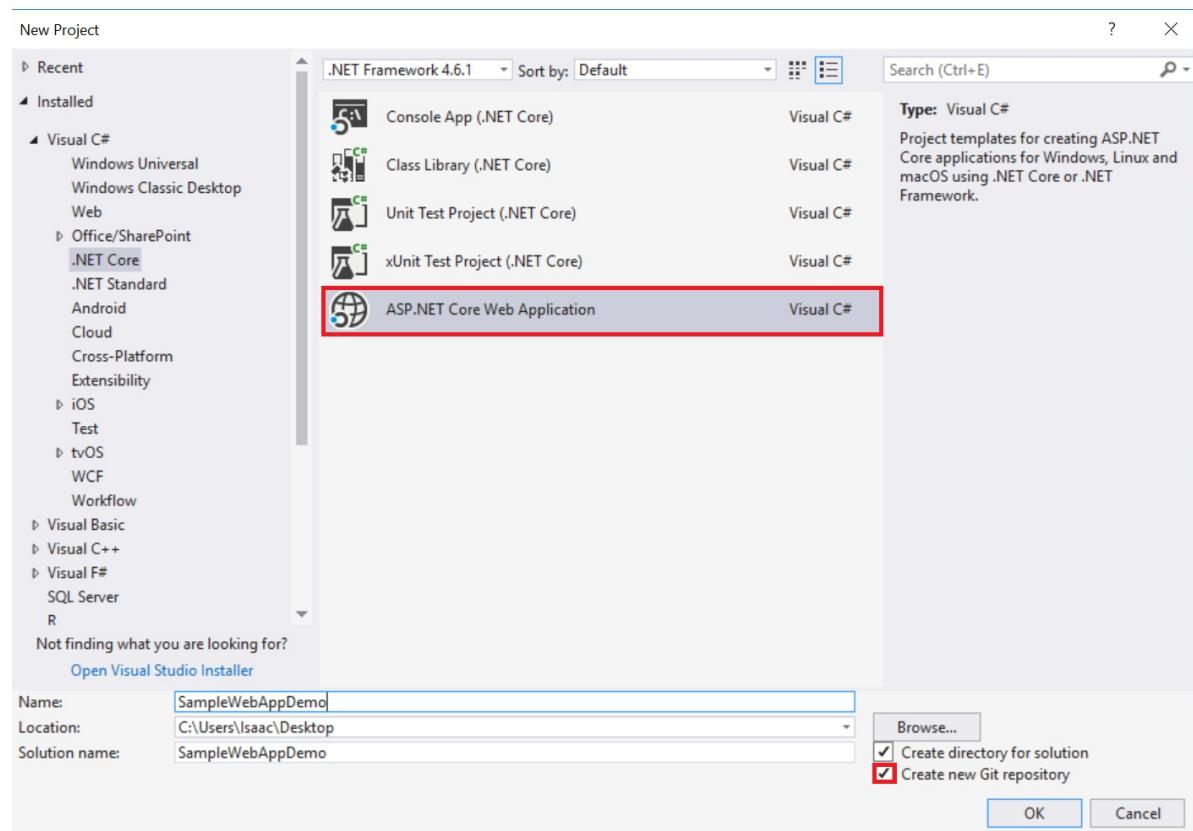
## Prerequisites

This tutorial assumes the following software is installed:

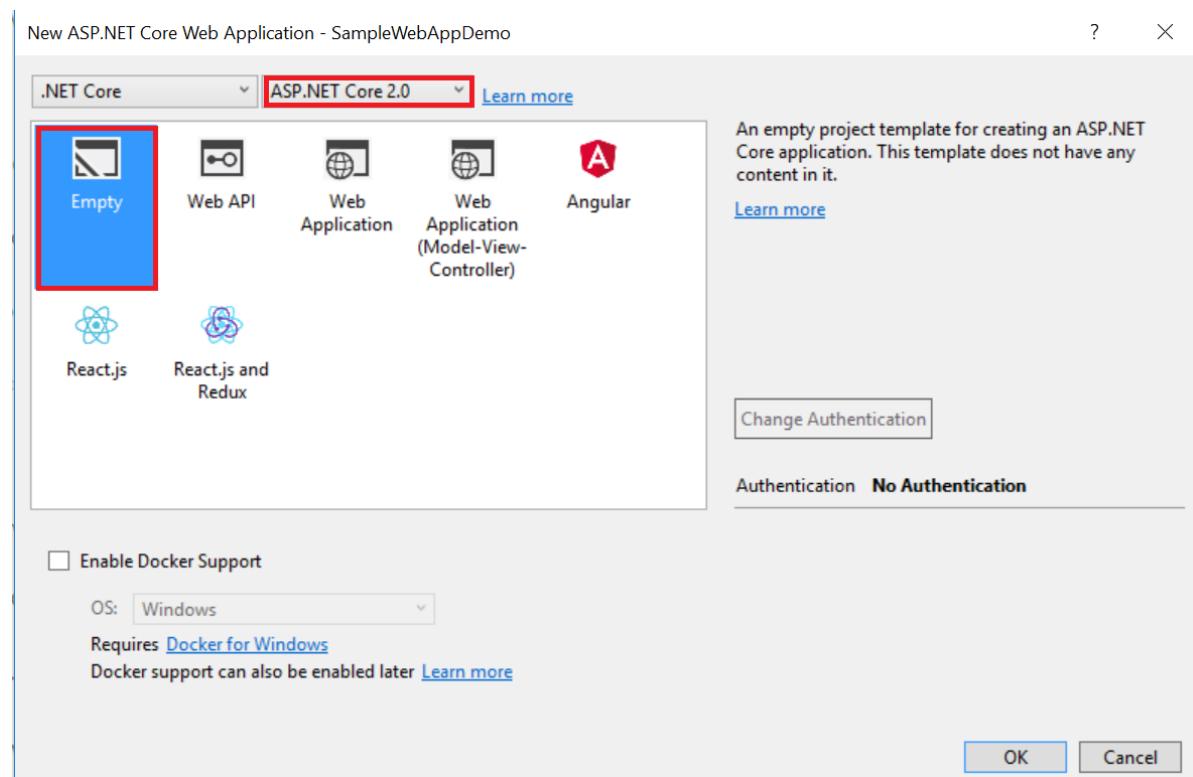
- [Visual Studio](#)
- [.NET Core SDK 2.0 or later](#)
- [Git for Windows](#)

## Create an ASP.NET Core web app

1. Start Visual Studio.
2. From the **File** menu, select **New > Project**.
3. Select the **ASP.NET Core Web Application** project template. It appears under **Installed > Templates > Visual C# > .NET Core**. Name the project `SampleWebAppDemo`. Select the **Create new Git repository** option and click **OK**.



4. In the **New ASP.NET Core Project** dialog, select the ASP.NET Core **Empty** template, then click **OK**.



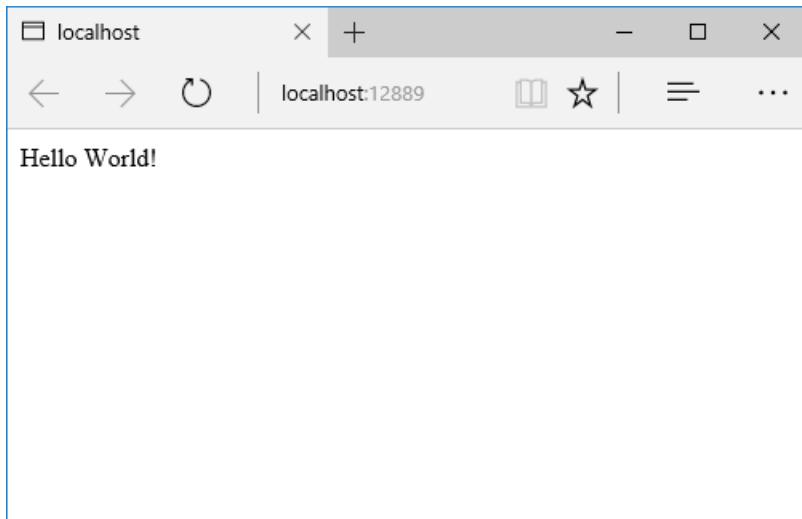
#### NOTE

The most recent release of .NET Core is 2.0.

#### Running the web app locally

1. Once Visual Studio finishes creating the app, run the app by selecting **Debug > Start Debugging**. As an alternative, press **F5**.

It may take time to initialize Visual Studio and the new app. Once it's complete, the browser shows the running app.

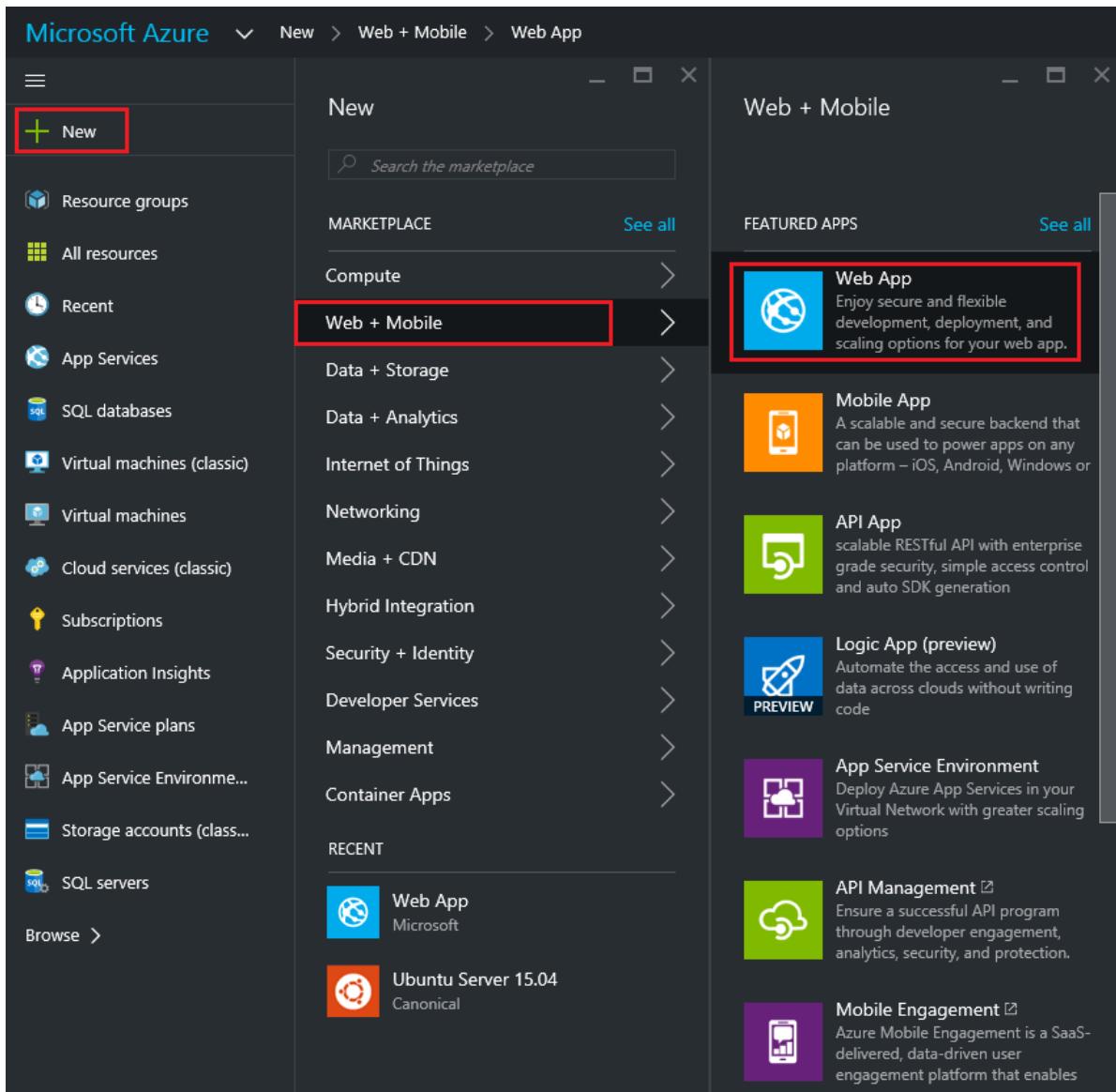


2. After reviewing the running Web app, close the browser and select the "Stop Debugging" icon in the toolbar of Visual Studio to stop the app.

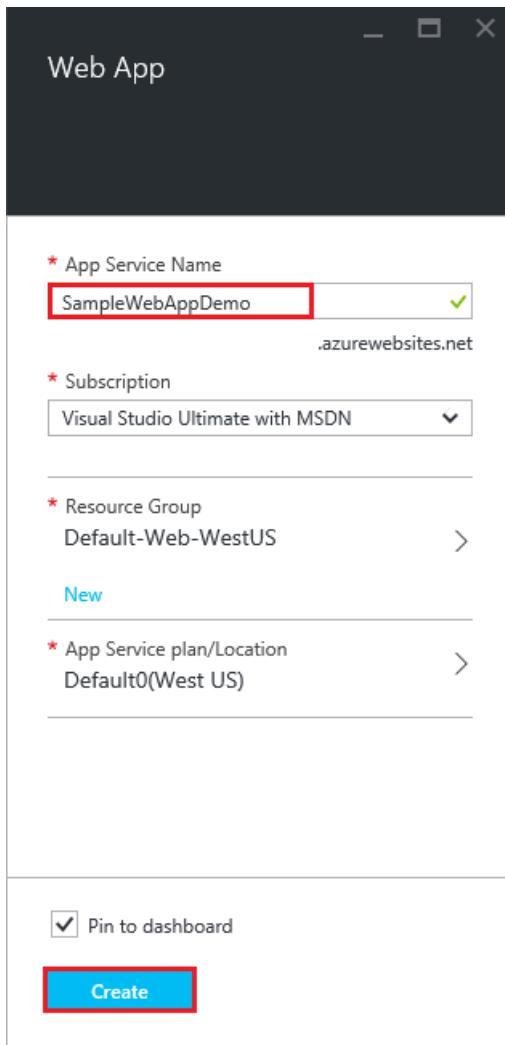
## Create a web app in the Azure Portal

The following steps create a web app in the Azure Portal:

1. Log in to the [Azure Portal](#).
2. Select **NEW** at the top left of the portal interface.
3. Select **Web + Mobile > Web App**.



4. In the **Web App** blade, enter a unique value for the **App Service Name**.



#### NOTE

The **App Service Name** name must be unique. The portal enforces this rule when the name is provided. If providing a different value, substitute that value for each occurrence of **SampleWebAppDemo** in this tutorial.

Also in the **Web App** blade, select an existing **App Service Plan/Location** or create a new one. If creating a new plan, select the pricing tier, location, and other options. For more information on App Service plans, see [Azure App Service plans in-depth overview](#).

5. Select **Create**. Azure will provision and start the web app.

The screenshot shows the Microsoft Azure portal interface. On the left, there's a sidebar with navigation links: 'New', 'Resource groups', 'All resources', 'Recent', 'App Services', 'SQL databases', 'Virtual machines (classic)', and 'Virtual machines'. The main content area is titled 'SampleWebAppDemo01' and 'Web app'. It includes a toolbar with icons for Settings, Tools, Browse, Stop, Swap, Restart, Delete, Get publish..., and More commands. Below the toolbar, the 'Essentials' section provides key details: Resource group (Default-Web-WestUS), Status (Running), Location (West US), Subscription name (Visual Studio Ultimate with MSDN), and Subscription id. At the bottom right of the essentials section is a link 'All settings →'.

## Enable Git publishing for the new web app

Git is a distributed version control system that can be used to deploy an Azure App Service web app. Web app code is stored in a local Git repository, and the code is deployed to Azure by pushing to a remote repository.

1. Log into the [Azure Portal](#).
2. Select **App Services** to view a list of the app services associated with the Azure subscription.
3. Select the web app created in the previous section of this tutorial.
4. In the **Deployment** blade, select **Deployment options** > **Choose Source** > **Local Git Repository**.

The screenshot shows the 'Deployment option' blade with the 'Choose Source' step selected. On the left, a sidebar lists 'Quickstart', 'Deployment credentials', 'Deployment slots', 'Deployment options' (which is highlighted with a red box), and 'Continuous Delivery (Preview)'. The main pane shows a list of source providers: 'Visual Studio Team Services By Microsoft', 'OneDrive By Microsoft', 'Local Git Repository By Git' (which is highlighted with a red box), 'GitHub By GitHub', 'Bitbucket By Atlassian', 'Dropbox By Dropbox', and 'External Repository'.

5. Select **OK**.
6. If deployment credentials for publishing a web app or other App Service app haven't previously been set up, set them up now:
  - Select **Settings** > **Deployment credentials**. The **Set deployment credentials** blade is displayed.
  - Create a user name and password. Save the password for later use when setting up Git.
  - Select **Save**.
7. In the **Web App** blade, select **Settings** > **Properties**. The URL of the remote Git repository to deploy to is

shown under **GIT URL**.

8. Copy the **GIT URL** value for later use in the tutorial.

The screenshot shows the 'Properties' blade for an Azure App Service named 'samplewebappdemo01'. The blade displays various configuration settings:

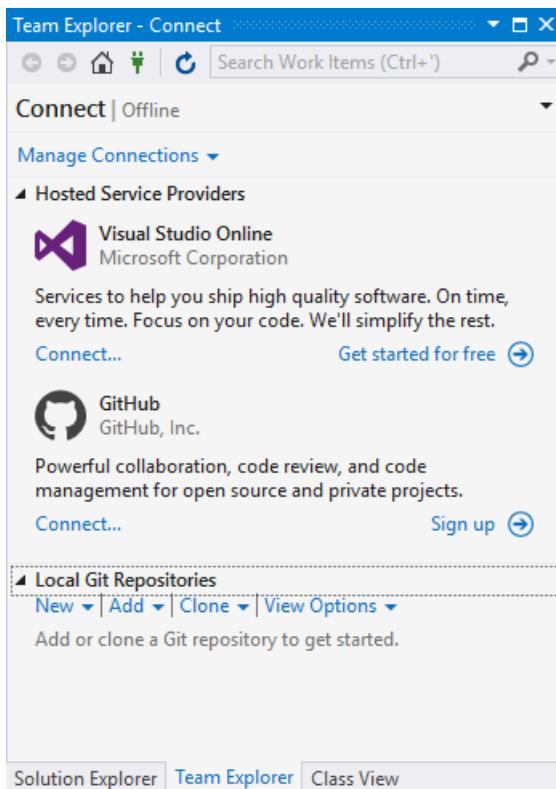
- STATUS:** Running
- URL:** samplewebappdemo01.azurewebsites.net
- VIRTUAL IP ADDRESS:** No IP-based SSL binding is configured
- MODE:** Free
- OUTBOUND IP ADDRESSES:** 23.99.3.91, 23.99.3.100, 23.99.3.101, 23.99.3
- FTP/DEPLOYMENT USER:** SampleWebAppDemo01\erikre01
- GIT URL:** https://erikre01@samplewebappdemo01. (This field is highlighted with a red border.)
- FTP HOST NAME:** ftp://waws-prod-bay-005.ftp.azurewebsites.net
- FTP DIAGNOSTIC LOGS:** ftp://waws-prod-bay-005.ftp.azurewebsites.net
- FTPS HOST NAME:** ftps://waws-prod-bay-005.ftp.azurewebsites.net
- FTPS DIAGNOSTIC LOGS:** ftps://waws-prod-bay-005.ftp.azurewebsites.net

## Publish the web app to Azure App Service

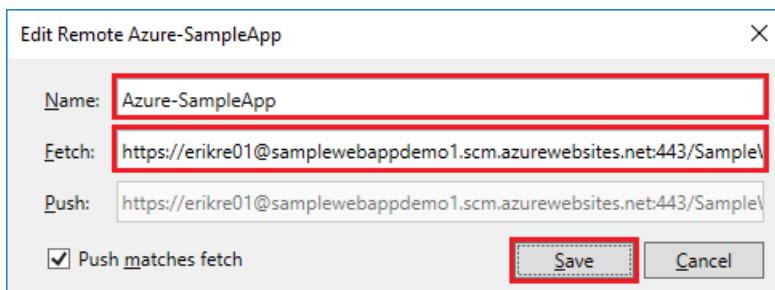
In this section, create a local Git repository using Visual Studio and push from that repository to Azure to deploy the web app. The steps involved include the following:

- Add the remote repository setting using the **GIT URL** value, so the local repository can be deployed to Azure.
- Commit project changes.
- Push project changes from the local repository to the remote repository on Azure.

1. In **Solution Explorer** right-click **Solution 'SampleWebAppDemo'** and select **Commit**. The **Team Explorer** is displayed.



2. In **Team Explorer**, select the **Home** (home icon) > **Settings** > **Repository Settings**.
3. In the **Remotes** section of the **Repository Settings**, select **Add**. The **Add Remote** dialog box is displayed.
4. Set the **Name** of the remote to **Azure-SampleApp**.
5. Set the value for **Fetch** to the **Git URL** that copied from Azure earlier in this tutorial. Note that this is the URL that ends with **.git**.

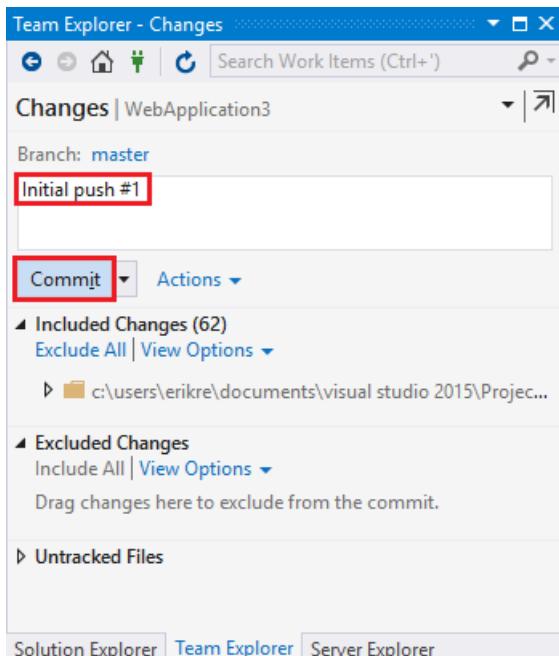


#### NOTE

As an alternative, specify the remote repository from the **Command Window** by opening the **Command Window**, changing to the project directory, and entering the command. Example:

```
git remote add Azure-SampleApp https://me@sampleapp.scm.azurewebsites.net:443/SampleApp.git
```

6. Select the **Home** (home icon) > **Settings** > **Global Settings**. Confirm that the name and email address are set. Select **Update** if required.
7. Select **Home** > **Changes** to return to the **Changes** view.
8. Enter a commit message, such as **Initial Push #1** and select **Commit**. This action creates a *commit* locally.



#### NOTE

As an alternative, commit changes from the **Command Window** by opening the **Command Window**, changing to the project directory, and entering the git commands. Example:

```
git add .  
git commit -am "Initial Push #1"
```

9. Select **Home > Sync > Actions > Open Command Prompt**. The command prompt opens to the project directory.

10. Enter the following command in the command window:

```
git push -u Azure-SampleApp master
```

11. Enter the Azure **deployment credentials** password created earlier in Azure.

This command starts the process of pushing the local project files to Azure. The output from the above command ends with a message that the deployment was successful.

```
remote: Finished successfully.  
remote: Running post deployment command(s)...  
remote: Deployment successful.  
To https://username@samplewebappdemo01.scm.azurewebsites.net:443/SampleWebAppDemo01.git  
* [new branch] master -> master  
Branch master set up to track remote branch master from Azure-SampleApp.
```

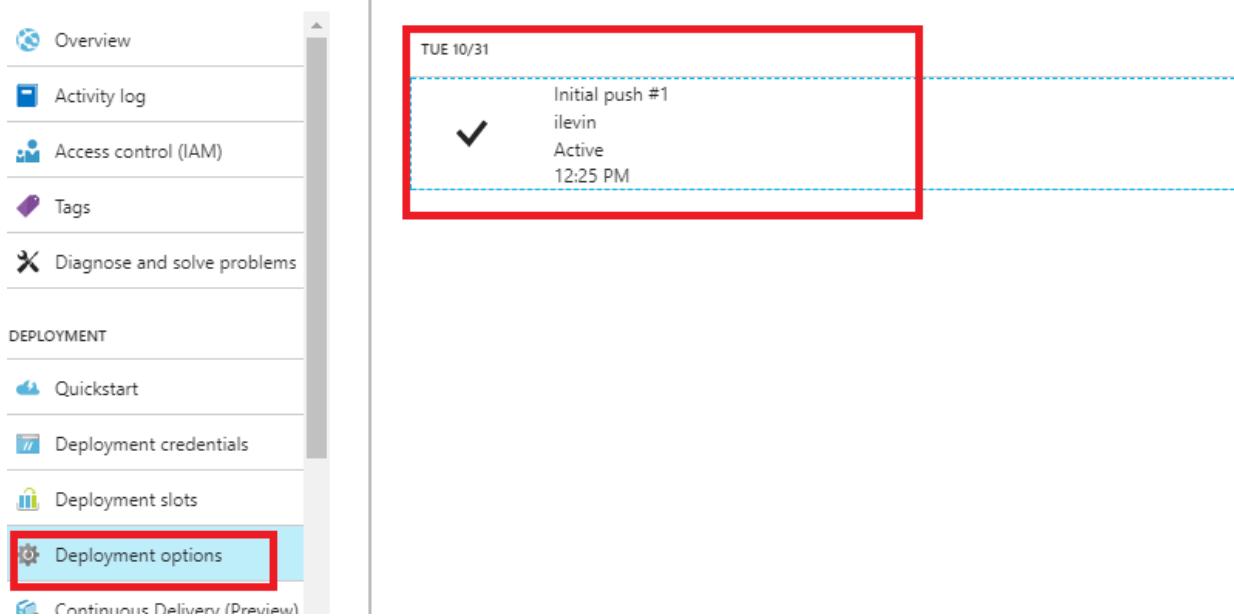
#### NOTE

If collaboration on the project is required, consider pushing to [GitHub](#) before pushing to Azure.

## Verify the Active Deployment

Verify that the web app transfer from the local environment to Azure is successful.

In the [Azure Portal](#), select the web app. Select **Deployment > Deployment options**.



## Run the app in Azure

Now that the web app is deployed to Azure, run the app.

This can be accomplished in two ways:

- In the Azure Portal, locate the web app blade for the web app. Select **Browse** to view the app in the default browser.
- Open a browser and enter the URL for the web app. Example: `http://SampleWebAppDemo.azurewebsites.net`

## Update the web app and republish

After making changes to the local code, republish:

1. In **Solution Explorer** of Visual Studio, open the `Startup.cs` file.
2. In the `Configure` method, modify the `Response.WriteAsync` method so that it appears as follows:

```
await context.Response.WriteAsync("Hello World! Deploy to Azure.");
```

3. Save the changes to `Startup.cs`.
4. In **Solution Explorer**, right-click **Solution 'SampleWebAppDemo'** and select **Commit**. The **Team Explorer** is displayed.
5. Enter a commit message, such as `Update #2`.
6. Press the **Commit** button to commit the project changes.
7. Select **Home > Sync > Actions > Push**.

### NOTE

As an alternative, push the changes from the **Command Window** by opening the **Command Window**, changing to the project directory, and entering a git command. Example:

```
git push -u Azure-SampleApp master
```

## View the updated web app in Azure

View the updated web app by selecting **Browse** from the web app blade in the Azure Portal or by opening a browser and entering the URL for the web app. Example: `http://SampleWebAppDemo.azurewebsites.net`

## Additional resources

- [Use VSTS to Build and Publish to an Azure Web App with Continuous Deployment](#)
- [Project Kudu](#)

# Troubleshoot ASP.NET Core on Azure App Service

6/21/2018 • 8 minutes to read • [Edit Online](#)

By [Luke Latham](#)

## IMPORTANT

### ASP.NET Core preview releases with Azure App Service

ASP.NET Core preview releases aren't deployed to Azure App Service by default. To host an app that uses an ASP.NET Core preview release, see [Deploy ASP.NET Core preview release to Azure App Service](#).

This article provides instructions on how to diagnose an ASP.NET Core app startup issue using Azure App Service's diagnostic tools. For additional troubleshooting advice, see [Azure App Service diagnostics overview](#) and [How to: Monitor Apps in Azure App Service](#) in the Azure documentation.

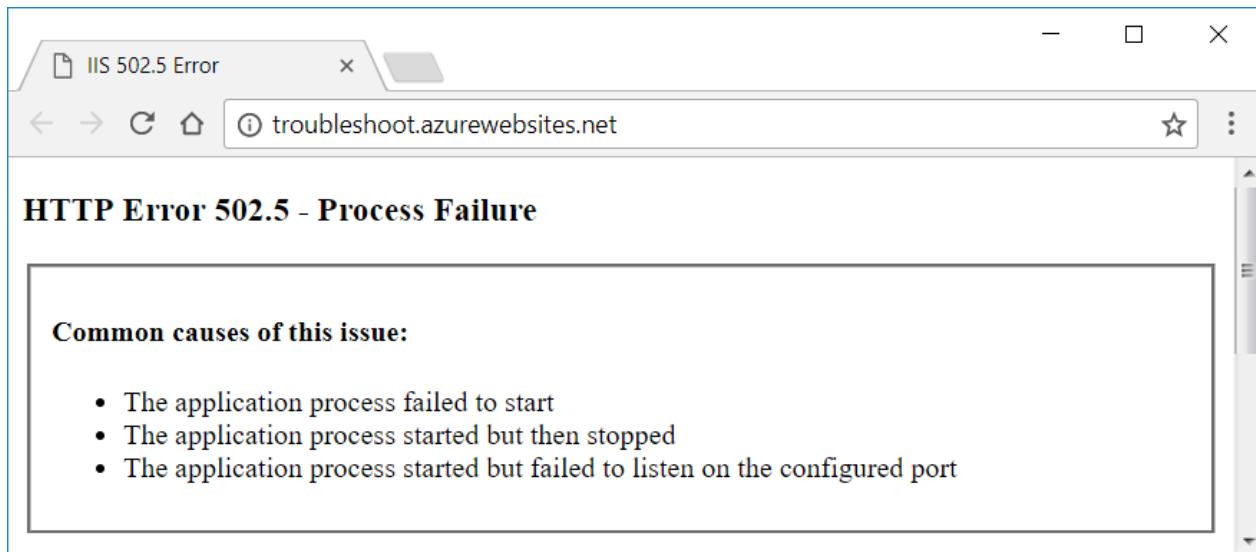
## App startup errors

### 502.5 Process Failure

The worker process fails. The app doesn't start.

The [ASP.NET Core Module](#) attempts to start the worker process but it fails to start. Examining the Application Event Log often helps troubleshoot this type of problem. Accessing the log is explained in the [Application Event Log](#) section.

The *502.5 Process Failure* error page is returned when a misconfigured app causes the worker process to fail:



### 500 Internal Server Error

The app starts, but an error prevents the server from fulfilling the request.

This error occurs within the app's code during startup or while creating a response. The response may contain no content, or the response may appear as a *500 Internal Server Error* in the browser. The Application Event Log usually states that the app started normally. From the server's perspective, that's correct. The app did start, but it can't generate a valid response. [Run the app in the Kudu console](#) or [enable the ASP.NET Core Module stdout log](#) to troubleshoot the problem.

### Connection reset

If an error occurs after the headers are sent, it's too late for the server to send a **500 Internal Server Error** when an error occurs. This often happens when an error occurs during the serialization of complex objects for a response. This type of error appears as a *connection reset* error on the client. [Application logging](#) can help troubleshoot these types of errors.

## Default startup limits

The ASP.NET Core Module is configured with a default *startupTimeLimit* of 120 seconds. When left at the default value, an app may take up to two minutes to start before the module logs a process failure. For information on configuring the module, see [Attributes of the `aspNetCore` element](#).

## Troubleshoot app startup errors

### Application Event Log

To access the Application Event Log, use the **Diagnose and solve problems** blade in the Azure portal :

1. In the Azure portal, open the app's blade in the **App Services** blade.
2. Select the **Diagnose and solve problems** blade.
3. Under **SELECT PROBLEM CATEGORY**, select the **Web App Down** button.
4. Under **Suggested Solutions**, open the pane for **Open Application Event Logs**. Select the **Open Application Event Logs** button.
5. Examine the latest error provided by the *IIS AspNetCoreModule* in the **Source** column.

An alternative to using the **Diagnose and solve problems** blade is to examine the Application Event Log file directly using [Kudu](#):

1. Select the **Advanced Tools** blade in the **DEVELOPMENT TOOLS** area. Select the **Go →** button. The Kudu console opens in a new browser tab or window.
2. Using the navigation bar at the top of the page, open **Debug console** and select **CMD**.
3. Open the **LogFiles** folder.
4. Select the pencil icon next to the *eventlog.xml* file.
5. Examine the log. Scroll to the bottom of the log to see the most recent events.

### Run the app in the Kudu console

Many startup errors don't produce useful information in the Application Event Log. You can run the app in the [Kudu](#) Remote Execution Console to discover the error:

1. Select the **Advanced Tools** blade in the **DEVELOPMENT TOOLS** area. Select the **Go →** button. The Kudu console opens in a new browser tab or window.
2. Using the navigation bar at the top of the page, open **Debug console** and select **CMD**.
3. Open the folders to the path **site > wwwroot**.
4. In the console, run the app by executing the app's assembly.
  - If the app is a [framework-dependent deployment](#), run the app's assembly with *dotnet.exe*. In the following command, substitute the name of the app's assembly for `<assembly_name>`:  
`dotnet .\<assembly_name>.dll`
  - If the app is a [self-contained deployment](#), run the app's executable. In the following command, substitute the name of the app's assembly for `<assembly_name> : <assembly_name>.exe`
5. The console output from the app, showing any errors, is piped to the Kudu console.

### ASP.NET Core Module stdout log

The ASP.NET Core Module stdout log often records useful error messages not found in the Application Event Log. To enable and view stdout logs:

1. Navigate to the **Diagnose and solve problems** blade in the Azure portal.
2. Under **SELECT PROBLEM CATEGORY**, select the **Web App Down** button.
3. Under **Suggested Solutions > Enable Stdout Log Redirection**, select the button to **Open Kudu Console to edit Web.Config**.
4. In the Kudu **Diagnostic Console**, open the folders to the path **site > wwwroot**. Scroll down to reveal the **web.config** file at the bottom of the list.
5. Click the pencil icon next to the **web.config** file.
6. Set **stdoutLogEnabled** to `true` and change the **stdoutLogFile** path to: `\?\%home%\LogFiles\stdout`.
7. Select **Save** to save the updated **web.config** file.
8. Make a request to the app.
9. Return to the Azure portal. Select the **Advanced Tools** blade in the **DEVELOPMENT TOOLS** area. Select the **Go →** button. The Kudu console opens in a new browser tab or window.
10. Using the navigation bar at the top of the page, open **Debug console** and select **CMD**.
11. Select the **LogFiles** folder.
12. Inspect the **Modified** column and select the pencil icon to edit the stdout log with the latest modification date.
13. When the log file opens, the error is displayed.

**Important!** Disable stdout logging when troubleshooting is complete.

1. In the Kudu **Diagnostic Console**, return to the path **site > wwwroot** to reveal the **web.config** file. Open the **web.config** file again by selecting the pencil icon.
2. Set **stdoutLogEnabled** to `false`.
3. Select **Save** to save the file.

#### WARNING

Failure to disable the stdout log can lead to app or server failure. There's no limit on log file size or the number of log files created. Only use stdout logging to troubleshoot app startup problems.

For general logging in an ASP.NET Core app after startup, use a logging library that limits log file size and rotates logs. For more information, see [third-party logging providers](#).

## Common startup errors

See the [ASP.NET Core common errors reference](#). Most of the common problems that prevent app startup are covered in the reference topic.

## Slow or hanging app

When an app responds slowly or hangs on a request, see [Troubleshoot slow web app performance issues in Azure App Service](#) for debugging guidance.

## Remote debugging

See the following topics:

- [Remote debugging web apps section of Troubleshoot a web app in Azure App Service using Visual Studio](#) (Azure documentation)
- [Remote Debug ASP.NET Core on IIS in Azure in Visual Studio 2017](#) (Visual Studio documentation)

## Application Insights

[Application Insights](#) provides telemetry from apps hosted in the Azure App Service, including error logging and reporting features. Application Insights can only report on errors that occur after the app starts when the app's logging features become available. For more information, see [Application Insights for ASP.NET Core](#).

## Monitoring blades

Monitoring blades provide an alternative troubleshooting experience to the methods described earlier in the topic. These blades can be used to diagnose 500-series errors.

Confirm that the ASP.NET Core Extensions are installed. If the extensions aren't installed, install them manually:

1. In the **DEVELOPMENT TOOLS** blade section, select the **Extensions** blade.
2. The **ASP.NET Core Extensions** should appear in the list.
3. If the extensions aren't installed, select the **Add** button.
4. Choose the **ASP.NET Core Extensions** from the list.
5. Select **OK** to accept the legal terms.
6. Select **OK** on the **Add extension** blade.
7. An informational pop-up message indicates when the extensions are successfully installed.

If stdout logging isn't enabled, follow these steps:

1. In the Azure portal, select the **Advanced Tools** blade in the **DEVELOPMENT TOOLS** area. Select the **Go→** button. The Kudu console opens in a new browser tab or window.
2. Using the navigation bar at the top of the page, open **Debug console** and select **CMD**.
3. Open the folders to the path **site > wwwroot** and scroll down to reveal the *web.config* file at the bottom of the list.
4. Click the pencil icon next to the *web.config* file.
5. Set **stdoutLogEnabled** to `true` and change the **stdoutLogFile** path to: `\?\%home%\LogFiles\stdout`.
6. Select **Save** to save the updated *web.config* file.

Proceed to activate diagnostic logging:

1. In the Azure portal, select the **Diagnostics logs** blade.
2. Select the **On** switch for **Application Logging (Filesystem)** and **Detailed error messages**. Select the **Save** button at the top of the blade.
3. To include failed request tracing, also known as Failed Request Event Buffering (FREB) logging, select the **On** switch for **Failed request tracing**.
4. Select the **Log stream** blade, which is listed immediately under the **Diagnostics logs** blade in the portal.
5. Make a request to the app.
6. Within the log stream data, the cause of the error is indicated.

**Important!** Be sure to disable stdout logging when troubleshooting is complete. See the instructions in the [ASP.NET Core Module stdout log](#) section.

To view the failed request tracing logs (FREB logs):

1. Navigate to the **Diagnose and solve problems** blade in the Azure portal.
2. Select **Failed Request Tracing Logs** from the **SUPPORT TOOLS** area of the sidebar.

See [Failed request traces section of the Enable diagnostics logging for web apps in Azure App Service topic](#) and the [Application performance FAQs for Web Apps in Azure: How do I turn on failed request tracing?](#) for more information.

For more information, see [Enable diagnostics logging for web apps in Azure App Service](#).

#### **WARNING**

Failure to disable the stdout log can lead to app or server failure. There's no limit on log file size or the number of log files created.

For routine logging in an ASP.NET Core app, use a logging library that limits log file size and rotates logs. For more information, see [third-party logging providers](#).

## Additional resources

- [Introduction to Error Handling in ASP.NET Core](#)
- [Common errors reference for Azure App Service and IIS with ASP.NET Core](#)
- [Troubleshoot a web app in Azure App Service using Visual Studio](#)
- [Troubleshoot HTTP errors of "502 bad gateway" and "503 service unavailable" in your Azure web apps](#)
- [Troubleshoot slow web app performance issues in Azure App Service](#)
- [Application performance FAQs for Web Apps in Azure](#)
- [Azure Web App sandbox \(App Service runtime execution limitations\)](#)
- [Azure Friday: Azure App Service Diagnostic and Troubleshooting Experience \(12-minute video\)](#)

# Host ASP.NET Core on Windows with IIS

7/11/2018 • 18 minutes to read • [Edit Online](#)

By [Luke Latham](#) and [Rick Anderson](#)

## Supported operating systems

The following operating systems are supported:

- Windows 7 or later
- Windows Server 2008 R2 or later

[HTTP.sys server](#) (formerly called [WebListener](#)) doesn't work in a reverse proxy configuration with IIS. Use the [Kestrel server](#).

## Application configuration

### Enable the IISIntegration components

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

A typical `Program.cs` calls `CreateDefaultBuilder` to begin setting up a host. `CreateDefaultBuilder` configures [Kestrel](#) as the web server and enables IIS integration by configuring the base path and port for the [ASP.NET Core Module](#):

```
public static IWebHost BuildWebHost(string[] args) =>
    WebHost.CreateDefaultBuilder(args)
    ...
}
```

The ASP.NET Core Module generates a dynamic port to assign to the back-end process. `CreateDefaultBuilder` calls the `UseIISIntegration` method, which picks up the dynamic port and configures Kestrel to listen on `http://localhost:{dynamicPort}/`. This overrides other URL configurations, such as calls to `UseUrls` or [Kestrel's Listen API](#). Therefore, calls to `UseUrls` or Kestrel's `Listen` API aren't required when using the module. If `UseUrls` or `Listen` is called, Kestrel listens on the port specified when running the app without IIS.

For more information on hosting, see [Host in ASP.NET Core](#).

### IIS options

To configure IIS options, include a service configuration for `IISOptions` in `ConfigureServices`. In the following example, forwarding client certificates to the app to populate `HttpContext.Connection.ClientCertificate` is disabled:

```
services.Configure<IISSettings>(options =>
{
    options.ForwardClientCertificate = false;
});
```

OPTION	DEFAULT	SETTING
--------	---------	---------

OPTION	DEFAULT	SETTING
<code>AutomaticAuthentication</code>	<code>true</code>	If <code>true</code> , IIS Integration Middleware sets the <code>HttpContext.User</code> authenticated by <a href="#">Windows Authentication</a> . If <code>false</code> , the middleware only provides an identity for <code>HttpContext.User</code> and responds to challenges when explicitly requested by the <code>AuthenticationScheme</code> . Windows Authentication must be enabled in IIS for <code>AutomaticAuthentication</code> to function. For more information, see the <a href="#">Windows Authentication</a> topic.
<code>AuthenticationDisplayName</code>	<code>null</code>	Sets the display name shown to users on login pages.
<code>ForwardClientCertificate</code>	<code>true</code>	If <code>true</code> and the <code>MS-ASPNETCORE-CLIENTCERT</code> request header is present, the <code>HttpContext.Connection.ClientCertificate</code> is populated.

## Proxy server and load balancer scenarios

The IIS Integration Middleware, which configures Forwarded Headers Middleware, and the ASP.NET Core Module are configured to forward the scheme (HTTP/HTTPS) and the remote IP address where the request originated. Additional configuration might be required for apps hosted behind additional proxy servers and load balancers. For more information, see [Configure ASP.NET Core to work with proxy servers and load balancers](#).

### web.config file

The `web.config` file configures the [ASP.NET Core Module](#). Creating, transforming, and publishing the `web.config` file is handled by an MSBuild target (`_TransformWebConfig`) when the project is published. This target is present in the Web SDK targets (`Microsoft.NET.Sdk.Web`). The SDK is set at the top of the project file:

```
<Project Sdk="Microsoft.NET.Sdk.Web">
```

If a `web.config` file isn't present in the project, the file is created with the correct `processPath` and `arguments` to configure the [ASP.NET Core Module](#) and moved to [published output](#).

If a `web.config` file is present in the project, the file is transformed with the correct `processPath` and `arguments` to configure the ASP.NET Core Module and moved to published output. The transformation doesn't modify IIS configuration settings in the file.

The `web.config` file may provide additional IIS configuration settings that control active IIS modules. For information on IIS modules that are capable of processing requests with ASP.NET Core apps, see the [IIS modules](#) topic.

To prevent the Web SDK from transforming the `web.config` file, use the `<IsTransformWebConfigDisabled>` property in the project file:

```
<PropertyGroup>
  <IsTransformWebConfigDisabled>true</IsTransformWebConfigDisabled>
</PropertyGroup>
```

When disabling the Web SDK from transforming the file, the `processPath` and `arguments` should be manually set by the developer. For more information, see the [ASP.NET Core Module configuration reference](#).

## web.config file location

In order to create the reverse proxy between IIS and the Kestrel server, the `web.config` file must be present at the content root path (typically the app base path) of the deployed app. This is the same location as the website physical path provided to IIS. The `web.config` file is required at the root of the app to enable the publishing of multiple apps using Web Deploy.

Sensitive files exist on the app's physical path, such as `<assembly>.runtimeconfig.json`, `<assembly>.xml` (XML Documentation comments), and `<assembly>.deps.json`. When the `web.config` file is present and the site starts normally, IIS doesn't serve these sensitive files if they're requested. If the `web.config` file is missing, incorrectly named, or unable to configure the site for normal startup, IIS may serve sensitive files publicly.

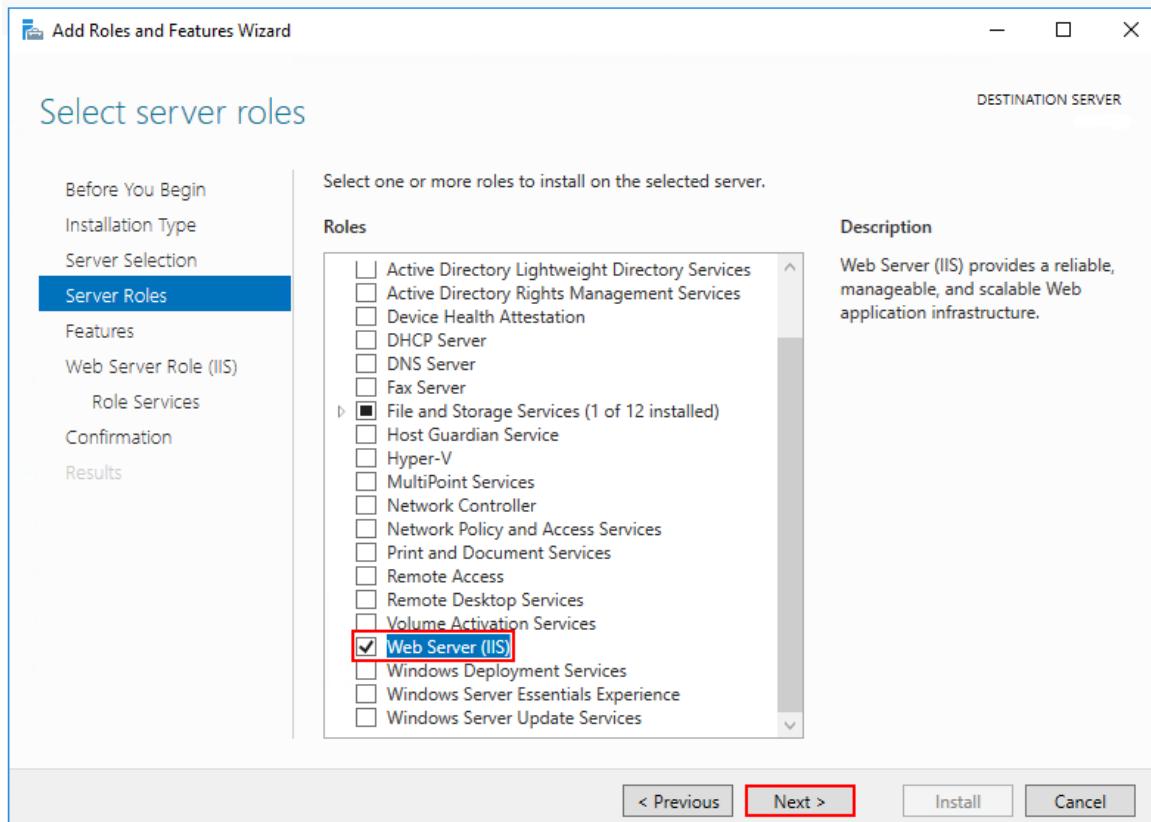
**The `web.config` file must be present in the deployment at all times, correctly named, and able to configure the site for normal start up. Never remove the `web.config` file from a production deployment.**

## IIS configuration

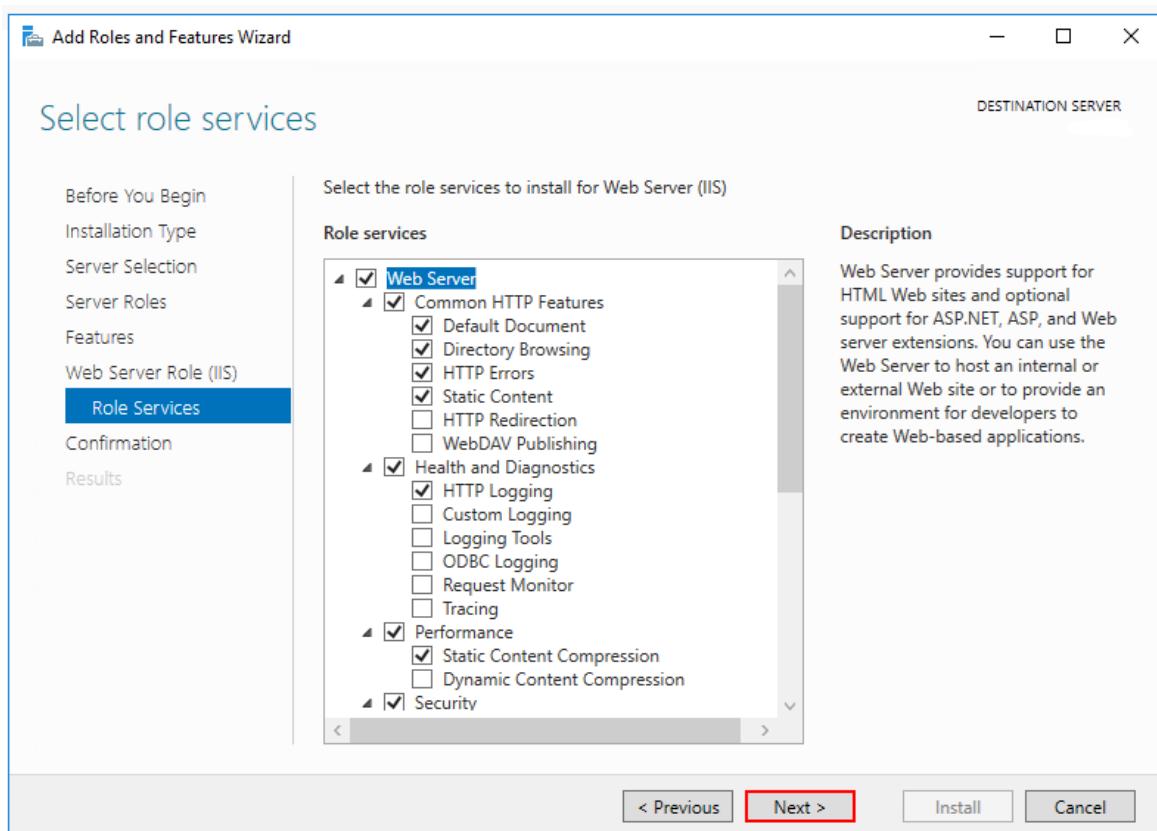
### Windows Server operating systems

Enable the **Web Server (IIS)** server role and establish role services.

1. Use the **Add Roles and Features** wizard from the **Manage** menu or the link in **Server Manager**. On the **Server Roles** step, check the box for **Web Server (IIS)**.



2. After the **Features** step, the **Role services** step loads for Web Server (IIS). Select the IIS role services desired or accept the default role services provided.



### Windows Authentication (Optional)

To enable Windows Authentication, expand the following nodes: **Web Server > Security**. Select the **Windows Authentication** feature. For more information, see [Windows Authentication <windowsAuthentication>](#) and [Configure Windows authentication](#).

### WebSockets (Optional)

WebSockets is supported with ASP.NET Core 1.1 or later. To enable WebSockets, expand the following nodes: **Web Server > Application Development**. Select the **WebSocket Protocol** feature. For more information, see [WebSockets](#).

3. Proceed through the **Confirmation** step to install the web server role and services. A server/IIS restart isn't required after installing the **Web Server (IIS)** role.

### Windows desktop operating systems

Enable the **IIS Management Console** and **World Wide Web Services**.

1. Navigate to **Control Panel > Programs > Programs and Features > Turn Windows features on or off** (left side of the screen).
2. Open the **Internet Information Services** node. Open the **Web Management Tools** node.
3. Check the box for **IIS Management Console**.
4. Check the box for **World Wide Web Services**.
5. Accept the default features for **World Wide Web Services** or customize the IIS features.

### Windows Authentication (Optional)

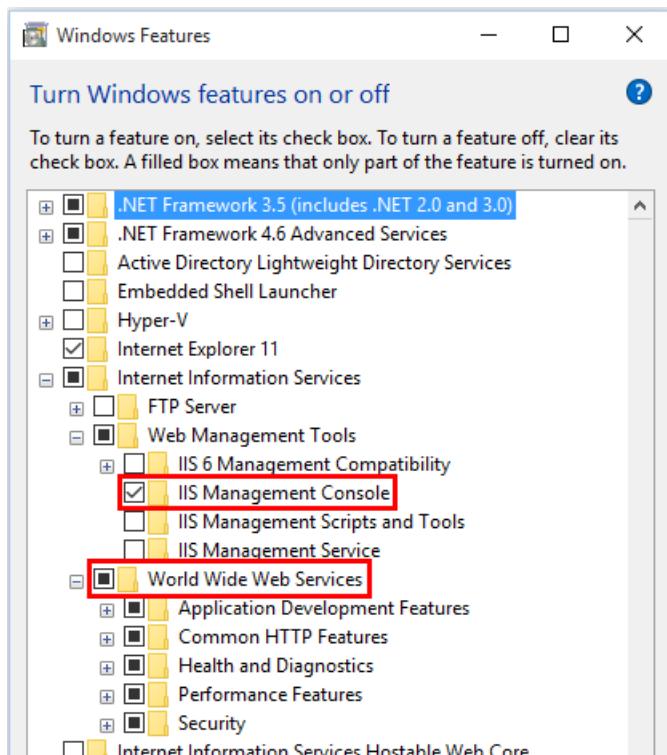
To enable Windows Authentication, expand the following nodes: **World Wide Web Services > Security**. Select the **Windows Authentication** feature. For more information, see [Windows Authentication <windowsAuthentication>](#) and [Configure Windows authentication](#).

### WebSockets (Optional)

WebSockets is supported with ASP.NET Core 1.1 or later. To enable WebSockets, expand the following

nodes: **World Wide Web Services > Application Development Features**. Select the **WebSocket Protocol** feature. For more information, see [WebSockets](#).

6. If the IIS installation requires a restart, restart the system.



## Install the .NET Core Hosting Bundle

1. Install the *.NET Core Hosting Bundle* on the hosting system. The bundle installs the .NET Core Runtime, .NET Core Library, and the [ASP.NET Core Module](#). The module creates the reverse proxy between IIS and the Kestrel server. If the system doesn't have an Internet connection, obtain and install the [Microsoft Visual C++ 2015 Redistributable](#) before installing the .NET Core Hosting Bundle.

- a. Navigate to the [.NET All Downloads page](#).
- b. In the **Runtime** column of the table, select the latest non-preview .NET Core runtime from the list (**X.Y Runtime (vX.Y.Z) downloads**). The latest runtime has a **Current** label. Unless you intend to work with preview software, avoid a runtime with the word "preview" or "rc" (Release Candidate) in its link text.
- c. On the .NET Core runtime download page under **Windows**, select the **Hosting Bundle Installer** link to download the *.NET Core Hosting Bundle* installer.
- d. Run the installer on the server.

**Important!** If the Hosting Bundle is installed before IIS, the bundle installation must be repaired. Run the Hosting Bundle installer again after installing IIS.

To prevent the installer from installing x86 packages on an x64 OS, run the installer from an administrator command prompt with the switch `OPT_NO_X86=1`.

2. Restart the system or execute `net stop was /y` followed by `net start w3svc` from a command prompt. Restarting IIS picks up a change to the system PATH, which is an environment variable, made by the installer.

### NOTE

For information on IIS Shared Configuration, see [ASP.NET Core Module with IIS Shared Configuration](#).

# Install Web Deploy when publishing with Visual Studio

When deploying apps to servers with [Web Deploy](#), install the latest version of Web Deploy on the server. To install Web Deploy, use the [Web Platform Installer \(WebPI\)](#) or obtain an installer directly from the [Microsoft Download Center](#). The preferred method is to use WebPI. WebPI offers a standalone setup and a configuration for hosting providers.

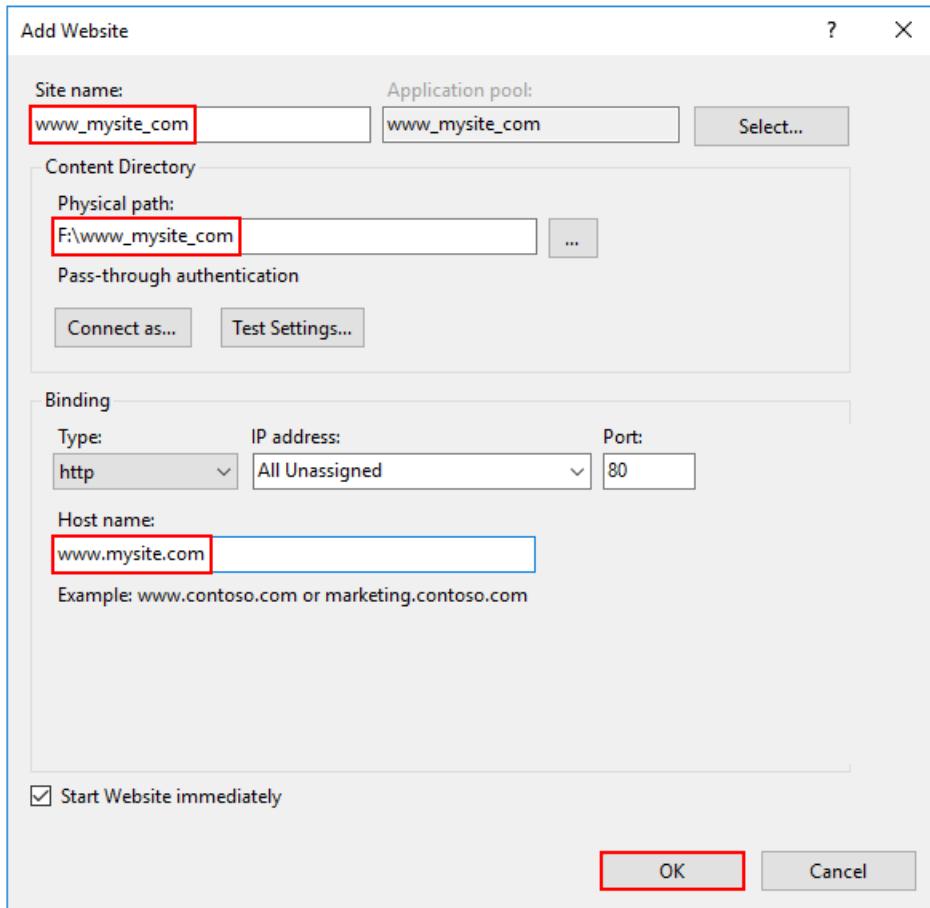
## Create the IIS site

1. On the hosting system, create a folder to contain the app's published folders and files. An app's deployment layout is described in the [Directory Structure](#) topic.
2. Within the new folder, create a *logs* folder to hold ASP.NET Core Module stdout logs when stdout logging is enabled. If the app is deployed with a *logs* folder in the payload, skip this step. For instructions on how to enable MSBuild to create the *logs* folder automatically when the project is built locally, see the [Directory structure](#) topic.

### IMPORTANT

Only use the stdout log to troubleshoot app startup failures. Never use stdout logging for routine app logging. There's no limit on log file size or the number of log files created. The app pool must have write access to the location where the logs are written. All of the folders on the path to the log location must exist. For more information on the stdout log, see [Log creation and redirection](#). For information on logging in an ASP.NET Core app, see the [Logging](#) topic.

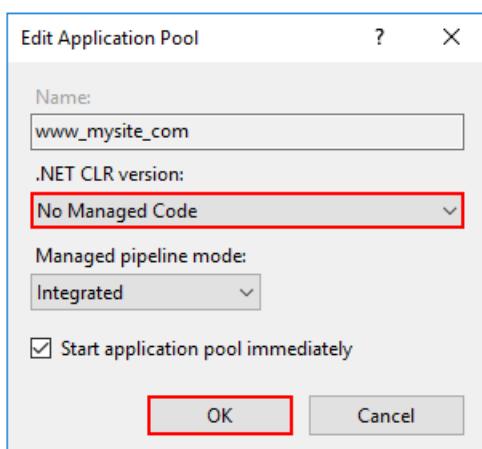
3. In **IIS Manager**, open the server's node in the **Connections** panel. Right-click the **Sites** folder. Select **Add Website** from the contextual menu.
4. Provide a **Site name** and set the **Physical path** to the app's deployment folder. Provide the **Binding** configuration and create the website by selecting **OK**:



#### WARNING

Top-level wildcard bindings (`http://*:80/` and `http://+:80`) should **not** be used. Top-level wildcard bindings can open up your app to security vulnerabilities. This applies to both strong and weak wildcards. Use explicit host names rather than wildcards. Subdomain wildcard binding (for example, `*.mysub.com`) doesn't have this security risk if you control the entire parent domain (as opposed to `*.com`, which is vulnerable). See [rfc7230 section-5.4](#) for more information.

5. Under the server's node, select **Application Pools**.
6. Right-click the site's app pool and select **Basic Settings** from the contextual menu.
7. In the **Edit Application Pool** window, set the **.NET CLR version** to **No Managed Code**:



ASP.NET Core runs in a separate process and manages the runtime. ASP.NET Core doesn't rely on loading the desktop CLR. Setting the **.NET CLR version** to **No Managed Code** is optional.

8. Confirm the process model identity has the proper permissions.

If the default identity of the app pool (**Process Model > Identity**) is changed from **ApplicationPoolIdentity** to another identity, verify that the new identity has the required permissions to access the app's folder, database, and other required resources. For example, the app pool requires read and write access to folders where the app reads and writes files.

### Windows Authentication configuration (Optional)

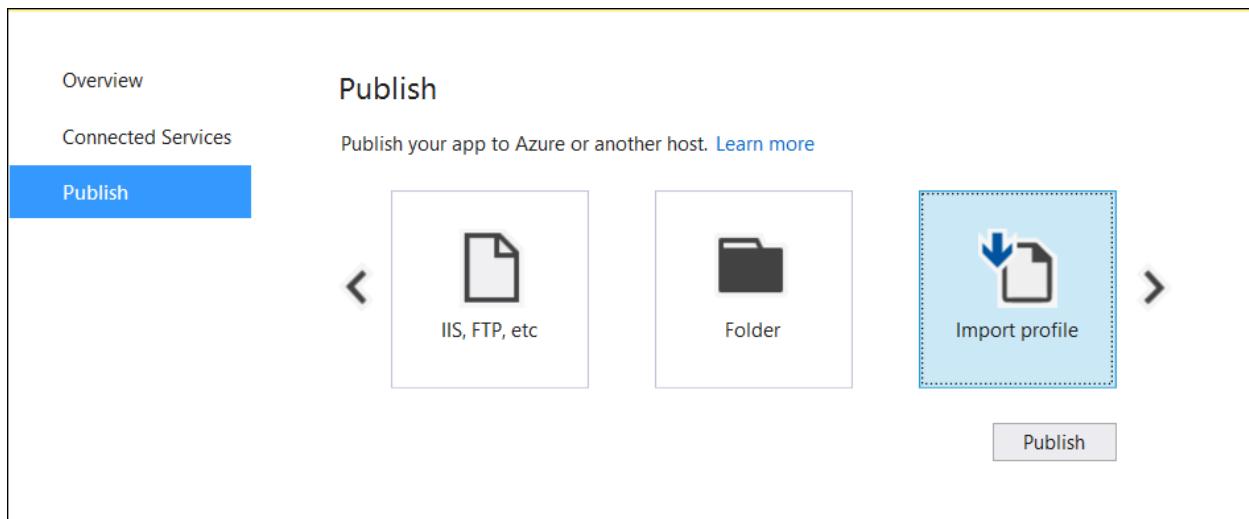
For more information, see [Configure Windows authentication](#).

## Deploy the app

Deploy the app to the folder created on the hosting system. [Web Deploy](#) is the recommended mechanism for deployment.

### Web Deploy with Visual Studio

See the [Visual Studio publish profiles for ASP.NET Core app deployment](#) topic to learn how to create a publish profile for use with Web Deploy. If the hosting provider provides a Publish Profile or support for creating one, download their profile and import it using the Visual Studio **Publish** dialog.



### Web Deploy outside of Visual Studio

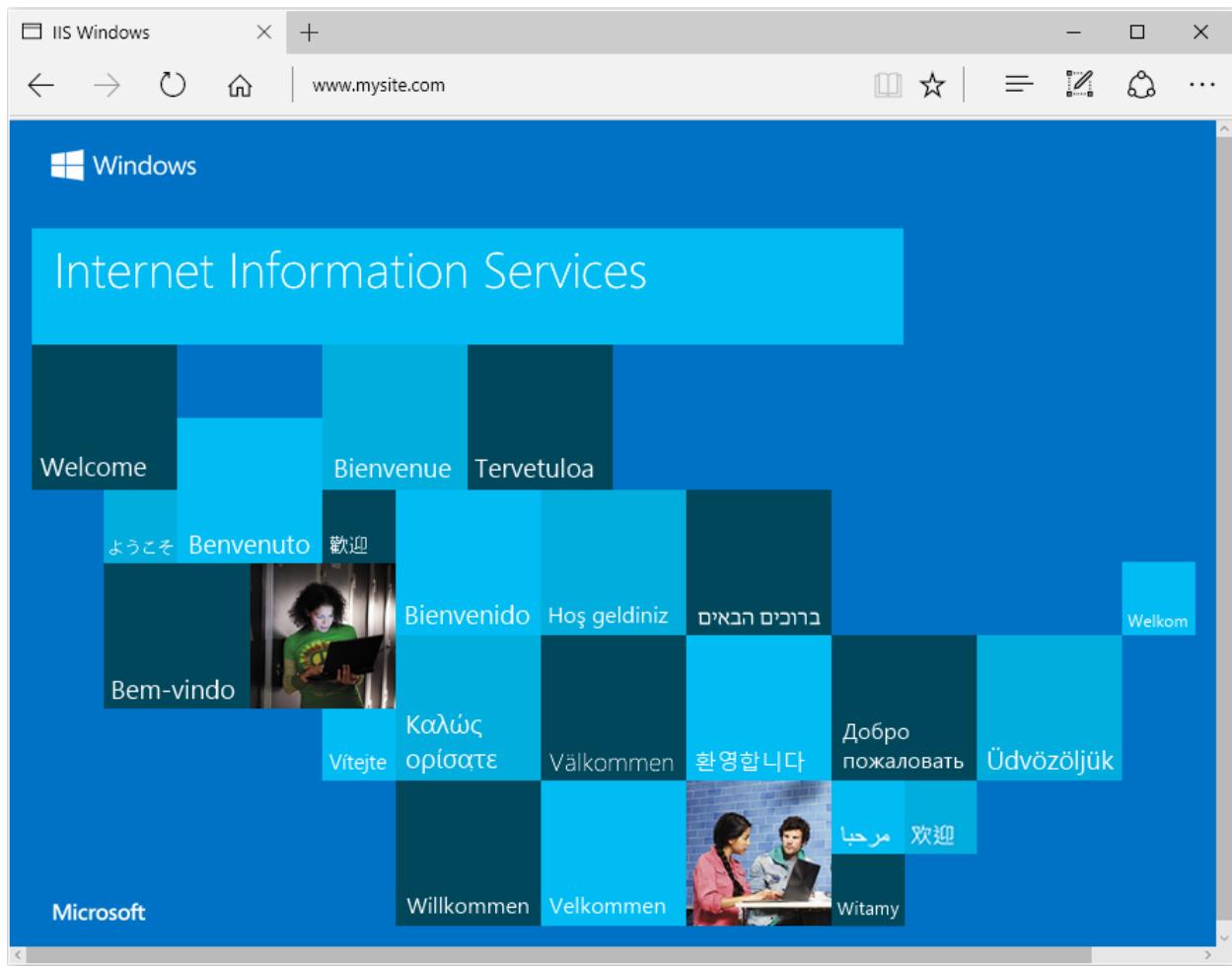
[Web Deploy](#) can also be used outside of Visual Studio from the command line. For more information, see [Web Deployment Tool](#).

### Alternatives to Web Deploy

Use any of several methods to move the app to the hosting system, such as manual copy, Xcopy, Robocopy, or PowerShell.

For more information on ASP.NET Core deployment to IIS, see the [Deployment resources for IIS administrators](#) section.

## Browse the website



## Locked deployment files

Files in the deployment folder are locked when the app is running. Locked files can't be overwritten during deployment. To release locked files in a deployment, stop the app pool using **one** of the following approaches:

- Use Web Deploy and reference `Microsoft.NET.Sdk.Web` in the project file. An `app_offline.htm` file is placed at the root of the web app directory. When the file is present, the ASP.NET Core Module gracefully shuts down the app and serves the `app_offline.htm` file during the deployment. For more information, see the [ASP.NET Core Module configuration reference](#).
- Manually stop the app pool in the IIS Manager on the server.
- Use PowerShell to stop and restart the app pool (requires PowerShell 5 or later):

```

$webAppPoolName = 'APP_POOL_NAME'

# Stop the AppPool
if((Get-WebAppPoolState $webAppPoolName).Value -ne 'Stopped') {
    Stop-WebAppPool -Name $webAppPoolName
    while((Get-WebAppPoolState $webAppPoolName).Value -ne 'Stopped') {
        Start-Sleep -s 1
    }
    Write-Host `'-AppPool Stopped
}

# Provide script commands here to deploy the app

# Restart the AppPool
if((Get-WebAppPoolState $webAppPoolName).Value -ne 'Started') {
    Start-WebAppPool -Name $webAppPoolName
    while((Get-WebAppPoolState $webAppPoolName).Value -ne 'Started') {
        Start-Sleep -s 1
    }
    Write-Host `'-AppPool Started
}

```

## Data protection

The [ASP.NET Core Data Protection stack](#) is used by several ASP.NET Core [middlewares](#), including middleware used in authentication. Even if Data Protection APIs aren't called by user code, data protection should be configured with a deployment script or in user code to create a persistent cryptographic [key store](#). If data protection isn't configured, the keys are held in memory and discarded when the app restarts.

If the key ring is stored in memory when the app restarts:

- All cookie-based authentication tokens are invalidated.
- Users are required to sign in again on their next request.
- Any data protected with the key ring can no longer be decrypted. This may include [CSRF tokens](#) and [ASP.NET Core MVC TempData cookies](#).

To configure data protection under IIS to persist the key ring, use **one** of the following approaches:

- **Create Data Protection Registry Keys**

Data protection keys used by ASP.NET Core apps are stored in the registry external to the apps. To persist the keys for a given app, create registry keys for the app pool.

For standalone, non-webfarm IIS installations, the [Data Protection Provision-AutoGenKeys.ps1 PowerShell script](#) can be used for each app pool used with an ASP.NET Core app. This script creates a registry key in the HKLM registry that's accessible only to the worker process account of the app's app pool. Keys are encrypted at rest using DPAPI with a machine-wide key.

In web farm scenarios, an app can be configured to use a UNC path to store its data protection key ring. By default, the data protection keys aren't encrypted. Ensure that the file permissions for the network share are limited to the Windows account the app runs under. An X509 certificate can be used to protect keys at rest. Consider a mechanism to allow users to upload certificates: Place certificates into the user's trusted certificate store and ensure they're available on all machines where the user's app runs. See [Configure ASP.NET Core Data Protection](#) for details.

- **Configure the IIS Application Pool to load the user profile**

This setting is in the **Process Model** section under the **Advanced Settings** for the app pool. Set Load User Profile to  True. This stores keys under the user profile directory and protects them using DPAPI

with a key specific to the user account used by the app pool.

- **Use the file system as a key ring store**

Adjust the app code to [use the file system as a key ring store](#). Use an X509 certificate to protect the key ring and ensure the certificate is a trusted certificate. If the certificate is self-signed, place the certificate in the Trusted Root store.

When using IIS in a web farm:

- Use a file share that all machines can access.
- Deploy an X509 certificate to each machine. Configure [data protection in code](#).

- **Set a machine-wide policy for data protection**

The data protection system has limited support for setting a default [machine-wide policy](#) for all apps that consume the Data Protection APIs. See the [data protection documentation](#) for details.

## Sub-application configuration

Sub-apps added under the root app shouldn't include the ASP.NET Core Module as a handler. If the module is added as a handler in a sub-app's *web.config* file, a *500.19 Internal Server Error* referencing the faulty config file is received when attempting to browse the sub-app.

The following example shows a published *web.config* file for an ASP.NET Core sub-app:

```
<?xml version="1.0" encoding="utf-8"?>
<configuration>
  <system.webServer>
    <aspNetCore processPath="dotnet"
      arguments=".\\<assembly_name>.dll"
      stdoutLogEnabled="false"
      stdoutLogFile=".\\logs\\stdout" />
  </system.webServer>
</configuration>
```

When hosting a non-ASP.NET Core sub-app underneath an ASP.NET Core app, explicitly remove the inherited handler in the sub-app *web.config* file:

```
<?xml version="1.0" encoding="utf-8"?>
<configuration>
  <system.webServer>
    <handlers>
      <remove name="aspNetCore" />
    </handlers>
    <aspNetCore processPath="dotnet"
      arguments=".\\<assembly_name>.dll"
      stdoutLogEnabled="false"
      stdoutLogFile=".\\logs\\stdout" />
  </system.webServer>
</configuration>
```

For more information on configuring the ASP.NET Core Module, see the [Introduction to ASP.NET Core Module](#) topic and the [ASP.NET Core Module configuration reference](#).

## Configuration of IIS with *web.config*

IIS configuration is influenced by the **<system.webServer>** section of *web.config* for those IIS features that apply to a reverse proxy configuration. If IIS is configured at the server level to use dynamic compression, the **<urlCompression>** element in the app's *web.config* file can disable it.

For more information, see the [configuration reference for <system.webServer>](#), [ASP.NET Core Module Configuration Reference](#), and [IIS Modules with ASP.NET Core](#). To set environment variables for individual apps running in isolated app pools (supported for IIS 10.0 or later), see the *AppCmd.exe command* section of the [Environment Variables <environmentVariables>](#) topic in the IIS reference documentation.

## Configuration sections of web.config

Configuration sections of ASP.NET 4.x apps in *web.config* aren't used by ASP.NET Core apps for configuration:

- **<system.web>**
- **<appSettings>**
- **<connectionStrings>**
- **<location>**

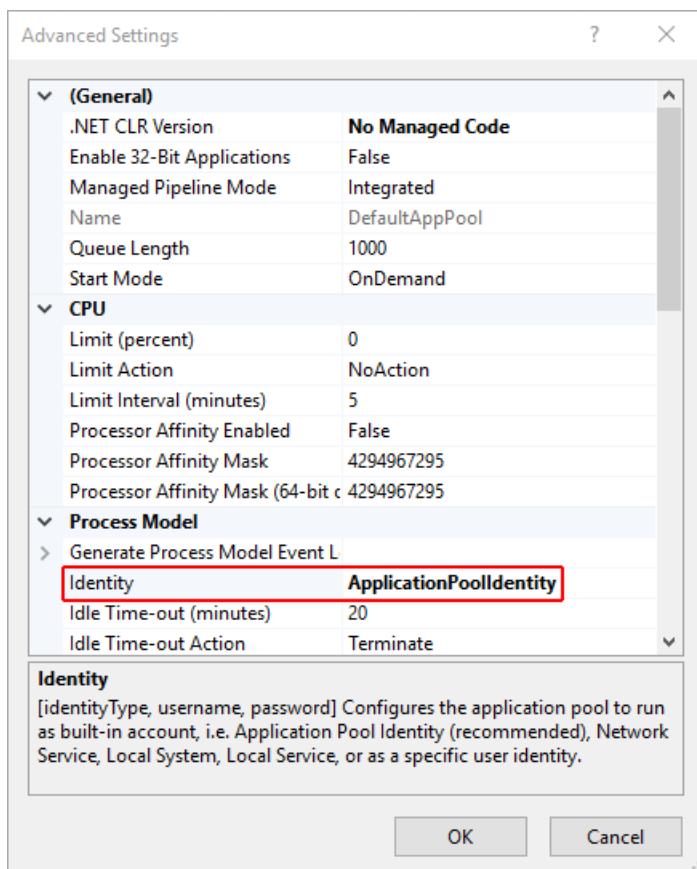
ASP.NET Core apps are configured using other configuration providers. For more information, see [Configuration](#).

## Application Pools

When hosting multiple websites on a server, we recommend isolating the apps from each other by running each app in its own app pool. The IIS **Add Website** dialog defaults to this configuration. When **Site name** is provided, the text is automatically transferred to the **Application pool** textbox. A new app pool is created using the site name when the site is added.

## Application Pool Identity

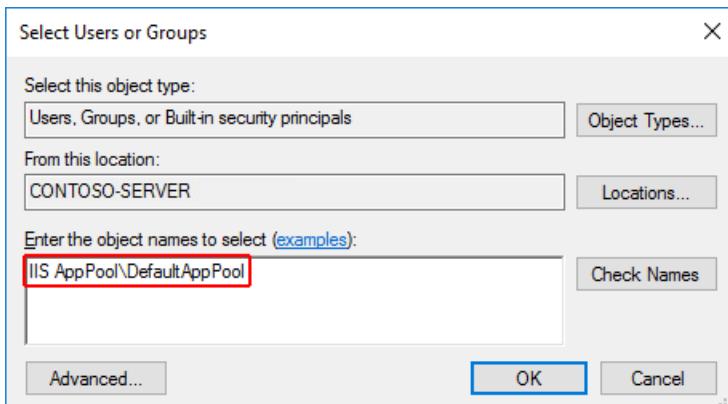
An app pool identity account allows an app to run under a unique account without having to create and manage domains or local accounts. On IIS 8.0 or later, the IIS Admin Worker Process (WAS) creates a virtual account with the name of the new app pool and runs the app pool's worker processes under this account by default. In the IIS Management Console under **Advanced Settings** for the app pool, ensure that the **Identity** is set to use **ApplicationPoolIdentity**:



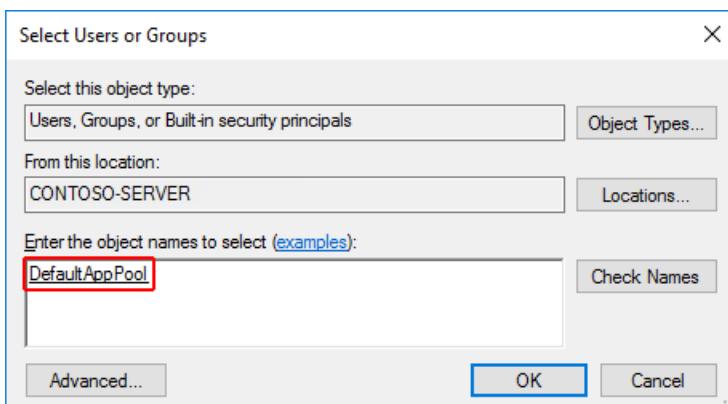
The IIS management process creates a secure identifier with the name of the app pool in the Windows Security System. Resources can be secured using this identity. However, this identity isn't a real user account and doesn't show up in the Windows User Management Console.

If the IIS worker process requires elevated access to the app, modify the Access Control List (ACL) for the directory containing the app:

1. Open Windows Explorer and navigate to the directory.
2. Right-click on the directory and select **Properties**.
3. Under the **Security** tab, select the **Edit** button and then the **Add** button.
4. Select the **Locations** button and make sure the system is selected.
5. Enter **IIS AppPool\<app\_pool\_name>** in **Enter the object names to select** area. Select the **Check Names** button. For the *DefaultAppPool* check the names using **IIS AppPool\DefaultAppPool**. When the **Check Names** button is selected, a value of **DefaultAppPool** is indicated in the object names area. It isn't possible to enter the app pool name directly into the object names area. Use the **IIS AppPool\<app\_pool\_name>** format when checking for the object name.



6. Select **OK**.



7. Read & execute permissions should be granted by default. Provide additional permissions as needed.

Access can also be granted at a command prompt using the **ICACLS** tool. Using the *DefaultAppPool* as an example, the following command is used:

```
ICACLS C:\sites\MyWebApp /grant "IIS AppPool\DefaultAppPool":F
```

For more information, see the [icacls](#) topic.

## Deployment resources for IIS administrators

Learn about IIS in-depth in the IIS documentation.

[IIS documentation](#)

Learn about .NET Core app deployment models.

[.NET Core application deployment](#)

Learn how the ASP.NET Core Module allows the Kestrel web server to use IIS or IIS Express as a reverse proxy server.

[ASP.NET Core Module](#)

Learn how to configure the ASP.NET Core Module for hosting ASP.NET Core apps.

[ASP.NET Core Module configuration reference](#)

Learn about the directory structure of published ASP.NET Core apps.

[Directory structure](#)

Discover active and inactive IIS modules for ASP.NET Core apps and how to manage IIS modules.

[IIS modules](#)

Learn how to diagnose problems with IIS deployments of ASP.NET Core apps.

[Troubleshoot](#)

Distinguish common errors when hosting ASP.NET Core apps on IIS.

[Common errors reference for Azure App Service and IIS](#)

## Additional resources

- [Introduction to ASP.NET Core](#)
- [The Official Microsoft IIS Site](#)
- [Windows Server technical content library](#)

# Troubleshoot ASP.NET Core on IIS

7/10/2018 • 7 minutes to read • [Edit Online](#)

By [Luke Latham](#)

This article provides instructions on how to diagnose an ASP.NET Core app startup issue when hosting with [Internet Information Services \(IIS\)](#). The information in this article applies to hosting in IIS on Windows Server and Windows Desktop.

In Visual Studio, an ASP.NET Core project defaults to [IIS Express](#) hosting during debugging. A [502.5 Process Failure](#) that occurs when debugging locally can be troubleshooted using the advice in this topic.

Additional troubleshooting topics:

## [Troubleshoot ASP.NET Core on Azure App Service](#)

Although App Service uses the [ASP.NET Core Module](#) and IIS to host apps, see the dedicated topic for instructions specific to App Service.

## [Handle errors](#)

Discover how to handle errors in ASP.NET Core apps during development on a local system.

## [Learn to debug using Visual Studio](#)

This topic introduces the features of the Visual Studio debugger.

## [Debugging with Visual Studio Code](#)

Learn about the debugging support built into Visual Studio Code.

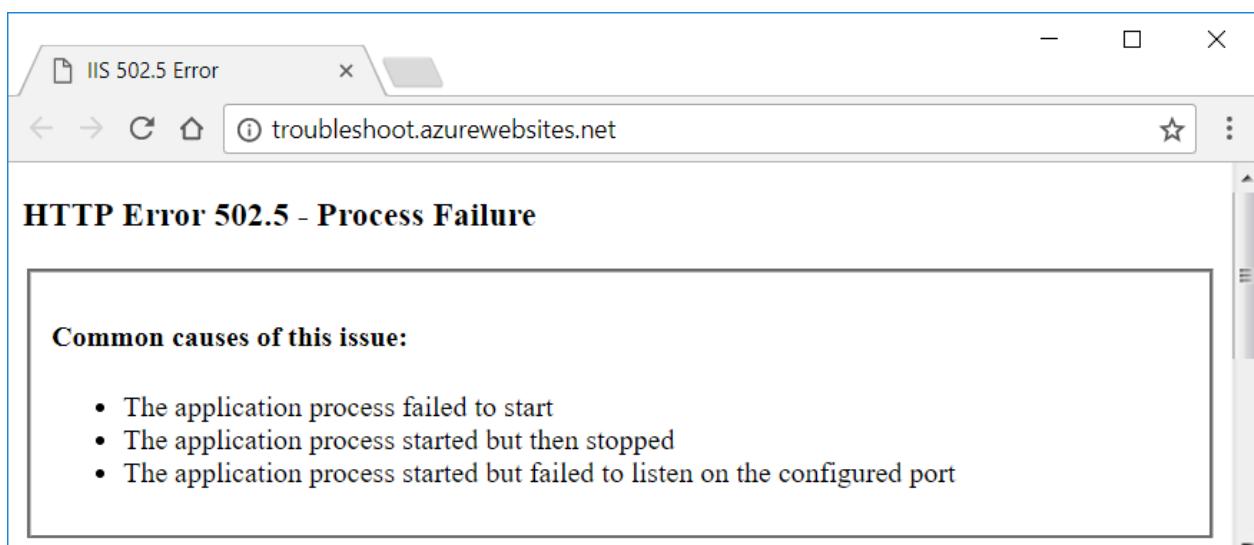
## App startup errors

### **502.5 Process Failure**

The worker process fails. The app doesn't start.

The ASP.NET Core Module attempts to start the worker process but it fails to start. The cause of a process startup failure can usually be determined from entries in the [Application Event Log](#) and the [ASP.NET Core Module stdout log](#).

The [502.5 Process Failure](#) error page is returned when a hosting or app misconfiguration causes the worker process to fail:



## 500 Internal Server Error

The app starts, but an error prevents the server from fulfilling the request.

This error occurs within the app's code during startup or while creating a response. The response may contain no content, or the response may appear as a *500 Internal Server Error* in the browser. The Application Event Log usually states that the app started normally. From the server's perspective, that's correct. The app did start, but it can't generate a valid response. [Run the app at a command prompt](#) on the server or [enable the ASP.NET Core Module stdout log](#) to troubleshoot the problem.

## Connection reset

If an error occurs after the headers are sent, it's too late for the server to send a **500 Internal Server Error** when an error occurs. This often happens when an error occurs during the serialization of complex objects for a response. This type of error appears as a *connection reset* error on the client. [Application logging](#) can help troubleshoot these types of errors.

## Default startup limits

The ASP.NET Core Module is configured with a default *startupTimeLimit* of 120 seconds. When left at the default value, an app may take up to two minutes to start before the module logs a process failure. For information on configuring the module, see [Attributes of the `aspNetCore` element](#).

## Troubleshoot app startup errors

### Application Event Log

Access the Application Event Log:

1. Open the Start menu, search for **Event Viewer**, and then select the **Event Viewer** app.
2. In **Event Viewer**, open the **Windows Logs** node.
3. Select **Application** to open the Application Event Log.
4. Search for errors associated with the failing app. Errors have a value of *IIS AspNetCore Module* or *IIS Express AspNetCore Module* in the *Source* column.

### Run the app at a command prompt

Many startup errors don't produce useful information in the Application Event Log. You can find the cause of some errors by running the app at a command prompt on the hosting system.

### Framework-dependent deployment

If the app is a [framework-dependent deployment](#):

1. At a command prompt, navigate to the deployment folder and run the app by executing the app's assembly with `dotnet.exe`. In the following command, substitute the name of the app's assembly for `<assembly_name>`:  
`dotnet .\<assembly_name>.dll`.
2. The console output from the app, showing any errors, is written to the console window.
3. If the errors occur when making a request to the app, make a request to the host and port where Kestrel listens. Using the default host and port, make a request to `http://localhost:5000/`. If the app responds normally at the Kestrel endpoint address, the problem is more likely related to the reverse proxy configuration and less likely within the app.

### Self-contained deployment

If the app is a [self-contained deployment](#):

1. At a command prompt, navigate to the deployment folder and run the app's executable. In the following command, substitute the name of the app's assembly for `<assembly_name>`: `<assembly_name>.exe`.

2. The console output from the app, showing any errors, is written to the console window.
3. If the errors occur when making a request to the app, make a request to the host and port where Kestrel listens. Using the default host and port, make a request to `http://localhost:5000/`. If the app responds normally at the Kestrel endpoint address, the problem is more likely related to the reverse proxy configuration and less likely within the app.

## ASP.NET Core Module stdout log

To enable and view stdout logs:

1. Navigate to the site's deployment folder on the hosting system.
2. If the `logs` folder isn't present, create the folder. For instructions on how to enable MSBuild to create the `logs` folder in the deployment automatically, see the [Directory structure](#) topic.
3. Edit the `web.config` file. Set `stdoutLogEnabled` to `true` and change the `stdoutLogFile` path to point to the `logs` folder (for example, `.\logs\stdout`). `stdout` in the path is the log file name prefix. A timestamp, process id, and file extension are added automatically when the log is created. Using `stdout` as the file name prefix, a typical log file is named `stdout_20180205184032_5412.log`.
4. Save the updated `web.config` file.
5. Make a request to the app.
6. Navigate to the `logs` folder. Find and open the most recent stdout log.
7. Study the log for errors.

**Important!** Disable stdout logging when troubleshooting is complete.

1. Edit the `web.config` file.
2. Set `stdoutLogEnabled` to `false`.
3. Save the file.

### WARNING

Failure to disable the stdout log can lead to app or server failure. There's no limit on log file size or the number of log files created.

For routine logging in an ASP.NET Core app, use a logging library that limits log file size and rotates logs. For more information, see [third-party logging providers](#).

## Enabling the Developer Exception Page

The `ASPNETCORE_ENVIRONMENT` environment variable can be added to `web.config` to run the app in the Development environment. As long as the environment isn't overridden in app startup by `UseEnvironment` on the host builder, setting the environment variable allows the [Developer Exception Page](#) to appear when the app is run.

```
<aspNetCore processPath="dotnet"
            arguments=".\\MyApp.dll"
            stdoutLogEnabled="false"
            stdoutLogFile=".\\logs\\stdout">
  <environmentVariables>
    <environmentVariable name="ASPNETCORE_ENVIRONMENT" value="Development" />
  </environmentVariables>
</aspNetCore>
```

Setting the environment variable for `ASPNETCORE_ENVIRONMENT` is only recommended for use on staging and testing servers that aren't exposed to the Internet. Remove the environment variable from the `web.config` file after troubleshooting. For information on setting environment variables in `web.config`, see [environmentVariables](#)

child element of `aspNetCore`.

## Common startup errors

See the [ASP.NET Core common errors reference](#). Most of the common problems that prevent app startup are covered in the reference topic.

## Slow or hanging app

When an app responds slowly or hangs on a request, obtain and analyze a [dump file](#). Dump files can be obtained using any of the following tools:

- [ProcDump](#)
- [DebugDiag](#)
- WinDbg: [Download Debugging tools for Windows](#), [Debugging Using WinDbg](#)

## Remote debugging

See [Remote Debug ASP.NET Core on a Remote IIS Computer in Visual Studio 2017](#) in the Visual Studio documentation.

## Application Insights

[Application Insights](#) provides telemetry from apps hosted by IIS, including error logging and reporting features. Application Insights can only report on errors that occur after the app starts when the app's logging features become available. For more information, see [Application Insights for ASP.NET Core](#).

## Additional troubleshooting advice

Sometimes a functioning app fails immediately after upgrading either the .NET Core SDK on the development machine or package versions within the app. In some cases, incoherent packages may break an app when performing major upgrades. Most of these issues can be fixed by following these instructions:

1. Delete the `bin` and `obj` folders.
2. Clear the package caches at `%UserProfile%\nuget\packages` and `%LocalAppData%\Nuget\v3-cache`.
3. Restore and rebuild the project.
4. Confirm that the prior deployment on the server has been completely deleted prior to redeploying the app.

### TIP

A convenient way to clear package caches is to execute `dotnet nuget locals all --clear` from a command prompt.

Clearing package caches can also be accomplished by using the [nuget.exe](#) tool and executing the command `nuget locals all -clear`. [nuget.exe](#) isn't a bundled install with the Windows desktop operating system and must be obtained separately from the [NuGet website](#).

## Additional resources

- [Introduction to Error Handling in ASP.NET Core](#)
- [Common errors reference for Azure App Service and IIS with ASP.NET Core](#)
- [ASP.NET Core Module configuration reference](#)
- [Troubleshoot ASP.NET Core on Azure App Service](#)

# ASP.NET Core Module configuration reference

6/21/2018 • 10 minutes to read • [Edit Online](#)

By [Luke Latham](#), [Rick Anderson](#), and [Sourabh Shirhatti](#)

This document provides instructions on how to configure the ASP.NET Core Module for hosting ASP.NET Core apps. For an introduction to the ASP.NET Core Module and installation instructions, see the [ASP.NET Core Module overview](#).

## Configuration with web.config

The ASP.NET Core Module is configured with the `aspNetCore` section of the `system.webServer` node in the site's `web.config` file.

The following `web.config` file is published for a [framework-dependent deployment](#) and configures the ASP.NET Core Module to handle site requests:

```
<?xml version="1.0" encoding="utf-8"?>
<configuration>
  <system.webServer>
    <handlers>
      <add name="aspNetCore" path="*" verb="*" modules="AspNetCoreModule" resourceType="Unspecified" />
    </handlers>
    <aspNetCore processPath="dotnet"
      arguments=".\\MyApp.dll"
      stdoutLogEnabled="false"
      stdoutLogFile=".\\logs\\stdout" />
  </system.webServer>
</configuration>
```

The following `web.config` is published for a [self-contained deployment](#):

```
<?xml version="1.0" encoding="utf-8"?>
<configuration>
  <system.webServer>
    <handlers>
      <add name="aspNetCore" path="*" verb="*" modules="AspNetCoreModule" resourceType="Unspecified" />
    </handlers>
    <aspNetCore processPath=".\\MyApp.exe"
      stdoutLogEnabled="false"
      stdoutLogFile=".\\logs\\stdout" />
  </system.webServer>
</configuration>
```

When an app is deployed to [Azure App Service](#), the `stdoutLogFile` path is set to `\?\%home%\LogFiles\stdout`. The path saves stdout logs to the *LogFiles* folder, which is a location automatically created by the service.

See [Sub-application configuration](#) for an important note pertaining to the configuration of `web.config` files in sub-apps.

### Attributes of the `aspNetCore` element

ATTRIBUTE	DESCRIPTION	DEFAULT
<code>arguments</code>	<p>Optional string attribute.</p> <p>Arguments to the executable specified in <b>processPath</b>.</p>	
<code>disableStartUpErrorPage</code>	<p>true or false.</p> <p>If true, the <b>502.5 - Process Failure</b> page is suppressed, and the 502 status code page configured in the <i>web.config</i> takes precedence.</p>	<code>false</code>
<code>forwardWindowsAuthToken</code>	<p>true or false.</p> <p>If true, the token is forwarded to the child process listening on %ASPNETCORE_PORT% as a header 'MS-ASPNETCORE-WINAUTHTOKEN' per request. It's the responsibility of that process to call CloseHandle on this token per request.</p>	<code>true</code>
<code>processPath</code>	<p>Required string attribute.</p> <p>Path to the executable that launches a process listening for HTTP requests. Relative paths are supported. If the path begins with <code>.</code>, the path is considered to be relative to the site root.</p>	
<code>rapidFailsPerMinute</code>	<p>Optional integer attribute.</p> <p>Specifies the number of times the process specified in <b>processPath</b> is allowed to crash per minute. If this limit is exceeded, the module stops launching the process for the remainder of the minute.</p>	<code>10</code>
<code>requestTimeout</code>	<p>Optional timespan attribute.</p> <p>Specifies the duration for which the ASP.NET Core Module waits for a response from the process listening on %ASPNETCORE_PORT%.</p> <p>In versions of the ASP.NET Core Module that shipped with the release of ASP.NET Core 2.0 or earlier, the <code>requestTimeout</code> must be specified in whole minutes only, otherwise it defaults to 2 minutes.</p>	<code>00:02:00</code>

ATTRIBUTE	DESCRIPTION	DEFAULT
<code>shutdownTimeLimit</code>	<p>Optional integer attribute.</p> <p>Duration in seconds that the module waits for the executable to gracefully shutdown when the <i>app_offline.htm</i> file is detected.</p>	10
<code>startupTimeLimit</code>	<p>Optional integer attribute.</p> <p>Duration in seconds that the module waits for the executable to start a process listening on the port. If this time limit is exceeded, the module kills the process. The module attempts to relaunch the process when it receives a new request and continues to attempt to restart the process on subsequent incoming requests unless the app fails to start <b>rapidFailsPerMinute</b> number of times in the last rolling minute.</p>	120
<code>stdoutLogEnabled</code>	<p>Optional Boolean attribute.</p> <p>If true, <b>stdout</b> and <b>stderr</b> for the process specified in <b>processPath</b> are redirected to the file specified in <b>stdoutLogFile</b>.</p>	false
<code>stdoutLogFile</code>	<p>Optional string attribute.</p> <p>Specifies the relative or absolute file path for which <b>stdout</b> and <b>stderr</b> from the process specified in <b>processPath</b> are logged.</p> <p>Relative paths are relative to the root of the site. Any path starting with <code>..</code> are relative to the site root and all other paths are treated as absolute paths. Any folders provided in the path must exist in order for the module to create the log file. Using underscore delimiters, a timestamp, process ID, and file extension (<i>.log</i>) are added to the last segment of the <b>stdoutLogFile</b> path. If <code>..\logs\stdout</code> is supplied as a value, an example stdout log is saved as <i>stdout_20180205194132_1934.log</i> in the <i>logs</i> folder when saved on 2/5/2018 at 19:41:32 with a process ID of 1934.</p>	aspnetcore-stdout

ATTRIBUTE	DESCRIPTION	DEFAULT
<code>arguments</code>	<p>Optional string attribute.</p> <p>Arguments to the executable specified in <b>processPath</b>.</p>	
<code>disableStartUpErrorPage</code>	<p>true or false.</p> <p>If true, the <b>502.5 - Process Failure</b> page is suppressed, and the 502 status code page configured in the <i>web.config</i> takes precedence.</p>	<code>false</code>
<code>forwardWindowsAuthToken</code>	<p>true or false.</p> <p>If true, the token is forwarded to the child process listening on %ASPNETCORE_PORT% as a header 'MS-ASPNETCORE-WINAUTHTOKEN' per request. It's the responsibility of that process to call CloseHandle on this token per request.</p>	<code>true</code>
<code>processPath</code>	<p>Required string attribute.</p> <p>Path to the executable that launches a process listening for HTTP requests. Relative paths are supported. If the path begins with <code>.</code>, the path is considered to be relative to the site root.</p>	
<code>rapidFailsPerMinute</code>	<p>Optional integer attribute.</p> <p>Specifies the number of times the process specified in <b>processPath</b> is allowed to crash per minute. If this limit is exceeded, the module stops launching the process for the remainder of the minute.</p>	<code>10</code>
<code>requestTimeout</code>	<p>Optional timespan attribute.</p> <p>Specifies the duration for which the ASP.NET Core Module waits for a response from the process listening on %ASPNETCORE_PORT%.</p> <p>In versions of the ASP.NET Core Module that shipped with the release of ASP.NET Core 2.1 or later, the <code>requestTimeout</code> is specified in hours, minutes, and seconds.</p>	<code>00:02:00</code>

ATTRIBUTE	DESCRIPTION	DEFAULT
<code>shutdownTimeLimit</code>	<p>Optional integer attribute.</p> <p>Duration in seconds that the module waits for the executable to gracefully shutdown when the <code>app_offline.htm</code> file is detected.</p>	<code>10</code>
<code>startupTimeLimit</code>	<p>Optional integer attribute.</p> <p>Duration in seconds that the module waits for the executable to start a process listening on the port. If this time limit is exceeded, the module kills the process. The module attempts to relaunch the process when it receives a new request and continues to attempt to restart the process on subsequent incoming requests unless the app fails to start <b>rapidFailsPerMinute</b> number of times in the last rolling minute.</p>	<code>120</code>
<code>stdoutLogEnabled</code>	<p>Optional Boolean attribute.</p> <p>If true, <b>stdout</b> and <b>stderr</b> for the process specified in <b>processPath</b> are redirected to the file specified in <b>stdoutLogFile</b>.</p>	<code>false</code>
<code>stdoutLogFile</code>	<p>Optional string attribute.</p> <p>Specifies the relative or absolute file path for which <b>stdout</b> and <b>stderr</b> from the process specified in <b>processPath</b> are logged.</p> <p>Relative paths are relative to the root of the site. Any path starting with <code>.</code> are relative to the site root and all other paths are treated as absolute paths. Any folders provided in the path must exist in order for the module to create the log file. Using underscore delimiters, a timestamp, process ID, and file extension (<code>.log</code>) are added to the last segment of the <b>stdoutLogFile</b> path. If <code>.\logs\stdout</code> is supplied as a value, an example stdout log is saved as <code>stdout_20180205194132_1934.log</code> in the <code>logs</code> folder when saved on 2/5/2018 at 19:41:32 with a process ID of 1934.</p>	<code>aspnetcore-stdout</code>

## Setting environment variables

Environment variables can be specified for the process in the `processPath` attribute. Specify an environment variable with the `environmentVariable` child element of an `environmentVariables` collection element.

Environment variables set in this section take precedence over system environment variables.

The following example sets two environment variables. `ASPNETCORE_ENVIRONMENT` configures the app's environment to `Development`. A developer may temporarily set this value in the `web.config` file in order to force the [Developer Exception Page](#) to load when debugging an app exception. `CONFIG_DIR` is an example of a user-defined environment variable, where the developer has written code that reads the value on startup to form a path for loading the app's configuration file.

```
<aspNetCore processPath="dotnet"
            arguments=".\\MyApp.dll"
            stdoutLogEnabled="false"
            stdoutLogFile="\\?\%home%\LogFiles\stdout">
  <environmentVariables>
    <environmentVariable name="ASPNETCORE_ENVIRONMENT" value="Development" />
    <environmentVariable name="CONFIG_DIR" value="f:\\application_config" />
  </environmentVariables>
</aspNetCore>
```

#### WARNING

Only set the `ASPNETCORE_ENVIRONMENT` environment variable to `Development` on staging and testing servers that aren't accessible to untrusted networks, such as the Internet.

## app\_offline.htm

If a file with the name `app_offline.htm` is detected in the root directory of an app, the ASP.NET Core Module attempts to gracefully shutdown the app and stop processing incoming requests. If the app is still running after the number of seconds defined in `shutdownTimeLimit`, the ASP.NET Core Module kills the running process.

While the `app_offline.htm` file is present, the ASP.NET Core Module responds to requests by sending back the contents of the `app_offline.htm` file. When the `app_offline.htm` file is removed, the next request starts the app.

## Start-up error page

If the ASP.NET Core Module fails to launch the backend process or the backend process starts but fails to listen on the configured port, a *502.5 Process Failure* status code page appears. To suppress this page and revert to the default IIS 502 status code page, use the `disableStartUpErrorPage` attribute. For more information on configuring custom error messages, see [HTTP Errors](#) `<httpErrors>`.

The screenshot shows an IIS error page for a 502.5 error. The title bar says "IIS 502.5 Error". The address bar shows "localhost:9001". The main content area has a heading "HTTP Error 502.5 - Process Failure". Below it, a section titled "Common causes of this issue:" lists three items: "The application process failed to start", "The application process started but then stopped", and "The application process started but failed to listen on the configured port". Another section titled "Troubleshooting steps:" lists three items: "Check the system event log for error messages", "Enable logging the application process' stdout messages", and "Attach a debugger to the application process and inspect". At the bottom, there is a link "For more information visit: <http://go.microsoft.com/fwlink/?LinkId=808681>".

## Log creation and redirection

The ASP.NET Core Module redirects stdout and stderr logs to disk if the `stdoutEnabled` and `stdoutLogFile` attributes of the `aspNetCore` element are set. Any folders in the `stdoutLogFile` path must exist in order for the module to create the log file. The app pool must have write access to the location where the logs are written (use `IIS AppPool\<app_pool_name>` to provide write permission).

Logs aren't rotated, unless process recycling/restart occurs. It's the responsibility of the hoster to limit the disk space the logs consume.

Using the stdout log is only recommended for troubleshooting app startup issues. Don't use the stdout log for general app logging purposes. For routine logging in an ASP.NET Core app, use a logging library that limits log file size and rotates logs. For more information, see [third-party logging providers](#).

A timestamp and file extension are added automatically when the log file is created. The log file name is composed by appending the timestamp, process ID, and file extension (`.log`) to the last segment of the `stdoutLogFile` path (typically `stdout`) delimited by underscores. If the `stdoutLogFile` path ends with `stdout`, a log for an app with a PID of 1934 created on 2/5/2018 at 19:42:32 has the file name `stdout_20180205194132_1934.log`.

The following sample `aspNetCore` element configures stdout logging for an app hosted in Azure App Service. A local path or network share path is acceptable for local logging. Confirm that the AppPool user identity has permission to write to the path provided.

```
<aspNetCore processPath="dotnet"
            arguments=".\\MyApp.dll"
            stdoutEnabled="true"
            stdoutLogFile="\\?\%home%\LogFiles\stdout">
</aspNetCore>
```

See [Configuration with web.config](#) for an example of the `aspNetCore` element in the `web.config` file.

## Proxy configuration uses HTTP protocol and a pairing token

The proxy created between the ASP.NET Core Module and Kestrel uses the HTTP protocol. Using HTTP is a performance optimization, where the traffic between the module and Kestrel takes place on a loopback address off of the network interface. There's no risk of eavesdropping the traffic between the module and Kestrel from a location off of the server.

A pairing token is used to guarantee that the requests received by Kestrel were proxied by IIS and didn't come from some other source. The pairing token is created and set into an environment variable (`ASPNETCORE_TOKEN`) by the module. The pairing token is also set into a header (`MS.AspNetCoreToken`) on every proxied request. IIS Middleware checks each request it receives to confirm that the pairing token header value matches the environment variable value. If the token values are mismatched, the request is logged and rejected. The pairing token environment variable and the traffic between the module and Kestrel aren't accessible from a location off of the server. Without knowing the pairing token value, an attacker can't submit requests that bypass the check in the IIS Middleware.

## ASP.NET Core Module with an IIS Shared Configuration

The ASP.NET Core Module installer runs with the privileges of the **SYSTEM** account. Because the local system account doesn't have modify permission for the share path used by the IIS Shared Configuration, the installer hits an access denied error when attempting to configure the module settings in *applicationHost.config* on the share. When using an IIS Shared Configuration, follow these steps:

1. Disable the IIS Shared Configuration.
2. Run the installer.
3. Export the updated *applicationHost.config* file to the share.
4. Re-enable the IIS Shared Configuration.

## Module version and Hosting Bundle installer logs

To determine the version of the installed ASP.NET Core Module:

1. On the hosting system, navigate to `%windir%\System32\inetsrv`.
2. Locate the `aspnetcore.dll` file.
3. Right-click the file and select **Properties** from the contextual menu.
4. Select the **Details** tab. The **File version** and **Product version** represent the installed version of the module.

The Hosting Bundle installer logs for the module are found at `C:\Users\%UserName%\AppData\Local\Temp`. The file is named `dd_DotNetCoreWinSvrHosting_<timestamp>_000_AspNetCoreModule_x64.log`.

## Module, schema, and configuration file locations

### Module

#### IIS (x86/amd64):

- `%windir%\System32\inetsrv\aspnetcore.dll`
- `%windir%\SysWOW64\inetsrv\aspnetcore.dll`

#### IIS Express (x86/amd64):

- `%ProgramFiles%\IIS Express\aspnetcore.dll`
- `%ProgramFiles(x86)%\IIS Express\aspnetcore.dll`

### Schema

#### IIS

- %windir%\System32\inetsrv\config\schema\aspnetcore\_schema.xml

## IIS Express

- %ProgramFiles%\IIS Express\config\schema\aspnetcore\_schema.xml

## Configuration

### IIS

- %windir%\System32\inetsrv\config\applicationHost.config

### IIS Express

- .vs\config\applicationHost.config

The files can be found by searching for *aspnetcore.dll* in the *applicationHost.config* file. For IIS Express, the *applicationHost.config* file won't exist by default. The file is created at *<application\_root>\.vs\config* when starting any web app project in the Visual Studio solution.

# Development-time IIS support in Visual Studio for ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

By Sourabh Shirhatti and Luke Latham

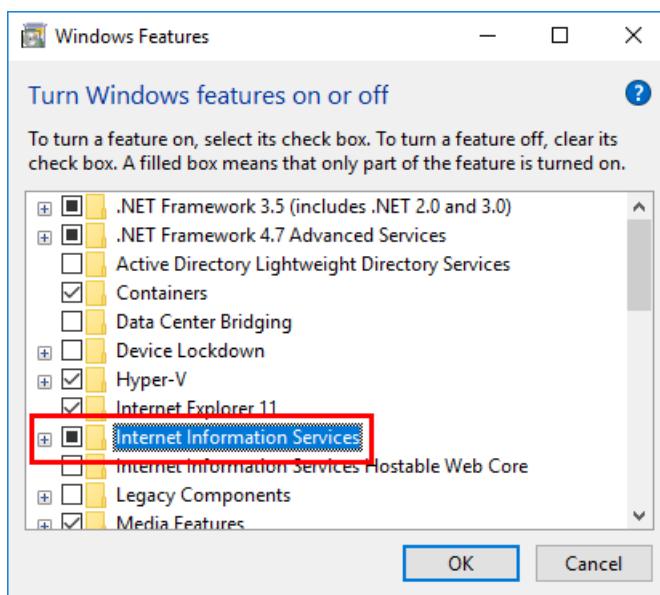
This article describes [Visual Studio](#) support for debugging ASP.NET Core apps running behind IIS on Windows Server. This topic walks through enabling this feature and setting up a project.

## Prerequisites

- [Visual Studio for Windows](#)
- **ASP.NET and web development** workload
- **.NET Core cross-platform development** workload
- X.509 security certificate

## Enable IIS

1. Navigate to **Control Panel > Programs > Programs and Features > Turn Windows features on or off** (left side of the screen).
2. Select the **Internet Information Services** check box.



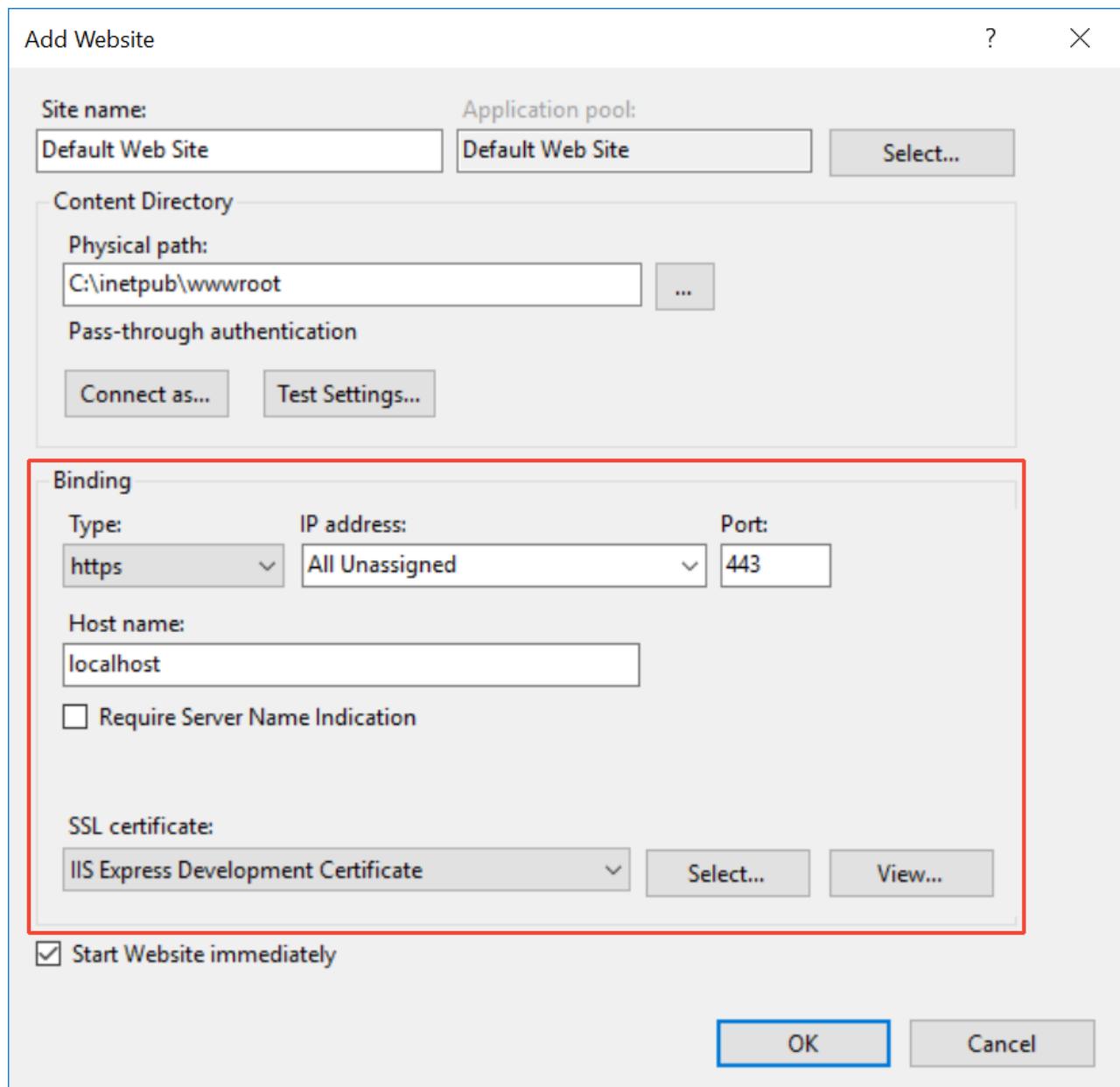
The IIS installation may require a system restart.

## Configure IIS

IIS must have a website configured with the following:

- A host name that matches the app's launch profile URL host name.
- Binding for port 443 with an assigned certificate.

For example, the **Host name** for an added website is set to "localhost" (the launch profile will also use "localhost" later in this topic). The port is set to "443" (HTTPS). The **IIS Express Development Certificate** is assigned to the website, but any valid certificate works:

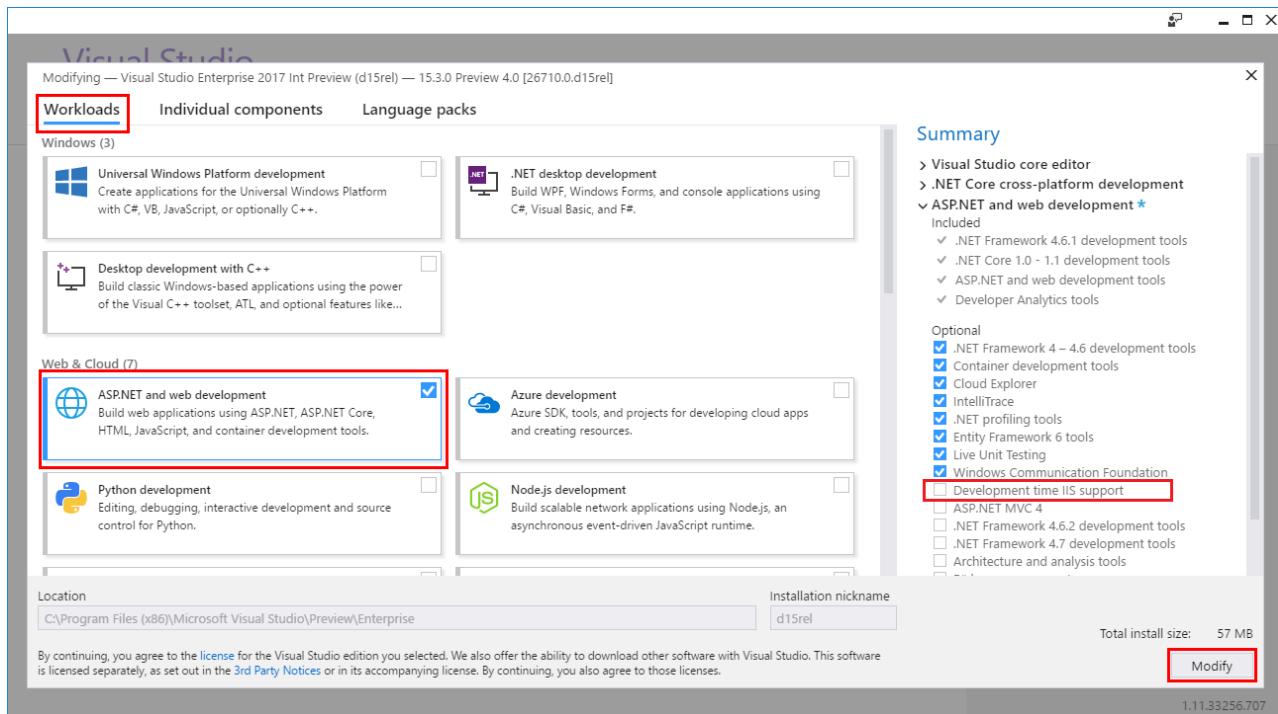


If the IIS installation already has a **Default Web Site** with a host name that matches the app's launch profile URL host name:

- Add a port binding for port 443 (HTTPS).
- Assign a valid certificate to the website.

## Enable development-time IIS support in Visual Studio

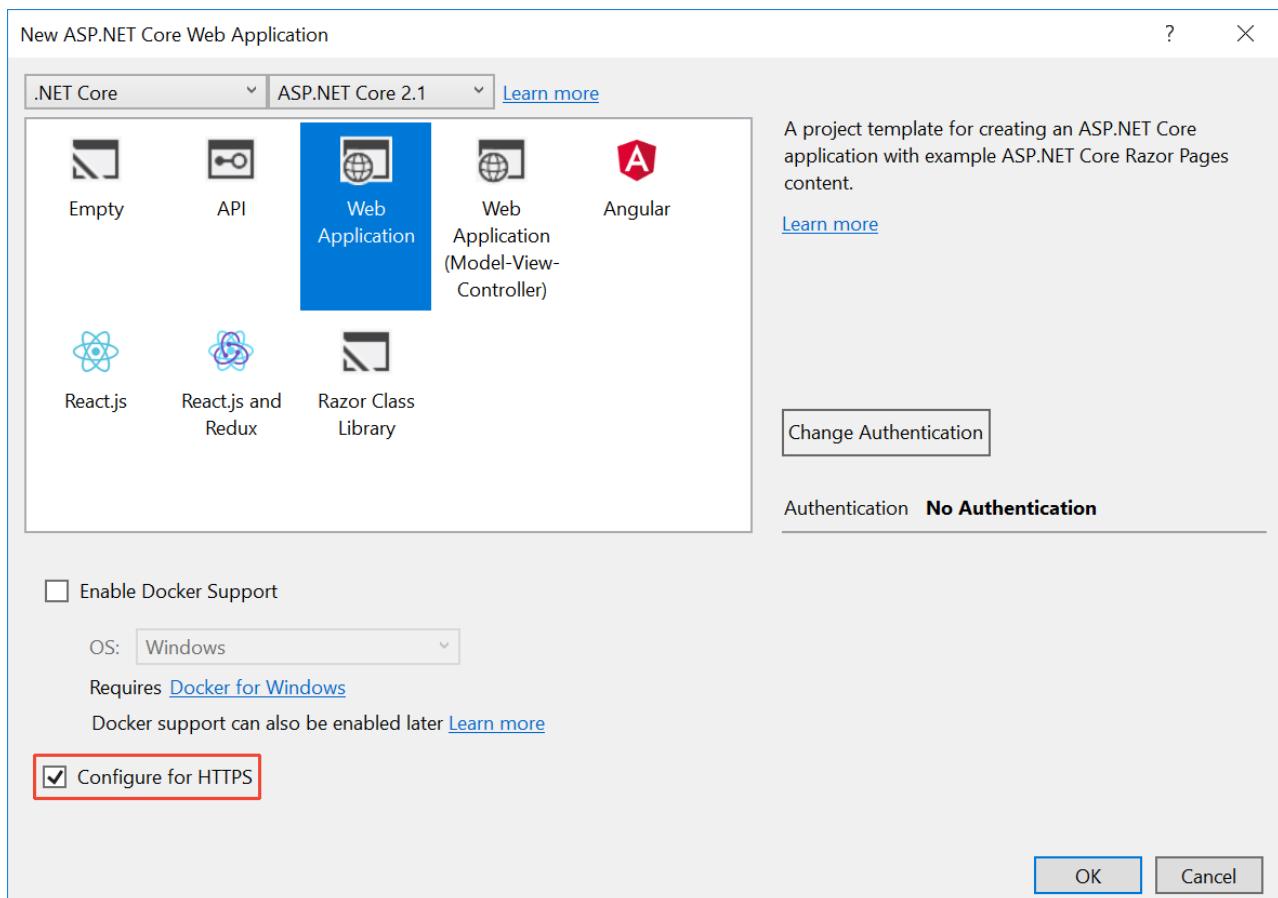
1. Launch the Visual Studio installer.
2. Select the **Development time IIS support** component. The component is listed as optional in the **Summary** panel for the **ASP.NET and web development** workload. The component installs the **ASP.NET Core Module**, which is a native IIS module required to run ASP.NET Core apps behind IIS in a reverse proxy configuration.



## Configure the project

### HTTPS redirection

For a new project, select the check box to **Configure for HTTPS** in the **New ASP.NET Core Web Application** window:



In an existing project, use HTTPS Redirection Middleware in `Startup.Configure` by calling the `UseHttpsRedirection` extension method:

```

public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
    }
    else
    {
        app.UseExceptionHandler("/Error");
        app.UseHsts();
    }

    app.UseHttpsRedirection();
    app.UseStaticFiles();
    app.UseCookiePolicy();

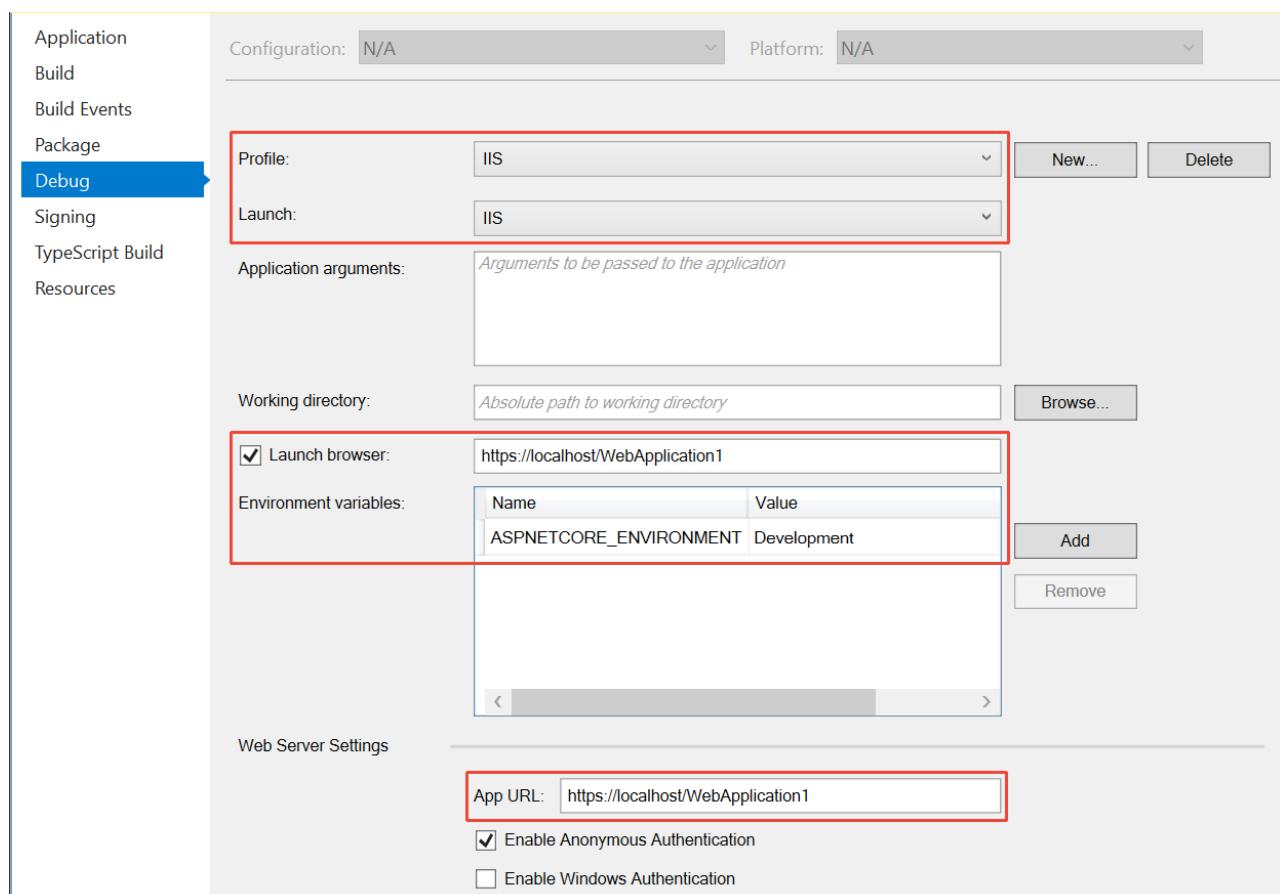
    app.UseMvc();
}

```

## IIS launch profile

Create a new launch profile to add development-time IIS support:

1. For **Profile**, select the **New** button. Name the profile "IIS" in the popup window. Select **OK** to create the profile.
2. For the **Launch** setting, select **IIS** from the list.
3. Select the check box for **Launch browser** and provide the endpoint URL. Use the HTTPS protocol. This example uses `https://localhost/WebApplication1`.
4. In the **Environment variables** section, select the **Add** button. Provide an environment variable with a key of `ASPNETCORE_ENVIRONMENT` and a value of `Development`.
5. In the **Web Server Settings** area, set the **App URL**. This example uses `https://localhost/WebApplication1`.
6. Save the profile.

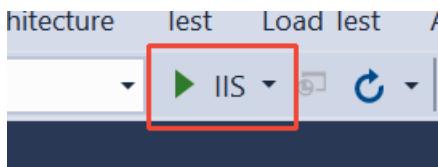


Alternatively, manually add a launch profile to the `launchSettings.json` file in the app:

```
{
  "iisSettings": {
    "windowsAuthentication": false,
    "anonymousAuthentication": true,
    "iis": {
      "applicationUrl": "https://localhost/WebApplication1",
      "sslPort": 0
    }
  },
  "profiles": {
    "IIS": {
      "commandName": "IIS",
      "launchBrowser": true,
      "launchUrl": "https://localhost/WebApplication1",
      "environmentVariables": {
        "ASPNETCORE_ENVIRONMENT": "Development"
      }
    }
  }
}
```

## Run the project

In the VS UI, set the Run button to the **IIS** profile and select the button to start the app:



Visual Studio may prompt a restart if not running as an administrator. If prompted, restart Visual Studio.

If an untrusted development certificate is used, the browser may require you to create an exception for the untrusted certificate.

## Additional resources

- [Host ASP.NET Core on Windows with IIS](#)
- [Introduction to ASP.NET Core Module](#)
- [ASP.NET Core Module configuration reference](#)
- [Enforce HTTPS](#)

# IIS modules with ASP.NET Core

6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Luke Latham](#)

ASP.NET Core apps are hosted by IIS in a reverse proxy configuration. Some of the native IIS modules and all of the IIS managed modules aren't available to process requests for ASP.NET Core apps. In many cases, ASP.NET Core offers an alternative to the features of IIS native and managed modules.

## Native modules

The table indicates native IIS modules that are functional on reverse proxy requests to ASP.NET Core apps.

MODULE	FUNCTIONAL WITH ASP.NET CORE APPS	ASP.NET CORE OPTION
<b>Anonymous Authentication</b> <code>AnonymousAuthenticationModule</code>	Yes	
<b>Basic Authentication</b> <code>BasicAuthenticationModule</code>	Yes	
<b>Client Certification Mapping Authentication</b> <code>CertificateMappingAuthenticationModule</code>	Yes	
<b>CGI</b> <code>CgiModule</code>	No	
<b>Configuration Validation</b> <code>ConfigurationValidationModule</code>	Yes	
<b>HTTP Errors</b> <code>CustomErrorModule</code>	No	<a href="#">Status Code Pages Middleware</a>
<b>Custom Logging</b> <code>CustomLoggingModule</code>	Yes	
<b>Default Document</b> <code>DefaultDocumentModule</code>	No	<a href="#">Default Files Middleware</a>
<b>Digest Authentication</b> <code>DigestAuthenticationModule</code>	Yes	
<b>Directory Browsing</b> <code>DirectoryListingModule</code>	No	<a href="#">Directory Browsing Middleware</a>
<b>Dynamic Compression</b> <code>DynamicCompressionModule</code>	Yes	<a href="#">Response Compression Middleware</a>
<b>Tracing</b> <code>FailedRequestsTracingModule</code>	Yes	<a href="#">ASP.NET Core Logging</a>

MODULE	FUNCTIONAL WITH ASP.NET CORE APPS	ASP.NET CORE OPTION
<b>File Caching</b> FileCacheModule	No	Response Caching Middleware
<b>HTTP Caching</b> HttpCacheModule	No	Response Caching Middleware
<b>HTTP Logging</b> HttpLoggingModule	Yes	ASP.NET Core Logging Implementations: <a href="#">elmah.io</a> , <a href="#">Loggr</a> , <a href="#">NLog</a> , <a href="#">Serilog</a>
<b>HTTP Redirection</b> HttpRedirectionModule	Yes	URL Rewriting Middleware
<b>IIS Client Certificate Mapping Authentication</b> IISCertificateMappingAuthenticationModule	Yes	
<b>IP and Domain Restrictions</b> IpRestrictionModule	Yes	
<b>ISAPI Filters</b> IsapiFilterModule	Yes	Middleware
<b>ISAPI</b> IsapiModule	Yes	Middleware
<b>Protocol Support</b> ProtocolSupportModule	Yes	
<b>Request Filtering</b> RequestFilteringModule	Yes	URL Rewriting Middleware <a href="#">IRule</a>
<b>Request Monitor</b> RequestMonitorModule	Yes	
<b>URL Rewriting</b> RewriteModule	Yes†	URL Rewriting Middleware
<b>Server-Side Includes</b> ServerSideIncludeModule	No	
<b>Static Compression</b> StaticCompressionModule	No	Response Compression Middleware
<b>Static Content</b> StaticFileModule	No	Static File Middleware
<b>Token Caching</b> TokenCacheModule	Yes	
<b>URI Caching</b> UriCacheModule	Yes	

MODULE	FUNCTIONAL WITH ASP.NET CORE APPS	ASP.NET CORE OPTION
<b>URL Authorization</b> UrlAuthorizationModule	Yes	<a href="#">ASP.NET Core Identity</a>
<b>Windows Authentication</b> WindowsAuthenticationModule	Yes	

<sup>†</sup>The URL Rewrite Module's `isFile` and `isDirectory` match types don't work with ASP.NET Core apps due to the changes in [directory structure](#).

## Managed modules

Managed modules are *not* functional with hosted ASP.NET Core apps when the app pool's .NET CLR version is set to **No Managed Code**. ASP.NET Core offers middleware alternatives in several cases.

MODULE	ASP.NET CORE OPTION
AnonymousIdentification	
DefaultAuthentication	
FileAuthorization	
FormsAuthentication	<a href="#">Cookie Authentication Middleware</a>
OutputCache	<a href="#">Response Caching Middleware</a>
Profile	
RoleManager	
ScriptModule-4.0	
Session	<a href="#">Session Middleware</a>
UrlAuthorization	
UrlMappingsModule	<a href="#">URL Rewriting Middleware</a>
UrlRoutingModule-4.0	<a href="#">ASP.NET Core Identity</a>
WindowsAuthentication	

## IIS Manager application changes

When using IIS Manager to configure settings, the `web.config` file of the app is changed. If deploying an app and including `web.config`, any changes made with IIS Manager are overwritten by the deployed `web.config` file. If changes are made to the server's `web.config` file, copy the updated `web.config` file on the server to the local project immediately.

## Disabling IIS modules

If an IIS module is configured at the server level that must be disabled for an app, an addition to the app's *web.config* file can disable the module. Either leave the module in place and deactivate it using a configuration setting (if available) or remove the module from the app.

## Module deactivation

Many modules offer a configuration setting that allows them to be disabled without removing the module from the app. This is the simplest and quickest way to deactivate a module. For example, the HTTP Redirection Module can be disabled with the **<httpRedirect>** element in *web.config*:

```
<configuration>
  <system.webServer>
    <httpRedirect enabled="false" />
  </system.webServer>
</configuration>
```

For more information on disabling modules with configuration settings, follow the links in the *Child Elements* section of [IIS <system.webServer>](#).

## Module removal

If opting to remove a module with a setting in *web.config*, unlock the module and unlock the **<modules>** section of *web.config* first:

1. Unlock the module at the server level. Select the IIS server in the IIS Manager **Connections** sidebar. Open the **Modules** in the **IIS** area. Select the module in the list. In the **Actions** sidebar on the right, select **Unlock**. Unlock as many modules as you plan to remove from *web.config* later.
2. Deploy the app without a **<modules>** section in *web.config*. If an app is deployed with a *web.config* containing the **<modules>** section without having unlocked the section first in the IIS Manager, the Configuration Manager throws an exception when attempting to unlock the section. Therefore, deploy the app without a **<modules>** section.
3. Unlock the **<modules>** section of *web.config*. In the **Connections** sidebar, select the website in **Sites**. In the **Management** area, open the **Configuration Editor**. Use the navigation controls to select the **system.webServer/modules** section. In the **Actions** sidebar on the right, select to **Unlock** the section.
4. At this point, a **<modules>** section can be added to the *web.config* file with a **<remove>** element to remove the module from the app. Multiple **<remove>** elements can be added to remove multiple modules. If *web.config* changes are made on the server, immediately make the same changes to the project's *web.config* file locally. Removing a module this way won't affect the use of the module with other apps on the server.

```
<configuration>
  <system.webServer>
    <modules>
      <remove name="MODULE_NAME" />
    </modules>
  </system.webServer>
</configuration>
```

An IIS module can also be removed with *Appcmd.exe*. Provide the **MODULE\_NAME** and **APPLICATION\_NAME** in the command:

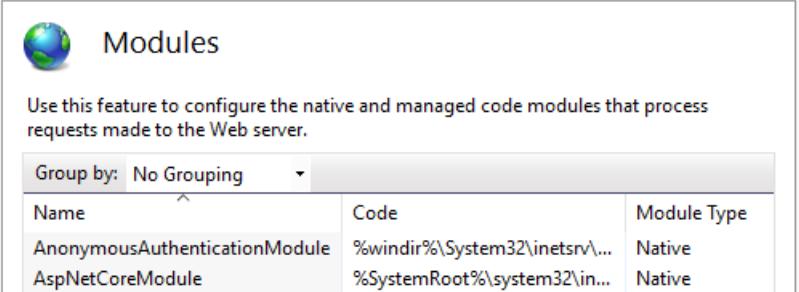
```
Appcmd.exe delete module MODULE_NAME /app.name:APPLICATION_NAME
```

For example, remove the **DynamicCompressionModule** from the Default Web Site:

```
%windir%\system32\inetsrv\appcmd.exe delete module DynamicCompressionModule /app.name:"Default Web Site"
```

## Minimum module configuration

The only modules required to run an ASP.NET Core app are the Anonymous Authentication Module and the ASP.NET Core Module.



The screenshot shows the 'Modules' section of the IIS Manager. It displays two modules: 'AnonymousAuthenticationModule' and 'AspNetCoreModule'. Both modules are of type 'Native' and are grouped under 'No Grouping'. The 'Code' column shows the physical path to the module files.

Name	Code	Module Type
AnonymousAuthenticationModule	%windir%\System32\inetsrv\...	Native
AspNetCoreModule	%SystemRoot%\system32\in...	Native

The URI Caching Module (`UriCacheModule`) allows IIS to cache website configuration at the URL level. Without this module, IIS must read and parse configuration on every request, even when the same URL is repeatedly requested. Parsing the configuration every request results in a significant performance penalty. *Although the URI Caching Module isn't strictly required for a hosted ASP.NET Core app to run, we recommend that the URI Caching Module be enabled for all ASP.NET Core deployments.*

The HTTP Caching Module (`HttpCacheModule`) implements the IIS output cache and also the logic for caching items in the HTTP.sys cache. Without this module, content is no longer cached in kernel mode, and cache profiles are ignored. Removing the HTTP Caching Module usually has adverse effects on performance and resource usage. *Although the HTTP Caching Module isn't strictly required for a hosted ASP.NET Core app to run, we recommend that the HTTP Caching Module be enabled for all ASP.NET Core deployments.*

## Additional resources

- [Host on Windows with IIS](#)
- [Introduction to IIS Architectures: Modules in IIS](#)
- [IIS Modules Overview](#)
- [Customizing IIS 7.0 Roles and Modules](#)
- [IIS `<system.webServer>`](#)

# Host ASP.NET Core in a Windows Service

7/10/2018 • 5 minutes to read • [Edit Online](#)

By [Luke Latham](#) and [Tom Dykstra](#)

An ASP.NET Core app can be hosted on Windows without using IIS as a [Windows Service](#). When hosted as a Windows Service, the app can automatically start after reboots and crashes without requiring human intervention.

[View or download sample code \(how to download\)](#)

## Get started

The following minimum changes are required to set up an existing ASP.NET Core project to run in a service:

1. In the project file:

- Confirm the presence of the runtime identifier or add it to the **<PropertyGroup>** that contains the target framework:

```
<PropertyGroup>
<TargetFramework>netcoreapp2.1</TargetFramework>
<RuntimeIdentifier>win7-x64</RuntimeIdentifier>
</PropertyGroup>
```

```
<PropertyGroup>
<TargetFramework>netcoreapp2.0</TargetFramework>
<RuntimeIdentifier>win7-x64</RuntimeIdentifier>
</PropertyGroup>
```

```
<PropertyGroup>
<TargetFramework>netcoreapp1.1</TargetFramework>
<RuntimeIdentifier>win7-x64</RuntimeIdentifier>
</PropertyGroup>
```

- Add a package reference for [Microsoft.AspNetCore.Hosting.WindowsServices](#).

2. Make the following changes in `Program.Main`:

- Call `host.RunAsService` instead of `host.Run`.
- Call `UseContentRoot` and use a path to the app's published location instead of `Directory.GetCurrentDirectory()`.

```

public static void Main(string[] args)
{
    CreateWebHostBuilder(args).Build().RunAsService();
}

public static IWebHostBuilder CreateWebHostBuilder(string[] args)
{
    var pathToExe = Process.GetCurrentProcess().MainModule.FileName;
    var pathToContentRoot = Path.GetDirectoryName(pathToExe);

    return WebHost.CreateDefaultBuilder(args)
        .UseContentRoot(pathToContentRoot)
        .UseStartup<Startup>();
}

```

```

public static void Main(string[] args)
{
    var pathToExe = Process.GetCurrentProcess().MainModule.FileName;
    var pathToContentRoot = Path.GetDirectoryName(pathToExe);

    var host = new WebHostBuilder()
        .UseKestrel()
        .UseContentRoot(pathToContentRoot)
        .UseIISIntegration()
        .UseStartup<Startup>()
        .Build();

    host.RunAsService();
}

```

3. Publish the app. Use [dotnet publish](#) or a [Visual Studio publish profile](#).

To publish the sample app from the command line, run the following command in a console window from the project folder:

```
dotnet publish --configuration Release
```

4. Use the `sc.exe` command-line tool to create the service. The `binPath` value is the path to the app's executable, which includes the executable file name. **The space between the equal sign and the quote character at the start of the path is required.**

```
sc create <SERVICE_NAME> binPath= "<PATH_TO_SERVICE_EXECUTABLE>"
```

For a service published in the project folder, use the path to the *publish* folder to create the service. In the following example, the service is:

- Named **MyService**.
- Published to the `c:\my_services\AspNetCoreService\bin\Release\<TARGET_FRAMEWORK>\publish` folder.
- Represented by an app executable named `AspNetCoreService.exe`.

Open a command shell with administrative privileges and run the following command:

```
sc create MyService binPath= "c:\my_services\AspNetCoreService\bin\Release\
<TARGET_FRAMEWORK>\publish\AspNetCoreService.exe"
```

## IMPORTANT

Make sure the space is present between the `binPath=` argument and its value.

To publish and start the service from a different folder:

- a. Use the `--output <OUTPUT_DIRECTORY>` option on the `dotnet publish` command.
- b. Create the service with the `sc.exe` command using the output folder path. Include the name of the service's executable in the path provided to `binPath`.
5. Start the service with the `sc start <SERVICE_NAME>` command.

To start the sample app service, use the following command:

```
sc start MyService
```

The command takes a few seconds to start the service.

6. The `sc query <SERVICE_NAME>` command can be used to check the status of the service to determine its status:

- `START_PENDING`
- `RUNNING`
- `STOP_PENDING`
- `STOPPED`

Use the following command to check the status of the sample app service:

```
sc query MyService
```

7. When the service is in the `RUNNING` state and if the service is a web app, browse the app at its path (by default, `http://localhost:5000`, which redirects to `https://localhost:5001` when using [HTTPS Redirection Middleware](#)).

For the sample app service, browse the app at `http://localhost:5000`.

8. Stop the service with the `sc stop <SERVICE_NAME>` command.

The following command stops the sample app service:

```
sc stop MyService
```

9. After a short delay to stop a service, uninstall the service with the `sc delete <SERVICE_NAME>` command.

Check the status of the sample app service:

```
sc query MyService
```

When the sample app service is in the `STOPPED` state, use the following command to uninstall the sample app service:

```
sc delete MyService
```

## Provide a way to run outside of a service

It's easier to test and debug when running outside of a service, so it's customary to add code that calls `RunAsService` only under certain conditions. For example, the app can run as a console app with a `--console` command-line argument or if the debugger is attached:

```
public static void Main(string[] args)
{
    var isService = !(Debugger.IsAttached || args.Contains("--console"));
    var builder = CreateWebHostBuilder(args.Where(arg => arg != "--console").ToArray());

    if (isService)
    {
        var pathToExe = Process.GetCurrentProcess().MainModule.FileName;
        var pathToContentRoot = Path.GetDirectoryName(pathToExe);
        builder.UseContentRoot(pathToContentRoot);
    }

    var host = builder.Build();

    if (isService)
    {
        host.RunAsService();
    }
    else
    {
        host.Run();
    }
}

public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
    WebHost.CreateDefaultBuilder(args)
        .UseStartup<Startup>();
```

Because ASP.NET Core configuration requires name-value pairs for command-line arguments, the `--console` switch is removed before the arguments are passed to `CreateDefaultBuilder`.

### NOTE

`isService` isn't passed from `Main` into `CreateWebHostBuilder` because the signature of `CreateWebHostBuilder` must be `CreateWebHostBuilder(string[])` in order for [integration testing](#) to work properly.

```

public static void Main(string[] args)
{
    var isService = true;

    if (Debugger.IsAttached || args.Contains("--console"))
    {
        isService = false;
    }

    var pathToContentRoot = Directory.GetCurrentDirectory();

    if (isService)
    {
        var pathToExe = Process.GetCurrentProcess().MainModule.FileName;
        pathToContentRoot = Path.GetDirectoryName(pathToExe);
    }

    var host = new WebHostBuilder()
        .UseKestrel()
        .UseContentRoot(pathToContentRoot)
        .UseIISIntegration()
        .UseStartup<Startup>()
        .Build();

    if (isService)
    {
        host.RunAsService();
    }
    else
    {
        host.Run();
    }
}

```

## Handle stopping and starting events

To handle [OnStarting](#), [OnStarted](#), and [OnStopping](#) events, make the following additional changes:

1. Create a class that derives from [WebHostService](#):

```

internal class CustomWebHostService : WebHostService
{
    public CustomWebHostService(IWebHost host) : base(host)
    {

    }

    protected override void OnStarting(string[] args)
    {
        base.OnStarting(args);
    }

    protected override void OnStarted()
    {
        base.OnStarted();
    }

    protected override void OnStopping()
    {
        base.OnStopping();
    }
}

```

2. Create an extension method for [IWebHost](#) that passes the custom `WebHostService` to [ServiceBase.Run](#):

```
public static class WebHostServiceExtensions
{
    public static void RunAsCustomService(this IWebHost host)
    {
        var webHostService = new CustomWebHostService(host);
        ServiceBase.Run(webHostService);
    }
}
```

3. In `Program.Main`, call the new extension method, `RunAsCustomService`, instead of `RunAsService`:

```
public static void Main(string[] args)
{
    var isService = !(Debugger.IsAttached || args.Contains("--console"));
    var builder = CreateWebHostBuilder(args.Where(arg => arg != "--console").ToArray());

    if (isService)
    {
        var pathToExe = Process.GetCurrentProcess().MainModule.FileName;
        var pathToContentRoot = Path.GetDirectoryName(pathToExe);
        builder.UseContentRoot(pathToContentRoot);
    }

    var host = builder.Build();

    if (isService)
    {
        host.RunAsCustomService();
    }
    else
    {
        host.Run();
    }
}

public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
    WebHost.CreateDefaultBuilder(args)
        .UseStartup<Startup>();
```

#### NOTE

`isService` isn't passed from `Main` into `CreateWebHostBuilder` because the signature of `CreateWebHostBuilder` must be `CreateWebHostBuilder(string[])` in order for [integration testing](#) to work properly.

```
public static void Main(string[] args)
{
    var isService = true;

    if (Debugger.IsAttached || args.Contains("--console"))
    {
        isService = false;
    }

    var pathToContentRoot = Directory.GetCurrentDirectory();

    if (isService)
    {
        var pathToExe = Process.GetCurrentProcess().MainModule.FileName;
        pathToContentRoot = Path.GetDirectoryName(pathToExe);
    }

    var host = new WebHostBuilder()
        .UseKestrel()
        .UseContentRoot(pathToContentRoot)
        .UseIISIntegration()
        .UseStartup<Startup>()
        .Build();

    if (isService)
    {
        host.RunAsCustomService();
    }
    else
    {
        host.Run();
    }
}
```

If the custom `WebHostService` code requires a service from dependency injection (such as a logger), obtain it from the `IWebHost.Services` property:

```
internal class CustomWebHostService : WebHostService
{
    private ILogger _logger;

    public CustomWebHostService(IWebHost host) : base(host)
    {
        _logger = host.Services
            .GetRequiredService<ILogger<CustomWebHostService>>();
    }

    protected override void OnStarting(string[] args)
    {
        _logger.LogDebug("OnStarting method called.");
        base.OnStarting(args);
    }

    protected override void OnStarted()
    {
        _logger.LogDebug("OnStarted method called.");
        base.OnStarted();
    }

    protected override void OnStopping()
    {
        _logger.LogDebug("OnStopping method called.");
        base.OnStopping();
    }
}
```

## Proxy server and load balancer scenarios

Services that interact with requests from the Internet or a corporate network and are behind a proxy or load balancer might require additional configuration. For more information, see [Configure ASP.NET Core to work with proxy servers and load balancers](#).

## Kestrel endpoint configuration

For information on Kestrel endpoint configuration, including HTTPS configuration and SNI support, see [Kestrel endpoint configuration](#).

# Host ASP.NET Core on Linux with Nginx

7/3/2018 • 10 minutes to read • [Edit Online](#)

By [Sourabh Shirhatti](#)

This guide explains setting up a production-ready ASP.NET Core environment on an Ubuntu 16.04 server. These instructions likely work with newer versions of Ubuntu, but the instructions haven't been tested with newer versions.

## NOTE

For Ubuntu 14.04, *supervisord* is recommended as a solution for monitoring the Kestrel process. *systemd* isn't available on Ubuntu 14.04. For Ubuntu 14.04 instructions, see the [previous version of this topic](#).

This guide:

- Places an existing ASP.NET Core app behind a reverse proxy server.
- Sets up the reverse proxy server to forward requests to the Kestrel web server.
- Ensures the web app runs on startup as a daemon.
- Configures a process management tool to help restart the web app.

## Prerequisites

1. Access to an Ubuntu 16.04 server with a standard user account with sudo privilege.
2. Install the .NET Core runtime on the server.
  - a. Visit the [.NET Core All Downloads page](#).
  - b. Select the latest non-preview runtime from the list under **Runtime**.
  - c. Select and follow the instructions for Ubuntu that match the Ubuntu version of the server.
3. An existing ASP.NET Core app.

## Publish and copy over the app

Configure the app for a [framework-dependent deployment](#).

Run `dotnet publish` from the development environment to package an app into a directory (for example, `bin/Release/<target_framework_moniker>/publish`) that can run on the server:

```
dotnet publish --configuration Release
```

The app can also be published as a [self-contained deployment](#) if you prefer not to maintain the .NET Core runtime on the server.

Copy the ASP.NET Core app to the server using a tool that integrates into the organization's workflow (for example, SCP, SFTP). It's common to locate web apps under the `var` directory (for example, `var/aspnetcore/hellomvc`).

#### NOTE

Under a production deployment scenario, a continuous integration workflow does the work of publishing the app and copying the assets to the server.

Test the app:

1. From the command line, run the app: `dotnet <app_assembly>.dll`.
2. In a browser, navigate to `http://<serveraddress>:<port>` to verify the app works on Linux locally.

## Configure a reverse proxy server

A reverse proxy is a common setup for serving dynamic web apps. A reverse proxy terminates the HTTP request and forwards it to the ASP.NET Core app.

#### NOTE

Either configuration—with or without a reverse proxy server—is a valid and supported hosting configuration for ASP.NET Core 2.0 or later apps. For more information, see [When to use Kestrel with a reverse proxy](#).

### Use a reverse proxy server

Kestrel is great for serving dynamic content from ASP.NET Core. However, the web serving capabilities aren't as feature rich as servers such as IIS, Apache, or Nginx. A reverse proxy server can offload work such as serving static content, caching requests, compressing requests, and SSL termination from the HTTP server. A reverse proxy server may reside on a dedicated machine or may be deployed alongside an HTTP server.

For the purposes of this guide, a single instance of Nginx is used. It runs on the same server, alongside the HTTP server. Based on requirements, a different setup may be chosen.

Because requests are forwarded by reverse proxy, use the [Forwarded Headers Middleware](#) from the [Microsoft.AspNetCore.HttpOverrides](#) package. The middleware updates the `Request.Scheme`, using the `X-Forwarded-Proto` header, so that redirect URIs and other security policies work correctly.

Any component that depends on the scheme, such as authentication, link generation, redirects, and geolocation, must be placed after invoking the Forwarded Headers Middleware. As a general rule, Forwarded Headers Middleware should run before other middleware except diagnostics and error handling middleware. This ordering ensures that the middleware relying on forwarded headers information can consume the header values for processing.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

Invoke the `UseForwardedHeaders` method in `Startup.Configure` before calling `UseAuthentication` or similar authentication scheme middleware. Configure the middleware to forward the `X-Forwarded-For` and `X-Forwarded-Proto` headers:

```
app.UseForwardedHeaders(new ForwardedHeadersOptions
{
    ForwardedHeaders = ForwardedHeaders.XForwardedFor | ForwardedHeaders.XForwardedProto
});

app.UseAuthentication();
```

If no `ForwardedHeadersOptions` are specified to the middleware, the default headers to forward are `None`.

Additional configuration might be required for apps hosted behind proxy servers and load balancers. For more information, see [Configure ASP.NET Core to work with proxy servers and load balancers](#).

## Install Nginx

Use `apt-get` to install Nginx. The installer creates a *systemd* init script that runs Nginx as daemon on system startup.

```
sudo -s
nginx=stable # use nginx=development for latest development version
add-apt-repository ppa:nginx/$nginx
apt-get update
apt-get install nginx
```

The Ubuntu Personal Package Archive (PPA) is maintained by volunteers and isn't distributed by [nginx.org](#). For more information, see [Nginx: Binary Releases: Official Debian/Ubuntu packages](#).

### NOTE

If optional Nginx modules are required, building Nginx from source might be required.

Since Nginx was installed for the first time, explicitly start it by running:

```
sudo service nginx start
```

Verify a browser displays the default landing page for Nginx. The landing page is reachable at

```
http://<server_IP_address>/index.nginx-debian.html .
```

## Configure Nginx

To configure Nginx as a reverse proxy to forward requests to your ASP.NET Core app, modify `/etc/nginx/sites-available/default`. Open it in a text editor, and replace the contents with the following:

```
server {
    listen      80;
    server_name example.com *.example.com;
    location / {
        proxy_pass          http://localhost:5000;
        proxy_http_version 1.1;
        proxy_set_header    Upgrade $http_upgrade;
        proxy_set_header    Connection keep-alive;
        proxy_set_header    Host $host;
        proxy_cache_bypass $http_upgrade;
        proxy_set_header    X-Forwarded-For $proxy_add_x_forwarded_for;
        proxy_set_header    X-Forwarded-Proto $scheme;
    }
}
```

When no `server_name` matches, Nginx uses the default server. If no default server is defined, the first server in the configuration file is the default server. As a best practice, add a specific default server which returns a status code of 444 in your configuration file. A default server configuration example is:

```
server {
    listen  80 default_server;
    # listen [::]:80 default_server deferred;
    return  444;
}
```

With the preceding configuration file and default server, Nginx accepts public traffic on port 80 with host header `example.com` or `*.example.com`. Requests not matching these hosts won't get forwarded to Kestrel. Nginx forwards the matching requests to Kestrel at `http://localhost:5000`. See [How nginx processes a request](#) for more information. To change Kestrel's IP/port, see [Kestrel: Endpoint configuration](#).

#### WARNING

Failure to specify a proper `server_name` directive exposes your app to security vulnerabilities. Subdomain wildcard binding (for example, `*.example.com`) doesn't pose this security risk if you control the entire parent domain (as opposed to `*.com`, which is vulnerable). See [rfc7230 section-5.4](#) for more information.

Once the Nginx configuration is established, run `sudo nginx -t` to verify the syntax of the configuration files. If the configuration file test is successful, force Nginx to pick up the changes by running `sudo nginx -s reload`.

To directly run the app on the server:

1. Navigate to the app's directory.
2. Run the app's executable: `./<app_executable>`.

If a permissions error occurs, change the permissions:

```
chmod u+x <app_executable>
```

If the app runs on the server but fails to respond over the Internet, check the server's firewall and confirm that port 80 is open. If using an Azure Ubuntu VM, add a Network Security Group (NSG) rule that enables inbound port 80 traffic. There's no need to enable an outbound port 80 rule, as the outbound traffic is automatically granted when the inbound rule is enabled.

When done testing the app, shut the app down with `ctrl+c` at the command prompt.

## Monitoring the app

The server is setup to forward requests made to `http://<serveraddress>:80` on to the ASP.NET Core app running on Kestrel at `http://127.0.0.1:5000`. However, Nginx isn't set up to manage the Kestrel process. `systemd` can be used to create a service file to start and monitor the underlying web app. `systemd` is an init system that provides many powerful features for starting, stopping, and managing processes.

### Create the service file

Create the service definition file:

```
sudo nano /etc/systemd/system/kestrel-hellomvc.service
```

The following is an example service file for the app:

```

[Unit]
Description=Example .NET Web API App running on Ubuntu

[Service]
WorkingDirectory=/var/aspnetcore/hellomvc
ExecStart=/usr/bin/dotnet /var/aspnetcore/hellomvc/hellomvc.dll
Restart=always
# Restart service after 10 seconds if the dotnet service crashes:
RestartSec=10
SyslogIdentifier=dotnet-example
User=www-data
Environment=ASPNETCORE_ENVIRONMENT=Production
Environment=DOTNET_PRINT_TELEMETRY_MESSAGE=false

[Install]
WantedBy=multi-user.target

```

If the user `www-data` isn't used by the configuration, the user defined here must be created first and given proper ownership for files.

Linux has a case-sensitive file system. Setting `ASPNETCORE_ENVIRONMENT` to "Production" results in searching for the configuration file `appsettings.Production.json`, not `appsettings.production.json`.

#### NOTE

Some values (for example, SQL connection strings) must be escaped for the configuration providers to read the environment variables. Use the following command to generate a properly escaped value for use in the configuration file:

```
systemd-escape "<value-to-escape>"
```

Save the file and enable the service.

```
systemctl enable kestrel-hellomvc.service
```

Start the service and verify that it's running.

```

systemctl start kestrel-hellomvc.service
systemctl status kestrel-hellomvc.service

● kestrel-hellomvc.service - Example .NET Web API App running on Ubuntu
   Loaded: loaded (/etc/systemd/system/kestrel-hellomvc.service; enabled)
   Active: active (running) since Thu 2016-10-18 04:09:35 NZDT; 35s ago
     Main PID: 9021 (dotnet)
        CGroup: /system.slice/kestrel-hellomvc.service
                  └─9021 /usr/local/bin/dotnet /var/aspnetcore/hellomvc/hellomvc.dll

```

With the reverse proxy configured and Kestrel managed through systemd, the web app is fully configured and can be accessed from a browser on the local machine at `http://localhost`. It's also accessible from a remote machine, barring any firewall that might be blocking. Inspecting the response headers, the `Server` header shows the ASP.NET Core app being served by Kestrel.

```
HTTP/1.1 200 OK
Date: Tue, 11 Oct 2016 16:22:23 GMT
Server: Kestrel
Keep-Alive: timeout=5, max=98
Connection: Keep-Alive
Transfer-Encoding: chunked
```

## Viewing logs

Since the web app using Kestrel is managed using `systemd`, all events and processes are logged to a centralized journal. However, this journal includes all entries for all services and processes managed by `systemd`. To view the `kestrel-hellomvc.service`-specific items, use the following command:

```
sudo journalctl -fu kestrel-hellomvc.service
```

For further filtering, time options such as `--since today`, `--until 1 hour ago` or a combination of these can reduce the amount of entries returned.

```
sudo journalctl -fu kestrel-hellomvc.service --since "2016-10-18" --until "2016-10-18 04:00"
```

## Securing the app

### Enable AppArmor

Linux Security Modules (LSM) is a framework that's part of the Linux kernel since Linux 2.6. LSM supports different implementations of security modules. [AppArmor](#) is a LSM that implements a Mandatory Access Control system which allows confining the program to a limited set of resources. Ensure AppArmor is enabled and properly configured.

### Configuring the firewall

Close off all external ports that are not in use. Uncomplicated firewall (ufw) provides a front end for `iptables` by providing a command line interface for configuring the firewall. Verify that `ufw` is configured to allow traffic on any ports needed.

```
sudo apt-get install ufw
sudo ufw enable

sudo ufw allow 80/tcp
sudo ufw allow 443/tcp
```

## Securing Nginx

### Change the Nginx response name

Edit `src/http/ngx_http_header_filter_module.c`:

```
static char ngx_http_server_string[] = "Server: Web Server" CRLF;
static char ngx_http_server_full_string[] = "Server: Web Server" CRLF;
```

### Configure options

Configure the server with additional required modules. Consider using a web app firewall, such as [ModSecurity](#), to harden the app.

### Configure SSL

- Configure the server to listen to HTTPS traffic on port `443` by specifying a valid certificate issued by a

trusted Certificate Authority (CA).

- Harden the security by employing some of the practices depicted in the following `/etc/nginx/nginx.conf` file. Examples include choosing a stronger cipher and redirecting all traffic over HTTP to HTTPS.
- Adding an `HTTP Strict-Transport-Security` (HSTS) header ensures all subsequent requests made by the client are over HTTPS only.
- Don't add the Strict-Transport-Security header or chose an appropriate `max-age` if SSL will be disabled in the future.

Add the `/etc/nginx/proxy.conf` configuration file:

```
proxy_redirect      off;
proxy_set_header    Host      $host;
proxy_set_header    X-Real-IP   $remote_addr;
proxy_set_header    X-Forwarded-For $proxy_add_x_forwarded_for;
proxy_set_header    X-Forwarded-Proto $scheme;
client_max_body_size 10m;
client_body_buffer_size 128k;
proxy_connect_timeout 90;
proxy_send_timeout 90;
proxy_read_timeout 90;
proxy_buffers 32 4k;
```

Edit the `/etc/nginx/nginx.conf` configuration file. The example contains both `http` and `server` sections in one configuration file.

```

http {
    include /etc/nginx/proxy.conf;
    limit_req_zone $binary_remote_addr zone=one:10m rate=5r/s;
    server_tokens off;

    sendfile on;
    keepalive_timeout 29; # Adjust to the lowest possible value that makes sense for your use case.
    client_body_timeout 10; client_header_timeout 10; send_timeout 10;

    upstream hellomvc{
        server localhost:5000;
    }

    server {
        listen *:80;
        add_header Strict-Transport-Security max-age=15768000;
        return 301 https://$host$request_uri;
    }

    server {
        listen *:443 ssl;
        server_name example.com;
        ssl_certificate /etc/ssl/certs/testCert.crt;
        ssl_certificate_key /etc/ssl/certs/testCert.key;
        ssl_protocols TLSv1.1 TLSv1.2;
        ssl_prefer_server_ciphers on;
        ssl_ciphers "EECDH+AESGCM:EDH+AESGCM:AES256+EECDH: AES256+EDH";
        ssl_ecdh_curve secp384r1;
        ssl_session_cache shared:SSL:10m;
        ssl_session_tickets off;
        ssl_stapling on; #ensure your cert is capable
        ssl_stapling_verify on; #ensure your cert is capable

        add_header Strict-Transport-Security "max-age=63072000; includeSubdomains; preload";
        add_header X-Frame-Options DENY;
        add_header X-Content-Type-Options nosniff;

        #Redirects all traffic
        location / {
            proxy_pass http://hellomvc;
            limit_req zone=one burst=10 nodelay;
        }
    }
}

```

### Secure Nginx from clickjacking

Clickjacking is a malicious technique to collect an infected user's clicks. Clickjacking tricks the victim (visitor) into clicking on an infected site. Use X-FRAME-OPTIONS to secure the site.

Edit the `nginx.conf` file:

```
sudo nano /etc/nginx/nginx.conf
```

Add the line `add_header X-Frame-Options "SAMEORIGIN";` and save the file, then restart Nginx.

### MIME-type sniffing

This header prevents most browsers from MIME-sniffing a response away from the declared content type, as the header instructs the browser not to override the response content type. With the `nosniff` option, if the server says the content is "text/html", the browser renders it as "text/html".

Edit the `nginx.conf` file:

```
sudo nano /etc/nginx/nginx.conf
```

Add the line `add_header X-Content-Type-Options "nosniff";` and save the file, then restart Nginx.

## Additional resources

- [Nginx: Binary Releases: Official Debian/Ubuntu packages](#)
- [Configure ASP.NET Core to work with proxy servers and load balancers](#)
- [NGINX: Using the Forwarded header](#)

# Host ASP.NET Core on Linux with Apache

7/3/2018 • 10 minutes to read • [Edit Online](#)

By [Shayne Boyer](#)

Using this guide, learn how to set up [Apache](#) as a reverse proxy server on [CentOS 7](#) to redirect HTTP traffic to an ASP.NET Core web app running on [Kestrel](#). The [mod\\_proxy extension](#) and related modules create the server's reverse proxy.

## Prerequisites

1. Server running CentOS 7 with a standard user account with sudo privilege.
2. Install the .NET Core runtime on the server.
  - a. Visit the [.NET Core All Downloads page](#).
  - b. Select the latest non-preview runtime from the list under **Runtime**.
  - c. Select and follow the instructions for CentOS/Oracle.
3. An existing ASP.NET Core app.

## Publish and copy over the app

Configure the app for a [framework-dependent deployment](#).

Run [dotnet publish](#) from the development environment to package an app into a directory (for example, `bin/Release/<target_framework_moniker>/publish`) that can run on the server:

```
dotnet publish --configuration Release
```

The app can also be published as a [self-contained deployment](#) if you prefer not to maintain the .NET Core runtime on the server.

Copy the ASP.NET Core app to the server using a tool that integrates into the organization's workflow (for example, SCP, SFTP). It's common to locate web apps under the `var` directory (for example, `var/aspnetcore/hellomvc`).

### NOTE

Under a production deployment scenario, a continuous integration workflow does the work of publishing the app and copying the assets to the server.

## Configure a proxy server

A reverse proxy is a common setup for serving dynamic web apps. The reverse proxy terminates the HTTP request and forwards it to the ASP.NET app.

A proxy server is one which forwards client requests to another server instead of fulfilling requests itself. A reverse proxy forwards to a fixed destination, typically on behalf of arbitrary clients. In this guide, Apache is configured as the reverse proxy running on the same server that Kestrel is serving the ASP.NET Core app.

Because requests are forwarded by reverse proxy, use the [Forwarded Headers Middleware](#) from the [Microsoft.AspNetCore.HttpOverrides](#) package. The middleware updates the `Request.Scheme`, using the

`X-Forwarded-Proto` header, so that redirect URIs and other security policies work correctly.

Any component that depends on the scheme, such as authentication, link generation, redirects, and geolocation, must be placed after invoking the Forwarded Headers Middleware. As a general rule, Forwarded Headers Middleware should run before other middleware except diagnostics and error handling middleware. This ordering ensures that the middleware relying on forwarded headers information can consume the header values for processing.

#### NOTE

Either configuration—with or without a reverse proxy server—is a valid and supported hosting configuration for ASP.NET Core 2.0 or later apps. For more information, see [When to use Kestrel with a reverse proxy](#).

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

Invoke the `UseForwardedHeaders` method in `Startup.Configure` before calling `UseAuthentication` or similar authentication scheme middleware. Configure the middleware to forward the `X-Forwarded-For` and `X-Forwarded-Proto` headers:

```
app.UseForwardedHeaders(new ForwardedHeadersOptions
{
    ForwardedHeaders = ForwardedHeaders.XForwardedFor | ForwardedHeaders.XForwardedProto
});

app.UseAuthentication();
```

If no `ForwardedHeadersOptions` are specified to the middleware, the default headers to forward are `None`.

Additional configuration might be required for apps hosted behind proxy servers and load balancers. For more information, see [Configure ASP.NET Core to work with proxy servers and load balancers](#).

## Install Apache

Update CentOS packages to their latest stable versions:

```
sudo yum update -y
```

Install the Apache web server on CentOS with a single `yum` command:

```
sudo yum -y install httpd mod_ssl
```

Sample output after running the command:

```
Downloading packages:  
httpd-2.4.6-40.el7.centos.4.x86_64.rpm | 2.7 MB 00:00:01  
Running transaction check  
Running transaction test  
Transaction test succeeded  
Running transaction  
Installing : httpd-2.4.6-40.el7.centos.4.x86_64 1/1  
Verifying : httpd-2.4.6-40.el7.centos.4.x86_64 1/1  
  
Installed:  
httpd.x86_64 0:2.4.6-40.el7.centos.4  
  
Complete!
```

#### NOTE

In this example, the output reflects httpd.86\_64 since the CentOS 7 version is 64 bit. To verify where Apache is installed, run `whereis httpd` from a command prompt.

## Configure Apache

Configuration files for Apache are located within the `/etc/httpd/conf.d/` directory. Any file with the `.conf` extension is processed in alphabetical order in addition to the module configuration files in `/etc/httpd/conf.modules.d/`, which contains any configuration files necessary to load modules.

Create a configuration file, named `hellomvc.conf`, for the app:

```
<VirtualHost *:*    RequestHeader set "X-Forwarded-Proto" expr=%{REQUEST_SCHEME}  
</VirtualHost>  
  
<VirtualHost *:80>  
    ProxyPreserveHost On  
    ProxyPass / http://127.0.0.1:5000/  
    ProxyPassReverse / http://127.0.0.1:5000/  
    ServerName www.example.com  
    ServerAlias *.example.com  
    ErrorLog ${APACHE_LOG_DIR}hellomvc-error.log  
    CustomLog ${APACHE_LOG_DIR}hellomvc-access.log common  
</VirtualHost>
```

The `VirtualHost` block can appear multiple times, in one or more files on a server. In the preceding configuration file, Apache accepts public traffic on port 80. The domain `www.example.com` is being served, and the `*.example.com` alias resolves to the same website. See [Name-based virtual host support](#) for more information. Requests are proxied at the root to port 5000 of the server at 127.0.0.1. For bi-directional communication, `ProxyPass` and `ProxyPassReverse` are required. To change Kestrel's IP/port, see [Kestrel: Endpoint configuration](#).

#### WARNING

Failure to specify a proper `ServerName` directive in the `VirtualHost` block exposes your app to security vulnerabilities. Subdomain wildcard binding (for example, `*.example.com`) doesn't pose this security risk if you control the entire parent domain (as opposed to `*.com`, which is vulnerable). See [rfc7230 section-5.4](#) for more information.

Logging can be configured per `VirtualHost` using `ErrorLog` and `CustomLog` directives. `ErrorLog` is the location where the server logs errors, and `CustomLog` sets the filename and format of log file. In this case, this is where request information is logged. There's one line for each request.

Save the file and test the configuration. If everything passes, the response should be `syntax [OK]`.

```
sudo service httpd configtest
```

Restart Apache:

```
sudo systemctl restart httpd
sudo systemctl enable httpd
```

## Monitoring the app

Apache is now setup to forward requests made to `http://localhost:80` to the ASP.NET Core app running on Kestrel at `http://127.0.0.1:5000`. However, Apache isn't set up to manage the Kestrel process. Use `systemd` and create a service file to start and monitor the underlying web app. `systemd` is an init system that provides many powerful features for starting, stopping, and managing processes.

### Create the service file

Create the service definition file:

```
sudo nano /etc/systemd/system/kestrel-hellomvc.service
```

An example service file for the app:

```
[Unit]
Description=Example .NET Web API App running on CentOS 7

[Service]
WorkingDirectory=/var/aspnetcore/hellomvc
ExecStart=/usr/local/bin/dotnet /var/aspnetcore/hellomvc/hellomvc.dll
Restart=always
# Restart service after 10 seconds if the dotnet service crashes:
RestartSec=10
SyslogIdentifier=dotnet-example
User=apache
Environment=ASPNETCORE_ENVIRONMENT=Production

[Install]
WantedBy=multi-user.target
```

#### NOTE

**User** — If the user `apache` isn't used by the configuration, the user must be created first and given proper ownership for files.

#### NOTE

Some values (for example, SQL connection strings) must be escaped for the configuration providers to read the environment variables. Use the following command to generate a properly escaped value for use in the configuration file:

```
systemd-escape "<value-to-escape>"
```

Save the file and enable the service:

```
sudo systemctl enable kestrel-hellomvc.service
```

Start the service and verify that it's running:

```
sudo systemctl start kestrel-hellomvc.service
sudo systemctl status kestrel-hellomvc.service

● kestrel-hellomvc.service - Example .NET Web API App running on CentOS 7
   Loaded: loaded (/etc/systemd/system/kestrel-hellomvc.service; enabled)
   Active: active (running) since Thu 2016-10-18 04:09:35 NZDT; 35s ago
     Main PID: 9021 (dotnet)
        CGroup: /system.slice/kestrel-hellomvc.service
                  └─9021 /usr/local/bin/dotnet /var/aspnetcore/hellomvc/hellomvc.dll
```

With the reverse proxy configured and Kestrel managed through *systemd*, the web app is fully configured and can be accessed from a browser on the local machine at `http://localhost`. Inspecting the response headers, the **Server** header indicates that the ASP.NET Core app is served by Kestrel:

```
HTTP/1.1 200 OK
Date: Tue, 11 Oct 2016 16:22:23 GMT
Server: Kestrel
Keep-Alive: timeout=5, max=98
Connection: Keep-Alive
Transfer-Encoding: chunked
```

## Viewing logs

Since the web app using Kestrel is managed using *systemd*, events and processes are logged to a centralized journal. However, this journal includes entries for all of the services and processes managed by *systemd*. To view the `kestrel-hellomvc.service`-specific items, use the following command:

```
sudo journalctl -fu kestrel-hellomvc.service
```

For time filtering, specify time options with the command. For example, use `--since today` to filter for the current day or `--until 1 hour ago` to see the previous hour's entries. For more information, see the [man page for journalctl](#).

```
sudo journalctl -fu kestrel-hellomvc.service --since "2016-10-18" --until "2016-10-18 04:00"
```

## Securing the app

### Configure firewall

*Firewalld* is a dynamic daemon to manage the firewall with support for network zones. Ports and packet filtering can still be managed by *iptables*. *Firewalld* should be installed by default. `yum` can be used to install the package or verify it's installed.

```
sudo yum install firewalld -y
```

Use `firewalld` to open only the ports needed for the app. In this case, port 80 and 443 are used. The following commands permanently set ports 80 and 443 to open:

```
sudo firewall-cmd --add-port=80/tcp --permanent  
sudo firewall-cmd --add-port=443/tcp --permanent
```

Reload the firewall settings. Check the available services and ports in the default zone. Options are available by inspecting `firewall-cmd -h`.

```
sudo firewall-cmd --reload  
sudo firewall-cmd --list-all
```

```
public (default, active)  
interfaces: eth0  
sources:  
services: dhcpcv6-client  
ports: 443/tcp 80/tcp  
masquerade: no  
forward-ports:  
icmp-blocks:  
rich rules:
```

## SSL configuration

To configure Apache for SSL, the `mod_ssl` module is used. When the `httpd` module was installed, the `mod_ssl` module was also installed. If it wasn't installed, use `yum` to add it to the configuration.

```
sudo yum install mod_ssl
```

To enforce SSL, install the `mod_rewrite` module to enable URL rewriting:

```
sudo yum install mod_rewrite
```

Modify the `hellomvc.conf` file to enable URL rewriting and secure communication on port 443:

```
<VirtualHost *:*>  
    RequestHeader set "X-Forwarded-Proto" expr=%{REQUEST_SCHEME}  
</VirtualHost>  
  
<VirtualHost *:80>  
    RewriteEngine On  
    RewriteCond %{HTTPS} !=on  
    RewriteRule ^/?(.*) https:// %{SERVER_NAME}/$1 [R,L]  
</VirtualHost>  
  
<VirtualHost *:443>  
    ProxyPreserveHost On  
    ProxyPass / http://127.0.0.1:5000/  
    ProxyPassReverse / http://127.0.0.1:5000/  
    ErrorLog /var/log/httpd/hellomvc-error.log  
    CustomLog /var/log/httpd/hellomvc-access.log common  
    SSLEngine on  
    SSLProtocol all -SSLv2  
    SSLCipherSuite ALL:!ADH:!EXPORT:!SSLv2:!RC4+RSA:+HIGH:+MEDIUM:!LOW:!RC4  
    SSLCertificateFile /etc/pki/tls/certs/localhost.crt  
    SSLCertificateKeyFile /etc/pki/tls/private/localhost.key  
</VirtualHost>
```

#### NOTE

This example is using a locally-generated certificate. **SSLCertificateFile** should be the primary certificate file for the domain name. **SSLCertificateKeyFile** should be the key file generated when CSR is created. **SSLCertificateChainFile** should be the intermediate certificate file (if any) that was supplied by the certificate authority.

Save the file and test the configuration:

```
sudo service httpd configtest
```

Restart Apache:

```
sudo systemctl restart httpd
```

## Additional Apache suggestions

### Additional headers

In order to secure against malicious attacks, there are a few headers that should either be modified or added.

Ensure that the `mod_headers` module is installed:

```
sudo yum install mod_headers
```

#### Secure Apache from clickjacking attacks

[Clickjacking](#), also known as a *UI redress attack*, is a malicious attack where a website visitor is tricked into clicking a link or button on a different page than they're currently visiting. Use `X-FRAME-OPTIONS` to secure the site.

Edit the `httpd.conf` file:

```
sudo nano /etc/httpd/conf/httpd.conf
```

Add the line `Header append X-FRAME-OPTIONS "SAMEORIGIN"`. Save the file. Restart Apache.

#### MIME-type sniffing

The `x-Content-Type-Options` header prevents Internet Explorer from *MIME-sniffing* (determining a file's `Content-Type` from the file's content). If the server sets the `Content-Type` header to `text/html` with the `nosniff` option set, Internet Explorer renders the content as `text/html` regardless of the file's content.

Edit the `httpd.conf` file:

```
sudo nano /etc/httpd/conf/httpd.conf
```

Add the line `Header set X-Content-Type-Options "nosniff"`. Save the file. Restart Apache.

#### Load Balancing

This example shows how to setup and configure Apache on CentOS 7 and Kestrel on the same instance machine. In order to not have a single point of failure; using `mod_proxy_balancer` and modifying the **VirtualHost** would allow for managing multiple instances of the web apps behind the Apache proxy server.

```
sudo yum install mod_proxy_balancer
```

In the configuration file shown below, an additional instance of the `hellomvc` app is setup to run on port 5001. The *Proxy* section is set with a balancer configuration with two members to load balance *byrequests*.

```
<VirtualHost *:*>
    RequestHeader set "X-Forwarded-Proto" expr=%{REQUEST_SCHEME}
</VirtualHost>

<VirtualHost *:80>
    RewriteEngine On
    RewriteCond %{HTTPS} !=on
    RewriteRule ^/?(.*) https:// %{SERVER_NAME}/$1 [R,L]
</VirtualHost>

<VirtualHost *:443>
    ProxyPass / balancer://mycluster/

    ProxyPassReverse / http://127.0.0.1:5000/
    ProxyPassReverse / http://127.0.0.1:5001/

    <Proxy balancer://mycluster>
        BalancerMember http://127.0.0.1:5000
        BalancerMember http://127.0.0.1:5001
        ProxySet lbmethod=byrequests
    </Proxy>

    <Location />
        SetHandler balancer
    </Location>
    ErrorLog /var/log/httpd/hellomvc-error.log
    CustomLog /var/log/httpd/hellomvc-access.log common
    SSLEngine on
    SSLProtocol all -SSLv2
    SSLCipherSuite ALL:!ADH:!EXPORT:!SSLv2:!RC4+RSA:+HIGH:+MEDIUM:!LOW:!RC4
    SSLCertificateFile /etc/pki/tls/certs/localhost.crt
    SSLCertificateKeyFile /etc/pki/tls/private/localhost.key
</VirtualHost>
```

## Rate Limits

Using *mod\_ratelimit*, which is included in the *httpd* module, the bandwidth of clients can be limited:

```
sudo nano /etc/httpd/conf.d/ratelimit.conf
```

The example file limits bandwidth as 600 KB/sec under the root location:

```
<IfModule mod_ratelimit.c>
    <Location />
        SetOutputFilter RATE_LIMIT
        SetEnv rate-limit 600
    </Location>
</IfModule>
```

## Additional resources

- [Configure ASP.NET Core to work with proxy servers and load balancers](#)

# Host ASP.NET Core in Docker containers

6/21/2018 • 2 minutes to read • [Edit Online](#)

The following articles are available for learning about hosting ASP.NET Core apps in Docker:

## [Introduction to Containers and Docker](#)

See how containerization is an approach to software development in which an application or service, its dependencies, and its configuration are packaged together as a container image. The image can be tested and then deployed to a host.

## [What is Docker](#)

Discover how Docker is an open-source project for automating the deployment of apps as portable, self-sufficient containers that can run on the cloud or on-premises.

## [Docker Terminology](#)

Learn terms and definitions for Docker technology.

## [Docker containers, images, and registries](#)

Find out how Docker container images are stored in an image registry for consistent deployment across environments.

## [Build Docker Images for .NET Core Applications](#)

Learn how to build and dockerize an ASP.NET Core app. Explore Docker images maintained by Microsoft and examine use cases.

## [Visual Studio Tools for Docker](#)

Discover how Visual Studio 2017 supports building, debugging, and running ASP.NET Core apps targeting either .NET Framework or .NET Core on Docker for Windows. Both Windows and Linux containers are supported.

## [Publish to a Docker Image](#)

Find out how to use the Visual Studio Tools for Docker extension to deploy an ASP.NET Core app to a Docker host on Azure using PowerShell.

## [Configure ASP.NET Core to work with proxy servers and load balancers](#)

Additional configuration might be required for apps hosted behind proxy servers and load balancers. Passing requests through a proxy often obscures information about the original request, such as the scheme and client IP. It might be necessary to forward some information about the request manually to the app.

# Visual Studio Tools for Docker with ASP.NET Core

6/21/2018 • 5 minutes to read • [Edit Online](#)

Visual Studio 2017 supports building, debugging, and running containerized ASP.NET Core apps targeting .NET Core. Both Windows and Linux containers are supported.

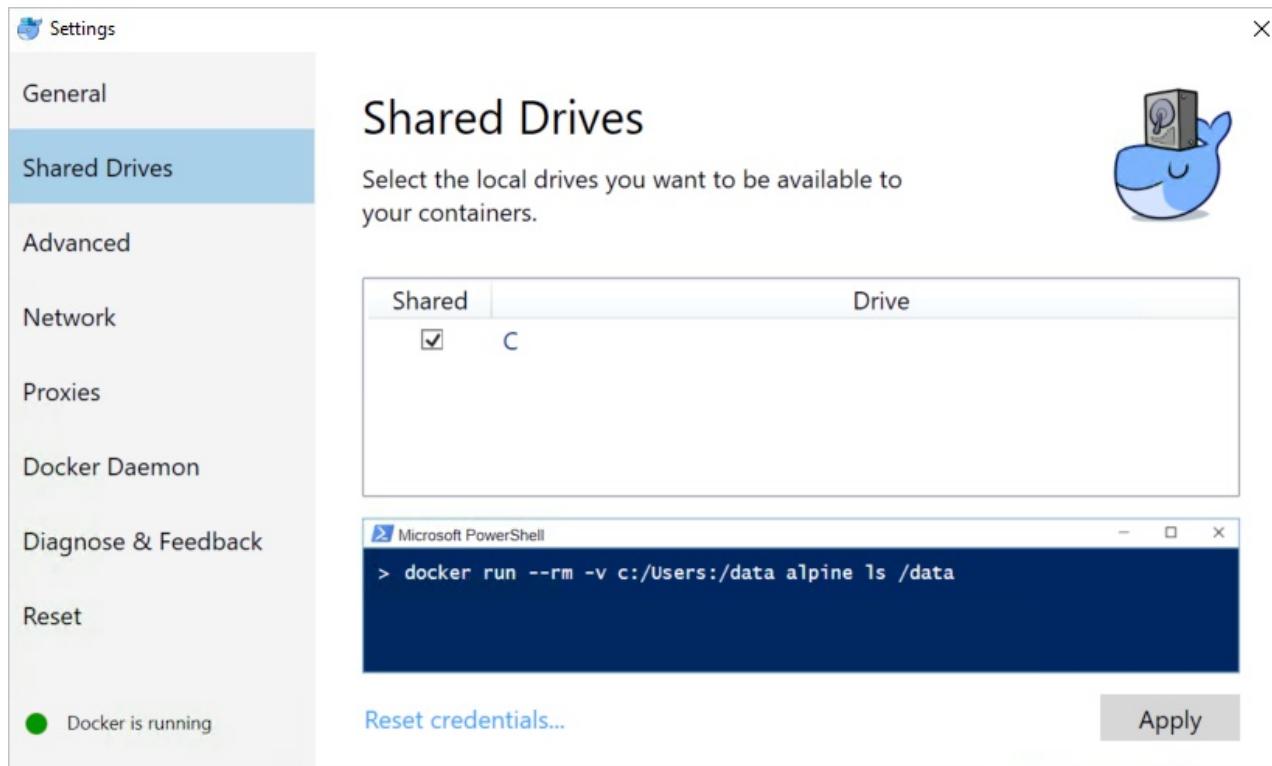
## Prerequisites

- Visual Studio 2017 with the **.NET Core cross-platform development** workload
- Docker for Windows

## Installation and setup

For Docker installation, review the information at [Docker for Windows: What to know before you install](#) and install [Docker For Windows](#).

**Shared Drives** in Docker for Windows must be configured to support volume mapping and debugging. Right-click the System Tray's Docker icon, select **Settings...**, and select **Shared Drives**. Select the drive where Docker stores files. Select **Apply**.



### TIP

Visual Studio 2017 versions 15.6 and later prompt when **Shared Drives** aren't configured.

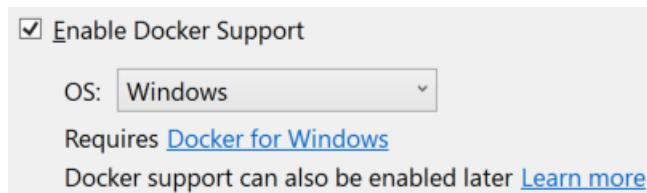
## Add Docker support to an app

In order to add Docker support to an ASP.NET Core project, the project must target .NET Core. Both Linux and Windows containers are supported.

When adding Docker support to a project, choose either a Windows or a Linux container. The Docker host must be running the same container type. To change the container type in the running Docker instance, right-click the System Tray's Docker icon and choose **Switch to Windows containers...** or **Switch to Linux containers...**

## New app

When creating a new app with the **ASP.NET Core Web Application** project templates, select the **Enable Docker Support** checkbox:



If the target framework is .NET Core, the **OS** drop-down allows for the selection of a container type.

## Existing app

The Visual Studio Tools for Docker don't support adding Docker to an existing ASP.NET Core project targeting .NET Framework. For ASP.NET Core projects targeting .NET Core, there are two options for adding Docker support via the tooling. Open the project in Visual Studio, and choose one of the following options:

- Select **Docker Support** from the **Project** menu.
- Right-click the project in Solution Explorer and select **Add > Docker Support**.

## Docker assets overview

The Visual Studio Tools for Docker add a *docker-compose* project to the solution, containing the following:

- *.dockerignore*: Contains a list of file and directory patterns to exclude when generating a build context.
- *docker-compose.yml*: The base **Docker Compose** file used to define the collection of images to be built and run with `docker-compose build` and `docker-compose run`, respectively.
- *docker-compose.override.yml*: An optional file, read by Docker Compose, containing configuration overrides for services. Visual Studio executes `docker-compose -f "docker-compose.yml" -f "docker-compose.override.yml"` to merge these files.

A *Dockerfile*, the recipe for creating a final Docker image, is added to the project root. Refer to [Dockerfile reference](#) for an understanding of the commands within it. This particular *Dockerfile* uses a [multi-stage build](#) containing four distinct, named build stages:

```

FROM microsoft/aspnetcore:2.0-nanoserver-1709 AS base
WORKDIR /app
EXPOSE 80

FROM microsoft/aspnetcore-build:2.0-nanoserver-1709 AS build
WORKDIR /src
COPY *.sln ./.
COPY HelloDockerTools/HelloDockerTools.csproj HelloDockerTools/
RUN dotnet restore
COPY . .
WORKDIR /src/HelloDockerTools
RUN dotnet build -c Release -o /app

FROM build AS publish
RUN dotnet publish -c Release -o /app

FROM base AS final
WORKDIR /app
COPY --from=publish /app .
ENTRYPOINT ["dotnet", "HelloDockerTools.dll"]

```

The *Dockerfile* is based on the [microsoft/aspnetcore](#) image. This base image includes the ASP.NET Core NuGet packages, which have been pre-jitted to improve startup performance.

The *docker-compose.yml* file contains the name of the image that's created when the project runs:

```

version: '3'

services:
  hellodockertools:
    image: hellodockertools
    build:
      context: .
    dockerfile: HelloDockerTools\Dockerfile

```

In the preceding example, `image: hellodockertools` generates the image `hellodockertools:dev` when the app runs in **Debug** mode. The `hellodockertools:latest` image is generated when the app runs in **Release** mode.

Prefix the image name with the [Docker Hub](#) username (for example, `dockerhubusername/hellodockertools`) if the image will be pushed to the registry. Alternatively, change the image name to include the private registry URL (for example, `privateregistry.domain.com/hellodockertools`) depending on the configuration.

## Debug

Select **Docker** from the debug drop-down in the toolbar, and start debugging the app. The **Docker** view of the **Output** window shows the following actions taking place:

- The *microsoft/aspnetcore* runtime image is acquired (if not already in the cache).
- The *microsoft/aspnetcore-build* compile/publish image is acquired (if not already in the cache).
- The *ASPNETCORE\_ENVIRONMENT* environment variable is set to `Development` within the container.
- Port 80 is exposed and mapped to a dynamically-assigned port for localhost. The port is determined by the Docker host and can be queried with the `docker ps` command.
- The app is copied to the container.
- The default browser is launched with the debugger attached to the container using the dynamically-assigned port.

The resulting Docker image is the *dev* image of the app with the *microsoft/aspnetcore* images as the base image. Run the `docker images` command in the **Package Manager Console** (PMC) window. The images on the machine

are displayed:

REPOSITORY	TAG	IMAGE ID	CREATED	SIZE
hellodockertools	latest	f8f9d6c923e2	About an hour ago	391MB
hellodockertools	dev	85c5ffee5258	About an hour ago	389MB
microsoft/aspnetcore-build	2.0-nanoserver-1709	d7cce94e3eb0	15 hours ago	1.86GB
microsoft/aspnetcore	2.0-nanoserver-1709	8872347d7e5d	40 hours ago	389MB

#### NOTE

The dev image lacks the app contents, as **Debug** configurations use volume mounting to provide the iterative experience. To push an image, use the **Release** configuration.

Run the `docker ps` command in PMC. Notice the app is running using the container:

CONTAINER ID	IMAGE	COMMAND	CREATED	STATUS
PORTS	NAMES			
baf9a678c88d	hellodockertools:dev	"C:\\remote_debugge..."	21 seconds ago	Up 19 seconds
0.0.0.0:37630->80/tcp	dockercompose4642749010770307127_hellodockertools_1			

## Edit and continue

Changes to static files and Razor views are automatically updated without the need for a compilation step. Make the change, save, and refresh the browser to view the update.

Modifications to code files requires compiling and a restart of Kestrel within the container. After making the change, use CTRL + F5 to perform the process and start the app within the container. The Docker container isn't rebuilt or stopped. Run the `docker ps` command in PMC. Notice the original container is still running as of 10 minutes ago:

CONTAINER ID	IMAGE	COMMAND	CREATED	STATUS
PORTS	NAMES			
baf9a678c88d	hellodockertools:dev	"C:\\remote_debugge..."	10 minutes ago	Up 10 minutes
0.0.0.0:37630->80/tcp	dockercompose4642749010770307127_hellodockertools_1			

## Publish Docker images

Once the develop and debug cycle of the app is completed, the Visual Studio Tools for Docker assist in creating the production image of the app. Change the configuration drop-down to **Release** and build the app. The tooling produces the image with the *latest* tag, which can be pushed to the private registry or Docker Hub.

Run the `docker images` command in PMC to see the list of images:

REPOSITORY	TAG	IMAGE ID	CREATED	SIZE
hellodockertools	latest	4cb1fca533f0	19 seconds ago	391MB
hellodockertools	dev	85c5ffee5258	About an hour ago	389MB
microsoft/aspnetcore-build	2.0-nanoserver-1709	d7cce94e3eb0	16 hours ago	1.86GB
microsoft/aspnetcore	2.0-nanoserver-1709	8872347d7e5d	40 hours ago	389MB

**NOTE**

The `docker images` command returns intermediary images with repository names and tags identified as `<none>` (not listed above). These unnamed images are produced by the [multi-stage build Dockerfile](#). They improve the efficiency of building the final image—only the necessary layers are rebuilt when changes occur. When the intermediary images are no longer needed, delete them using the `docker rmi` command.

There may be an expectation for the production or release image to be smaller in size by comparison to the *dev* image. Because of the volume mapping, the debugger and app were running from the local machine and not within the container. The *latest* image has packaged the necessary app code to run the app on a host machine. Therefore, the delta is the size of the app code.

# Configure ASP.NET Core to work with proxy servers and load balancers

7/10/2018 • 10 minutes to read • [Edit Online](#)

By [Luke Latham](#) and [Chris Ross](#)

In the recommended configuration for ASP.NET Core, the app is hosted using IIS/ASP.NET Core Module, Nginx, or Apache. Proxy servers, load balancers, and other network appliances often obscure information about the request before it reaches the app:

- When HTTPS requests are proxied over HTTP, the original scheme (HTTPS) is lost and must be forwarded in a header.
- Because an app receives a request from the proxy and not its true source on the Internet or corporate network, the originating client IP address must also be forwarded in a header.

This information may be important in request processing, for example in redirects, authentication, link generation, policy evaluation, and client geolocation.

## Forwarded headers

By convention, proxies forward information in HTTP headers.

HEADER	DESCRIPTION
X-Forwarded-For	Holds information about the client that initiated the request and subsequent proxies in a chain of proxies. This parameter may contain IP addresses (and, optionally, port numbers). In a chain of proxy servers, the first parameter indicates the client where the request was first made. Subsequent proxy identifiers follow. The last proxy in the chain isn't in the list of parameters. The last proxy's IP address, and optionally a port number, are available as the remote IP address at the transport layer.
X-Forwarded-Proto	The value of the originating scheme (HTTP/HTTPS). The value may also be a list of schemes if the request has traversed multiple proxies.
X-Forwarded-Host	The original value of the Host header field. Usually, proxies don't modify the Host header. See <a href="#">Microsoft Security Advisory CVE-2018-0787</a> for information on an elevation-of-privileges vulnerability that affects systems where the proxy doesn't validate or restrict Host headers to known good values.

The Forwarded Headers Middleware, from the [Microsoft.AspNetCore.HttpOverrides](#) package, reads these headers and fills in the associated fields on [HttpContext](#).

The middleware updates:

- `HttpContext.Connection.RemoteIpAddress` – Set using the `X-Forwarded-For` header value. Additional settings influence how the middleware sets `RemoteIpAddress`. For details, see the [Forwarded Headers Middleware options](#).

- `HttpContext.Request.Scheme` – Set using the `X-Forwarded-Proto` header value.
- `HttpContext.Request.Host` – Set using the `X-Forwarded-Host` header value.

Forwarded Headers Middleware [default settings](#) can be configured. The default settings are:

- There is only *one proxy* between the app and the source of the requests.
- Only loopback addresses are configured for known proxies and known networks.
- The forwarded headers are named `X-Forwarded-For` and `X-Forwarded-Proto`.

Not all network appliances add the `X-Forwarded-For` and `X-Forwarded-Proto` headers without additional configuration. Consult your appliance manufacturer's guidance if proxied requests don't contain these headers when they reach the app. If the appliance uses different header names than `X-Forwarded-For` and `X-Forwarded-Proto`, set the `ForwardedForHeaderName` and `ForwardedProtoHeaderName` options to match the header names used by the appliance. For more information, see [Forwarded Headers Middleware options](#) and [Configuration for a proxy that uses different header names](#).

## IIS/IIS Express and ASP.NET Core Module

Forwarded Headers Middleware is enabled by default by IIS Integration Middleware when the app is run behind IIS and the ASP.NET Core Module. Forwarded Headers Middleware is activated to run first in the middleware pipeline with a restricted configuration specific to the ASP.NET Core Module due to trust concerns with forwarded headers (for example, [IP spoofing](#)). The middleware is configured to forward the `X-Forwarded-For` and `X-Forwarded-Proto` headers and is restricted to a single localhost proxy. If additional configuration is required, see the [Forwarded Headers Middleware options](#).

## Other proxy server and load balancer scenarios

Outside of using IIS Integration Middleware, Forwarded Headers Middleware isn't enabled by default. Forwarded Headers Middleware must be enabled for an app to process forwarded headers with `UseForwardedHeaders`. After enabling the middleware if no `ForwardedHeadersOptions` are specified to the middleware, the default `ForwardedHeadersOptions.ForwardedHeaders` are `ForwardedHeaders.None`.

Configure the middleware with `ForwardedHeadersOptions` to forward the `X-Forwarded-For` and `X-Forwarded-Proto` headers in `Startup.ConfigureServices`. Invoke the `UseForwardedHeaders` method in `Startup.Configure` before calling other middleware:

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc();

    services.Configure<ForwardedHeadersOptions>(options =>
    {
        options.ForwardedHeaders =
            ForwardedHeaders.XForwardedFor | ForwardedHeaders.XForwardedProto;
    });
}

public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    app.UseForwardedHeaders();

    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
    }
    else
    {
        app.UseExceptionHandler("/Home/Error");
    }

    app.UseStaticFiles();
    // In ASP.NET Core 1.x, replace the following line with: app.UseIdentity();
    app.UseAuthentication();
    app.UseMvc();
}

```

#### NOTE

If no `ForwardedHeadersOptions` are specified in `Startup.ConfigureServices` or directly to the extension method with `UseForwardedHeaders(IApplicationBuilder, ForwardedHeadersOptions)`, the default headers to forward are `ForwardedHeaders.None`. The `ForwardedHeadersOptions.ForwardedHeaders` property must be configured with the headers to forward.

## Nginx configuration

To forward the `X-Forwarded-For` and `X-Forwarded-Proto` headers, see [Host ASP.NET Core on Linux with Nginx](#). For more information, see [NGINX: Using the Forwarded header](#).

## Apache configuration

`X-Forwarded-For` is added automatically (see [Apache Module mod\\_proxy: Reverse Proxy Request Headers](#)). For information on how to forward the `X-Forwarded-Proto` header, see [Host ASP.NET Core on Linux with Apache](#).

## Forwarded Headers Middleware options

`ForwardedHeadersOptions` control the behavior of the Forwarded Headers Middleware. The following example changes the default values:

- Limit the number of entries in the forwarded headers to `2`.
- Add a known proxy address of `127.0.10.1`.
- Change the forwarded header name from the default `X-Forwarded-For` to `X-Forwarded-For-My-Custom-Header-Name`.

```

services.Configure<ForwardedHeadersOptions>(options =>
{
    options.ForwardLimit = 2;
    options.KnownProxies.Add(IPAddress.Parse("127.0.10.1"));
    options.ForwardedForHeaderName = "X-Forwarded-For-My-Custom-Header-Name";
});

```

OPTION	DESCRIPTION
AllowedHosts	<p>Restricts hosts by the <code>X-Forwarded-Host</code> header to the values provided.</p> <ul style="list-style-type: none"> <li>Values are compared using ordinal-ignore-case.</li> <li>Port numbers must be excluded.</li> <li>If the list is empty, all hosts are allowed.</li> <li>A top-level wildcard <code>*</code> allows all non-empty hosts.</li> <li>Subdomain wildcards are permitted but don't match the root domain. For example, <code>*.contoso.com</code> matches the subdomain <code>foo.contoso.com</code> but not the root domain <code>contoso.com</code>.</li> <li>Unicode host names are allowed but are converted to <a href="#">Punycode</a> for matching.</li> <li><a href="#">IPv6 addresses</a> must include bounding brackets and be in <a href="#">conventional form</a> (for example, <code>[ABCD:EF01:2345:6789:ABCD:EF01:2345:6789]</code>). IPv6 addresses aren't special-cased to check for logical equality between different formats, and no canonicalization is performed.</li> <li>Failure to restrict the allowed hosts may allow an attacker to spoof links generated by the service.</li> </ul> <p>The default value is an empty <code>IList&lt;string&gt;</code>.</p>
ForwardedForHeaderName	<p>Use the header specified by this property instead of the one specified by <a href="#">ForwardedHeadersDefaults.XForwardedForHeaderName</a>. This option is used when the proxy/forwarder doesn't use the <code>X-Forwarded-For</code> header but uses some other header to forward the information.</p> <p>The default is <code>X-Forwarded-For</code>.</p>
ForwardedHeaders	<p>Identifies which forwarders should be processed. See the <a href="#">ForwardedHeaders Enum</a> for the list of fields that apply. Typical values assigned to this property are <code>ForwardedHeaders.XForwardedFor   ForwardedHeaders.XForwardedProto</code>.</p> <p>The default value is <code>ForwardedHeaders.None</code>.</p>
ForwardedHostHeaderName	<p>Use the header specified by this property instead of the one specified by <a href="#">ForwardedHeadersDefaults.XForwardedHostHeaderName</a>. This option is used when the proxy/forwarder doesn't use the <code>X-Forwarded-Host</code> header but uses some other header to forward the information.</p> <p>The default is <code>X-Forwarded-Host</code>.</p>

OPTION	DESCRIPTION
ForwardedProtoHeaderName	<p>Use the header specified by this property instead of the one specified by <a href="#">ForwardedHeadersDefaults.XForwardedProtoHeaderName</a>.</p> <p>This option is used when the proxy/forwarder doesn't use the <code>X-Forwarded-Proto</code> header but uses some other header to forward the information.</p> <p>The default is <code>X-Forwarded-Proto</code>.</p>
ForwardLimit	<p>Limits the number of entries in the headers that are processed. Set to <code>null</code> to disable the limit, but this should only be done if <code>KnownProxies</code> or <code>KnownNetworks</code> are configured.</p> <p>The default is 1.</p>
KnownNetworks	<p>Address ranges of known proxies to accept forwarded headers from. Provide IP ranges using Classless Interdomain Routing (CIDR) notation.</p> <p>The default is an <code>IList&lt;IPNetwork&gt;</code> containing a single entry for <code>IPAddress.Loopback</code>.</p>
KnownProxies	<p>Addresses of known proxies to accept forwarded headers from. Use <code>KnownProxies</code> to specify exact IP address matches.</p> <p>The default is an <code>IList&lt;IPAddress&gt;</code> containing a single entry for <code>IPAddress.IPv6Loopback</code>.</p>
OriginalForHeaderName	<p>Use the header specified by this property instead of the one specified by <a href="#">ForwardedHeadersDefaults.XOriginalForHeaderName</a>.</p> <p>The default is <code>x-Original-For</code>.</p>
OriginalHostHeaderName	<p>Use the header specified by this property instead of the one specified by <a href="#">ForwardedHeadersDefaults.XOriginalHostHeaderName</a>.</p> <p>The default is <code>x-Original-Host</code>.</p>
OriginalProtoHeaderName	<p>Use the header specified by this property instead of the one specified by <a href="#">ForwardedHeadersDefaults.XOriginalProtoHeaderName</a>.</p> <p>The default is <code>x-Original-Proto</code>.</p>
RequireHeaderSymmetry	<p>Require the number of header values to be in sync between the <code>ForwardedHeadersOptions.ForwardedHeaders</code> being processed.</p> <p>The default in ASP.NET Core 1.x is <code>true</code>. The default in ASP.NET Core 2.0 or later is <code>false</code>.</p>

OPTION	DESCRIPTION
ForwardedForHeaderName	<p>Use the header specified by this property instead of the one specified by <a href="#">ForwardedHeadersDefaults.XForwardedForHeaderName</a>. This option is used when the proxy/forwarder doesn't use the <code>X-Forwarded-For</code> header but uses some other header to forward the information.</p> <p>The default is <code>X-Forwarded-For</code>.</p>
ForwardedHeaders	<p>Identifies which forwarders should be processed. See the <a href="#">ForwardedHeaders Enum</a> for the list of fields that apply. Typical values assigned to this property are <code>ForwardedHeaders.XForwardedFor   ForwardedHeaders.XForwardedProto</code>.</p> <p>The default value is <code>ForwardedHeaders.None</code>.</p>
ForwardedHostHeaderName	<p>Use the header specified by this property instead of the one specified by <a href="#">ForwardedHeadersDefaults.XForwardedHostHeaderName</a>. This option is used when the proxy/forwarder doesn't use the <code>X-Forwarded-Host</code> header but uses some other header to forward the information.</p> <p>The default is <code>X-Forwarded-Host</code>.</p>
ForwardedProtoHeaderName	<p>Use the header specified by this property instead of the one specified by <a href="#">ForwardedHeadersDefaults.XForwardedProtoHeaderName</a>. This option is used when the proxy/forwarder doesn't use the <code>X-Forwarded-Proto</code> header but uses some other header to forward the information.</p> <p>The default is <code>X-Forwarded-Proto</code>.</p>
ForwardLimit	<p>Limits the number of entries in the headers that are processed. Set to <code>null</code> to disable the limit, but this should only be done if <code>KnownProxies</code> or <code>KnownNetworks</code> are configured.</p> <p>The default is 1.</p>
KnownNetworks	<p>Address ranges of known proxies to accept forwarded headers from. Provide IP ranges using Classless Interdomain Routing (CIDR) notation.</p> <p>The default is an <code>IList&lt;IPNetwork&gt;</code> containing a single entry for <code>IPAddress.Loopback</code>.</p>
KnownProxies	<p>Addresses of known proxies to accept forwarded headers from. Use <code>KnownProxies</code> to specify exact IP address matches.</p> <p>The default is an <code>IList&lt;IPAddress&gt;</code> containing a single entry for <code>IPAddress.IPv6Loopback</code>.</p>

OPTION	DESCRIPTION
OriginalForHeaderName	Use the header specified by this property instead of the one specified by <code>ForwardedHeadersDefaults.XOriginalForHeaderName</code> . The default is <code>x-Original-For</code> .
OriginalHostHeaderName	Use the header specified by this property instead of the one specified by <code>ForwardedHeadersDefaults.XOriginalHostHeaderName</code> . The default is <code>x-Original-Host</code> .
OriginalProtoHeaderName	Use the header specified by this property instead of the one specified by <code>ForwardedHeadersDefaults.XOriginalProtoHeaderName</code> . The default is <code>x-Original-Proto</code> .
RequireHeaderSymmetry	Require the number of header values to be in sync between the <code>ForwardedHeadersOptions.ForwardedHeaders</code> being processed. The default in ASP.NET Core 1.x is <code>true</code> . The default in ASP.NET Core 2.0 or later is <code>false</code> .

## Scenarios and use cases

### When it isn't possible to add forwarded headers and all requests are secure

In some cases, it might not be possible to add forwarded headers to the requests proxied to the app. If the proxy is enforcing that all public external requests are HTTPS, the scheme can be manually set in `Startup.Configure` before using any type of middleware:

```
app.Use((context, next) =>
{
    context.Request.Scheme = "https";
    return next();
});
```

This code can be disabled with an environment variable or other configuration setting in a development or staging environment.

### Deal with path base and proxies that change the request path

Some proxies pass the path intact but with an app base path that should be removed so that routing works properly. `UsePathBaseExtensions.UsePathBase` middleware splits the path into `HttpRequest.Path` and the app base path into `HttpRequest.PathBase`.

If `/foo` is the app base path for a proxy path passed as `/foo/api/1`, the middleware sets `Request.PathBase` to `/foo` and `Request.Path` to `/api/1` with the following command:

```
app.UsePathBase("/foo");
```

The original path and path base are reapplied when the middleware is called again in reverse. For more information on middleware order processing, see [ASP.NET Core Middleware](#).

If the proxy trims the path (for example, forwarding `/foo/api/1` to `/api/1`), fix redirects and links by setting the request's [PathBase](#) property:

```
app.Use((context, next) =>
{
    context.Request.PathBase = new PathString("/foo");
    return next();
});
```

If the proxy is adding path data, discard part of the path to fix redirects and links by using [StartsWithSegments\(PathString, PathString\)](#) and assigning to the [Path](#) property:

```
app.Use((context, next) =>
{
    if (context.Request.Path.StartsWithSegments("/foo", out var remainder))
    {
        context.Request.Path = remainder;
    }

    return next();
});
```

### Configuration for a proxy that uses different header names

If the proxy doesn't use headers named `X-Forwarded-For` and `X-Forwarded-Proto` to forward the proxy address/port and originating scheme information, set the [ForwardedForHeaderName](#) and [ForwardedProtoHeaderName](#) options to match the header names used by the proxy:

```
services.Configure<ForwardedHeadersOptions>(options =>
{
    options.ForwardedForHeaderName = "Header_Name_Used_By_Proxy_For_X-Forwarded-For_Header";
    options.ForwardedProtoHeaderName = "Header_Name_Used_By_Proxy_For_X-Forwarded-Proto_Header";
});
```

## Troubleshoot

When headers aren't forwarded as expected, enable [logging](#). If the logs don't provide sufficient information to troubleshoot the problem, enumerate the request headers received by the server. The headers can be written to an app response using inline middleware:

```

public void Configure(IApplicationBuilder app, ILoggerFactory loggerfactory)
{
    app.Run(async (context) =>
    {
        context.Response.ContentType = "text/plain";

        // Request method, scheme, and path
        await context.Response.WriteAsync(
            $"Request Method: {context.Request.Method}{Environment.NewLine}");
        await context.Response.WriteAsync(
            $"Request Scheme: {context.Request.Scheme}{Environment.NewLine}");
        await context.Response.WriteAsync(
            $"Request Path: {context.Request.Path}{Environment.NewLine}");

        // Headers
        await context.Response.WriteAsync($"Request Headers:{Environment.NewLine}");

        foreach (var header in context.Request.Headers)
        {
            await context.Response.WriteAsync($"{header.Key}: " +
                $"{header.Value}{Environment.NewLine}");
        }

        await context.Response.WriteAsync(Environment.NewLine);

        // Connection: RemoteIp
        await context.Response.WriteAsync(
            $"Request RemoteIp: {context.Connection.RemoteIpAddress}");
    });
}

```

Ensure that the X-Forwarded-\* headers are received by the server with the expected values. If there are multiple values in a given header, note Forwarded Headers Middleware processes headers in reverse order from right to left.

The request's original remote IP must match an entry in the `KnownProxies` or `KnownNetworks` lists before X-Forwarded-For is processed. This limits header spoofing by not accepting forwarders from untrusted proxies.

## Additional resources

[Microsoft Security Advisory CVE-2018-0787: ASP.NET Core Elevation Of Privilege Vulnerability](#)

# Visual Studio publish profiles for ASP.NET Core app deployment

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By [Sayed Ibrahim Hashimi](#) and [Rick Anderson](#)

This document focuses on using Visual Studio 2017 to create and use publish profiles. The publish profiles created with Visual Studio can be run from MSBuild and Visual Studio 2017. See [Publish an ASP.NET Core web app to Azure App Service using Visual Studio](#) for instructions on publishing to Azure.

The following project file was created with the command `dotnet new mvc`:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
<Project Sdk="Microsoft.NET.Sdk.Web">

    <PropertyGroup>
        <TargetFramework>netcoreapp2.0</TargetFramework>
    </PropertyGroup>

    <ItemGroup>
        <PackageReference Include="Microsoft.AspNetCore.All" Version="2.0.0" />
    </ItemGroup>

    <ItemGroup>
        <DotNetCliToolReference Include="Microsoft.VisualStudio.Web.CodeGeneration.Tools" Version="2.0.0" />
    </ItemGroup>

</Project>
```

The `<Project>` element's `Sdk` attribute accomplishes the following tasks:

- Imports the properties file from `$(MSBuildSDKsPath)\Microsoft.NET.Sdk.Web\Sdk\Sdk.props` at the beginning.
- Imports the targets file from `$(MSBuildSDKsPath)\Microsoft.NET.Sdk.Web\Sdk\Sdk.targets` at the end.

The default location for `MSBuildSDKsPath` (with Visual Studio 2017 Enterprise) is the `%programfiles(x86)%\Microsoft Visual Studio\2017\Enterprise\MSBuild\Sdks` folder.

The `Microsoft.NET.Sdk.Web` SDK depends on:

- `Microsoft.NET.Sdk.Web.ProjectSystem`
- `Microsoft.NET.Sdk.Publish`

Which causes the following properties and targets to be imported:

- `$(MSBuildSDKsPath)\Microsoft.NET.Sdk.Web.ProjectSystem\Sdk\Sdk.props`
- `$(MSBuildSDKsPath)\Microsoft.NET.Sdk.Web.ProjectSystem\Sdk\Sdk.targets`
- `$(MSBuildSDKsPath)\Microsoft.NET.Sdk.Publish\Sdk\Sdk.props`
- `$(MSBuildSDKsPath)\Microsoft.NET.Sdk.Publish\Sdk\Sdk.targets`

Publish targets import the right set of targets based on the publish method used.

When MSBuild or Visual Studio loads a project, the following high-level actions occur:

- Build project
- Compute files to publish
- Publish files to destination

## Compute project items

When the project is loaded, the project items (files) are computed. The `item type` attribute determines how the file is processed. By default, `.cs` files are included in the `Compile` item list. Files in the `Compile` item list are compiled.

The `Content` item list contains files that are published in addition to the build outputs. By default, files matching the pattern `wwwroot/**` are included in the `Content` item. The `wwwroot/\*\*\*` globbing pattern matches all files in the `wwwroot` folder **and** subfolders. To explicitly add a file to the publish list, add the file directly in the `.csproj` file as shown in [Include Files](#).

When selecting the **Publish** button in Visual Studio or when publishing from the command line:

- The properties/items are computed (the files that are needed to build).
- **Visual Studio only:** NuGet packages are restored. (Restore needs to be explicit by the user on the CLI.)
- The project builds.
- The publish items are computed (the files that are needed to publish).
- The project is published (the computed files are copied to the publish destination).

When an ASP.NET Core project references `Microsoft.NET.Sdk.Web` in the project file, an `app_offline.htm` file is placed at the root of the web app directory. When the file is present, the ASP.NET Core Module gracefully shuts down the app and serves the `app_offline.htm` file during the deployment. For more information, see the [ASP.NET Core Module configuration reference](#).

## Basic command-line publishing

Command-line publishing works on all .NET Core-supported platforms and doesn't require Visual Studio. In the samples below, the `dotnet publish` command is run from the project directory (which contains the `.csproj` file). If not in the project folder, explicitly pass in the project file path. For example:

```
dotnet publish C:\Webs\Web1
```

Run the following commands to create and publish a web app:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
dotnet new mvc  
dotnet publish
```

The `dotnet publish` command produces output similar to the following:

```
C:\Webs\Web1>dotnet publish
Microsoft (R) Build Engine version 15.3.409.57025 for .NET Core
Copyright (C) Microsoft Corporation. All rights reserved.

Web1 -> C:\Webs\Web1\bin\Debug\netcoreapp2.0\Web1.dll
Web1 -> C:\Webs\Web1\bin\Debug\netcoreapp2.0\publish\
```

The default publish folder is `bin\$(Configuration)\netcoreapp<version>\publish`. The default for `$(Configuration)` is `Debug`. In the preceding sample, the `<TargetFramework>` is `netcoreapp2.0`.

`dotnet publish -h` displays help information for publish.

The following command specifies a `Release` build and the publishing directory:

```
dotnet publish -c Release -o C:\MyWebs\test
```

The `dotnet publish` command calls MSBuild, which invokes the `Publish` target. Any parameters passed to `dotnet publish` are passed to MSBuild. The `-c` parameter maps to the `Configuration` MSBuild property. The `-o` parameter maps to `OutputPath`.

MSBuild properties can be passed using either of the following formats:

- `p:<NAME>=<VALUE>`
- `/p:<NAME>=<VALUE>`

The following command publishes a `Release` build to a network share:

```
dotnet publish -c Release /p:PublishDir=/r8/release/AdminWeb
```

The network share is specified with forward slashes (`//r8/`) and works on all .NET Core supported platforms.

Confirm that the published app for deployment isn't running. Files in the `publish` folder are locked when the app is running. Deployment can't occur because locked files can't be copied.

## Publish profiles

This section uses Visual Studio 2017 to create a publishing profile. Once created, publishing from Visual Studio or the command line is available.

Publish profiles can simplify the publishing process, and any number of profiles can exist. Create a publish profile in Visual Studio by choosing one of the following paths:

- Right-click the project in Solution Explorer and select **Publish**.
- Select **Publish <project\_name>** from the **Build** menu.

The **Publish** tab of the app capacities page is displayed. If the project lacks a publish profile, the following page is displayed:

x

## Pick a publish target

 App Service

 Azure Virtual Machines

 IIS, FTP, etc

 Folder

### Azure App Service

Fully managed, and highly scalable cloud environment

Create New

Select Existing

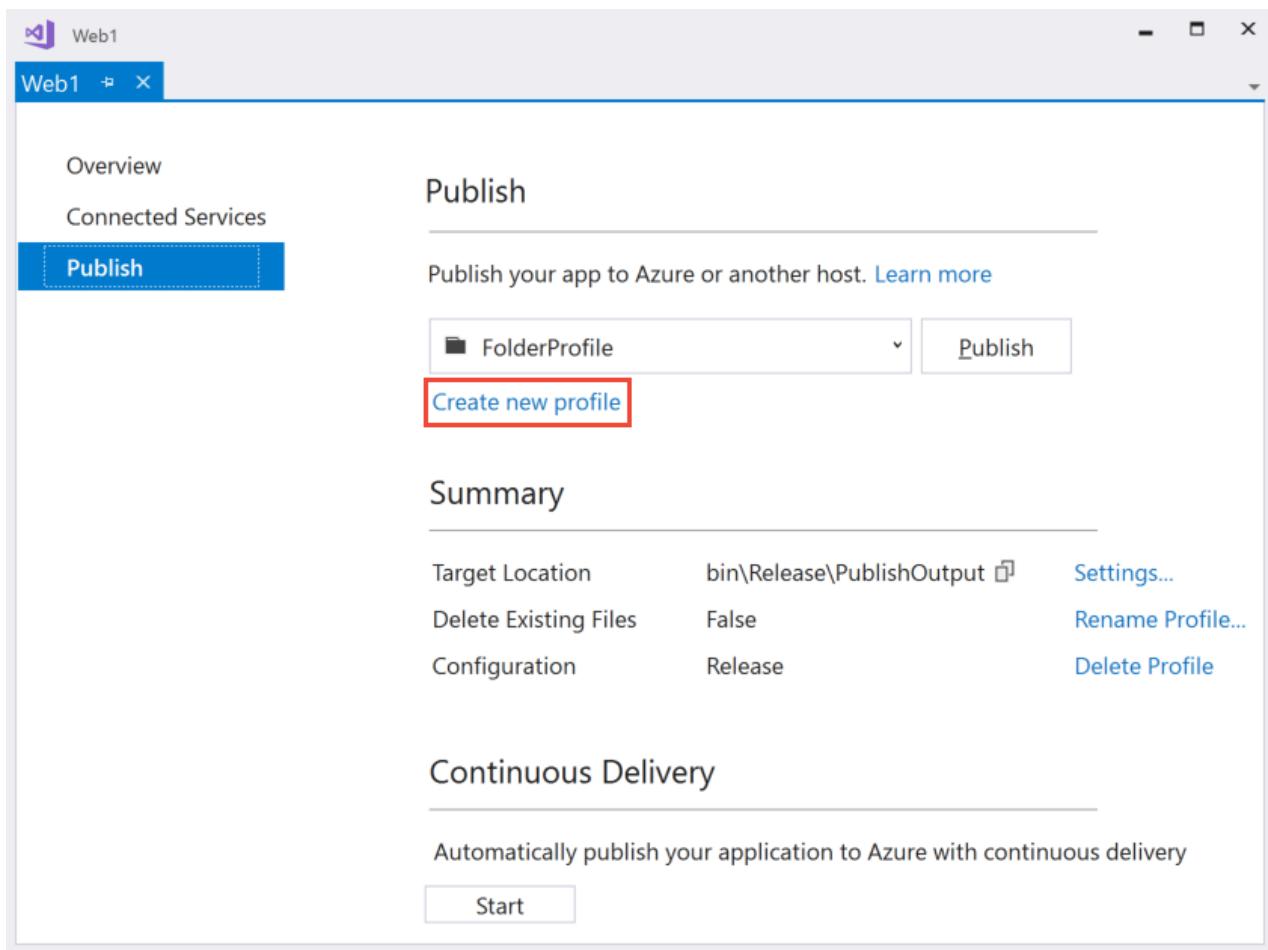
[Import Profile...](#)

[Create Profile ▾](#)

[Cancel](#)

When **Folder** is selected, specify a folder path to store the published assets. The default folder is `bin\Release\PublishOutput`. Click the **Create Profile** button to finish.

Once a publish profile is created, the **Publish** tab changes. The newly created profile appears in a drop-down list. Click **Create new profile** to create another new profile.



The Publish wizard supports the following publish targets:

- Azure App Service
- Azure Virtual Machines
- IIS, FTP, etc. (for any web server)
- Folder
- Import Profile

For more information, see [What publishing options are right for me.](#)

When creating a publish profile with Visual Studio, a *Properties/PublishProfiles/<profile\_name>.pubxml* MSBuild file is created. The *.pubxml* file is a MSBuild file and contains publish configuration settings. This file can be changed to customize the build and publish process. This file is read by the publishing process.

`<LastUsedBuildConfiguration>` is special because it's a global property and shouldn't be in any file that's imported in the build. See [MSBuild: how to set the configuration property](#) for more information.

When publishing to an Azure target, the *.pubxml* file contains your Azure subscription identifier. With that target type, adding this file to source control is discouraged. When publishing to a non-Azure target, it's safe to check in the *.pubxml* file.

Sensitive information (like the publish password) is encrypted on a per user/machine level. It's stored in the *Properties/PublishProfiles/<profile\_name>.pubxml.user* file. Because this file can store sensitive information, it shouldn't be checked into source control.

For an overview of how to publish a web app on ASP.NET Core, see [Host and deploy](#). The MSBuild tasks and targets necessary to publish an ASP.NET Core app are open-source at <https://github.com/aspnet/websdk>.

`dotnet publish` can use folder, MSDeploy, and Kudu publish profiles:

Folder (works cross-platform):

```
dotnet publish WebApplication.csproj /p:PublishProfile=<FolderProfileName>
```

MSDeploy (currently this only works in Windows since MS Deploy isn't cross-platform):

```
dotnet publish WebApplication.csproj /p:PublishProfile=<MsDeployProfileName> /p:Password=<DeploymentPassword>
```

MSDeploy package (currently this only works in Windows since MS Deploy isn't cross-platform):

```
dotnet publish WebApplication.csproj /p:PublishProfile=<MsDeployPackageProfileName>
```

In the preceding samples, **don't** pass `deployonbuild` to `dotnet publish`.

For more information, see [Microsoft.NET.Sdk.Publish](#).

`dotnet publish` supports Kudu APIs to publish to Azure from any platform. Visual Studio publish supports the Kudu APIs, but it's supported by WebSDK for cross-platform publish to Azure.

Add a publish profile to the *Properties/PublishProfiles* folder with the following content:

```
<Project>
  <PropertyGroup>
    <PublishProtocol>Kudu</PublishProtocol>
    <PublishSiteName>nodewebapp</PublishSiteName>
    <UserName>username</UserName>
    <Password>password</Password>
  </PropertyGroup>
</Project>
```

Run the following command to zip up the publish contents and publish it to Azure using the Kudu APIs:

```
dotnet publish /p:PublishProfile=Azure /p:Configuration=Release
```

Set the following MSBuild properties when using a publish profile:

- `DeployOnBuild=true`
- `PublishProfile=<Publish profile name>`

When publishing with a profile named *FolderProfile*, either of the commands below can be executed:

- `dotnet build /p:DeployOnBuild=true /p:PublishProfile=FolderProfile`
- `msbuild /p:DeployOnBuild=true /p:PublishProfile=FolderProfile`

When invoking `dotnet build`, it calls `msbuild` to run the build and publish process. Calling either `dotnet build` or `msbuild` is equivalent when passing in a folder profile. When calling MSBuild directly on Windows, the .NET Framework version of MSBuild is used. MSDeploy is currently limited to Windows machines for publishing. Calling `dotnet build` on a non-folder profile invokes MSBuild, and MSBuild uses MSDeploy on non-folder profiles. Calling `dotnet build` on a non-folder profile invokes MSBuild (using MSDeploy) and results in a failure (even when running on a Windows platform). To publish with a non-folder profile, call MSBuild directly.

The following folder publish profile was created with Visual Studio and publishes to a network share:

```

<?xml version="1.0" encoding="utf-8"?>
<!--
This file is used by the publish/package process of your Web project.
You can customize the behavior of this process by editing this
MSBuild file.
-->
<Project ToolsVersion="4.0" xmlns="http://schemas.microsoft.com/developer/msbuild/2003">
  <PropertyGroup>
    <WebPublishMethod>FileSystem</WebPublishMethod>
    <PublishProvider>FileSystem</PublishProvider>
    <LastUsedBuildConfiguration>Release</LastUsedBuildConfiguration>
    <LastUsedPlatform>Any CPU</LastUsedPlatform>
    <SiteUrlToLaunchAfterPublish />
    <LaunchSiteAfterPublish>True</LaunchSiteAfterPublish>
    <ExcludeApp_Data>False</ExcludeApp_Data>
    <PublishFramework>netcoreapp1.1</PublishFramework>
    <ProjectGuid>c30c453c-312e-40c4-aec9-394a145dee0b</ProjectGuid>
    <publishUrl>\r8\Release\AdminWeb</publishUrl>
    <DeleteExistingFiles>False</DeleteExistingFiles>
  </PropertyGroup>
</Project>

```

Note `<LastUsedBuildConfiguration>` is set to `Release`. When publishing from Visual Studio, the `<LastUsedBuildConfiguration>` configuration property value is set using the value when the publish process is started. The `<LastUsedBuildConfiguration>` configuration property is special and shouldn't be overridden in an imported MSBuild file. This property can be overridden from the command line.

Using the .NET Core CLI:

```
dotnet build -c Release /p:DeployOnBuild=true /p:PublishProfile=FolderProfile
```

Using MSBuild:

```
msbuild /p:Configuration=Release /p:DeployOnBuild=true /p:PublishProfile=FolderProfile
```

## Publish to an MSDeploy endpoint from the command line

Publishing can be accomplished using the .NET Core CLI or MSBuild. `dotnet publish` runs in the context of .NET Core. The `msbuild` command requires .NET Framework, which limits it to Windows environments.

The easiest way to publish with MSDeploy is to first create a publish profile in Visual Studio 2017 and use the profile from the command line.

In the following sample, an ASP.NET Core web app is created (using `dotnet new mvc`), and an Azure publish profile is added with Visual Studio.

Run `msbuild` from a **Developer Command Prompt for VS 2017**. The Developer Command Prompt has the correct `msbuild.exe` in its path with some MSBuild variables set.

MSBuild uses the following syntax:

```
msbuild <path-to-project-file> /p:DeployOnBuild=true /p:PublishProfile=<Publish Profile> /p:Username=<USERNAME> /p:Password=<PASSWORD>
```

Get the `Password` from the `<Publish name>.PublishSettings` file. Download the `.PublishSettings` file from either:

- Solution Explorer: Right-click on the Web App and select **Download Publish Profile**.

- Azure portal: Click **Get publish profile** on the Web App's **Overview** panel.

`Username` can be found in the publish profile.

The following sample uses the *Web11112 - Web Deploy* publish profile:

```
msbuild "C:\Webs\Web1\Web1.csproj" /p:DeployOnBuild=true
/p:PublishProfile="Web11112 - Web Deploy" /p:Username="$Web11112"
/p:Password=<password removed>
```

## Exclude files

When publishing ASP.NET Core web apps, the build artifacts and contents of the `wwwroot` folder are included.

`msbuild` supports [globbing patterns](#). For example, the following `<Content>` element excludes all text (`.txt`) files from the `wwwroot/content` folder and all its subfolders.

```
<ItemGroup>
<Content Update="wwwroot/content/**/*.txt" CopyToPublishDirectory="Never" />
</ItemGroup>
```

The preceding markup can be added to a publish profile or the `.csproj` file. When added to the `.csproj` file, the rule is added to all publish profiles in the project.

The following `<MsDeploySkipRules>` element excludes all files from the `wwwroot/content` folder:

```
<ItemGroup>
<MsDeploySkipRules Include="CustomSkipFolder">
<ObjectName>dirPath</ObjectName>
<AbsolutePath>wwwroot\\content</AbsolutePath>
</MsDeploySkipRules>
</ItemGroup>
```

`<MsDeploySkipRules>` won't delete the *skip* targets from the deployment site. `<Content>` targeted files and folders are deleted from the deployment site. For example, suppose a deployed web app had the following files:

- `Views/Home/About1.cshtml`
- `Views/Home/About2.cshtml`
- `Views/Home/About3.cshtml`

If the following `<MsDeploySkipRules>` elements are added, those files wouldn't be deleted on the deployment site.

```
<ItemGroup>
<MsDeploySkipRules Include="CustomSkipFile">
<ObjectName>filePath</ObjectName>
<AbsolutePath>Views\\Home\\About1.cshtml</AbsolutePath>
</MsDeploySkipRules>

<MsDeploySkipRules Include="CustomSkipFile">
<ObjectName>filePath</ObjectName>
<AbsolutePath>Views\\Home\\About2.cshtml</AbsolutePath>
</MsDeploySkipRules>

<MsDeploySkipRules Include="CustomSkipFile">
<ObjectName>filePath</ObjectName>
<AbsolutePath>Views\\Home\\About3.cshtml</AbsolutePath>
</MsDeploySkipRules>
</ItemGroup>
```

The preceding `<MsDeploySkipRules>` elements prevent the *skipped* files from being deployed. It won't delete those files once they're deployed.

The following `<Content>` element deletes the targeted files at the deployment site:

```
<ItemGroup>
  <Content Update="Views/Home/About?.cshtml" CopyToPublishDirectory="Never" />
</ItemGroup>
```

Using command-line deployment with the preceding `<Content>` element yields the following output:

```
MSDeployPublish:
  Starting Web deployment task from source:
manifest(C:\Webs\Web1\obj\Release\netcoreapp1.1\PubTmp\Web1.SourceManifest.xml) to Destination: auto().
  Deleting file (Web11112\Views\Home\About1.cshtml).
  Deleting file (Web11112\Views\Home\About2.cshtml).
  Deleting file (Web11112\Views\Home\About3.cshtml).
  Updating file (Web11112\web.config).
  Updating file (Web11112\Web1.deps.json).
  Updating file (Web11112\Web1.dll).
  Updating file (Web11112\Web1.pdb).
  Updating file (Web11112\Web1.runtimeconfig.json).
  Successfully executed Web deployment task.
  Publish Succeeded.
Done Building Project "C:\Webs\Web1\Web1.csproj" (default targets).
```

## Include files

The following markup includes an *images* folder outside the project directory to the *wwwroot/images* folder of the publish site:

```
<ItemGroup>
  <_CustomFiles Include="$(MSBuildProjectDirectory)/../images/**/*" />
  <DotnetPublishFiles Include="@(_CustomFiles)">
    <DestinationRelativePath>wwwroot/images/%(RecursiveDir)%{filename}%(Extension)</DestinationRelativePath>
  </DotnetPublishFiles>
</ItemGroup>
```

The markup can be added to the *.csproj* file or the publish profile. If it's added to the *.csproj* file, it's included in each publish profile in the project.

The following highlighted markup shows how to:

- Copy a file from outside the project into the *wwwroot* folder.
- Exclude the *wwwroot\Content* folder.
- Exclude *Views\Home\About2.cshtml*.

```

<?xml version="1.0" encoding="utf-8"?>
<!--
This file is used by the publish/package process of your Web project.
You can customize the behavior of this process by editing this
MSBuild file.
-->
<Project ToolsVersion="4.0" xmlns="http://schemas.microsoft.com/developer/msbuild/2003">
  <PropertyGroup>
    <WebPublishMethod>FileSystem</WebPublishMethod>
    <PublishProvider>FileSystem</PublishProvider>
    <LastUsedBuildConfiguration>Release</LastUsedBuildConfiguration>
    <LastUsedPlatform>Any CPU</LastUsedPlatform>
    <SiteUrlToLaunchAfterPublish />
    <LaunchSiteAfterPublish>True</LaunchSiteAfterPublish>
    <ExcludeApp_Data>False</ExcludeApp_Data>
    <PublishFramework />
    <ProjectGuid>afa9f185-7ce0-4935-9da1-ab676229d68a</ProjectGuid>
    <publishUrl>bin\Release\PublishOutput</publishUrl>
    <DeleteExistingFiles>False</DeleteExistingFiles>
  </PropertyGroup>
  <ItemGroup>
    <ResolvedFileToPublish Include="..\ReadMe2.MD">
      <RelativePath>wwwroot\ReadMe2.MD</RelativePath>
    </ResolvedFileToPublish>

    <Content Update="wwwroot\Content\**\*" CopyToPublishDirectory="Never" />
    <Content Update="Views\Home\About2.cshtml" CopyToPublishDirectory="Never" />
  </ItemGroup>
</Project>

```

See the [WebSDK Readme](#) for more deployment samples.

## Run a target before or after publishing

The built-in `BeforePublish` and `AfterPublish` targets execute a target before or after the publish target. Add the following elements to the publish profile to log console messages both before and after publishing:

```

<Target Name="CustomActionsBeforePublish" BeforeTargets="BeforePublish">
  <Message Text="Inside BeforePublish" Importance="high" />
</Target>
<Target Name="CustomActionsAfterPublish" AfterTargets="AfterPublish">
  <Message Text="Inside AfterPublish" Importance="high" />
</Target>

```

## Publish to a server using an untrusted certificate

Add the `<AllowUntrustedCertificate>` property with a value of `True` to the publish profile:

```

<PropertyGroup>
  <AllowUntrustedCertificate>True</AllowUntrustedCertificate>
</PropertyGroup>

```

## The Kudu service

To view the files in an Azure App Service web app deployment, use the [Kudu service](#). Append the `scm` token to the web app name. For example:

URL	RESULT
<code>http://mysite.azurewebsites.net/</code>	Web App
<code>http://mysite.scm.azurewebsites.net/</code>	Kudu service

Select the [Debug Console](#) menu item to view, edit, delete, or add files.

## Additional resources

- [Web Deploy](#) (MS Deploy) simplifies deployment of web apps and websites to IIS servers.
- <https://github.com/aspnet/websdk>: File issues and request features for deployment.

# ASP.NET Core directory structure

6/26/2018 • 2 minutes to read • [Edit Online](#)

By [Luke Latham](#)

In ASP.NET Core, the published application directory, *publish*, is comprised of application files, config files, static assets, packages, and the runtime (for [self-contained deployments](#)).

APP TYPE	DIRECTORY STRUCTURE
<a href="#">Framework-dependent Deployment</a>	<ul style="list-style-type: none"><li>• publish†<ul style="list-style-type: none"><li>◦ Logst (optional unless required to receive stdout logs)</li><li>◦ Viewst (MVC apps; if views aren't precompiled)</li><li>◦ Pagest (MVC or Razor Pages apps; if pages aren't precompiled)</li><li>◦ wwwroot†</li><li>◦ *.dll files</li><li>◦ &lt;assembly-name&gt;.deps.json</li><li>◦ &lt;assembly-name&gt;.dll</li><li>◦ &lt;assembly-name&gt;.pdb</li><li>◦ &lt;assembly-name&gt;.PrecompiledViews.dll</li><li>◦ &lt;assembly-name&gt;.PrecompiledViews.pdb</li><li>◦ &lt;assembly-name&gt;.runtimeconfig.json</li><li>◦ web.config (IIS deployments)</li></ul></li></ul>
<a href="#">Self-contained Deployment</a>	<ul style="list-style-type: none"><li>• publish†<ul style="list-style-type: none"><li>◦ Logst (optional unless required to receive stdout logs)</li><li>◦ refst</li><li>◦ Viewst (MVC apps; if views aren't precompiled)</li><li>◦ Pagest (MVC or Razor Pages apps; if pages aren't precompiled)</li><li>◦ wwwroot†</li><li>◦ *.dll files</li><li>◦ &lt;assembly-name&gt;.deps.json</li><li>◦ &lt;assembly-name&gt;.exe</li><li>◦ &lt;assembly-name&gt;.pdb</li><li>◦ &lt;assembly-name&gt;.PrecompiledViews.dll</li><li>◦ &lt;assembly-name&gt;.PrecompiledViews.pdb</li><li>◦ &lt;assembly-name&gt;.runtimeconfig.json</li><li>◦ web.config (IIS deployments)</li></ul></li></ul>

†Indicates a directory

The *publish* directory represents the *content root path*, also called the *application base path*, of the deployment. Whatever name is given to the *publish* directory of the deployed app on the server, its location serves as the server's physical path to the hosted app.

The *wwwroot* directory, if present, only contains static assets.

The *stdout Logs* directory can be created for the deployment using one of the following two approaches:

- Add the following `<Target>` element to the project file:

```
<Target Name="CreateLogsFolder" AfterTargets="Publish">
  <MakeDir Directories="$(PublishDir)Logs"
    Condition="!Exists('$(PublishDir)Logs')" />
  <WriteLinesToFile File="$(PublishDir)Logs\.log"
    Lines="Generated file"
    Overwrite="True"
    Condition="!Exists('$(PublishDir)Logs\.log')" />
</Target>
```

The `<MakeDir>` element creates an empty *Logs* folder in the published output. The element uses the `PublishDir` property to determine the target location for creating the folder. Several deployment methods, such as Web Deploy, skip empty folders during deployment. The `<WriteLinesToFile>` element generates a file in the *Logs* folder, which guarantees deployment of the folder to the server. Note that folder creation may still fail if the worker process doesn't have write access to the target folder.

- Physically create the *Logs* directory on the server in the deployment.

The deployment directory requires Read/Execute permissions. The *Logs* directory requires Read/Write permissions. Additional directories where files are written require Read/Write permissions.

# Common errors reference for Azure App Service and IIS with ASP.NET Core

6/21/2018 • 8 minutes to read • [Edit Online](#)

By [Luke Latham](#)

The following isn't a complete list of errors. If you encounter an error not listed here, [open a new issue](#) with detailed instructions to reproduce the error.

Collect the following information:

- Browser behavior
- Application Event Log entries
- ASP.NET Core Module stdout log entries

Compare the information to the following common errors. If a match is found, follow the troubleshooting advice.

## IMPORTANT

### ASP.NET Core preview releases with Azure App Service

ASP.NET Core preview releases aren't deployed to Azure App Service by default. To host an app that uses an ASP.NET Core preview release, see [Deploy ASP.NET Core preview release to Azure App Service](#).

## Installer unable to obtain VC++ Redistributable

- **Installer Exception:** 0x80072efd or 0x80072f76 - Unspecified error
- **Installer Log Exception:** Error 0x80072efd or 0x80072f76: Failed to execute EXE package

+The log is located at C:\Users\{USER}\AppData\Local\Temp\dd\_DotNetCoreWinSvrHosting\_{timestamp}.log.

Troubleshooting:

- If the system doesn't have Internet access while installing the Hosting Bundle, this exception occurs when the installer is prevented from obtaining the *Microsoft Visual C++ 2015 Redistributable*. Obtain an installer from the [Microsoft Download Center](#). If the installer fails, the server may not receive the .NET Core runtime required to host a framework-dependent deployment (FDD). If hosting an FDD, confirm that the runtime is installed in Programs & Features. If needed, obtain a runtime installer from [.NET All Downloads](#). After installing the runtime, restart the system or restart IIS by executing **net stop was /y** followed by **net start w3svc** from a command prompt.

## OS upgrade removed the 32-bit ASP.NET Core Module

- **Application Log:** The Module DLL **C:\WINDOWS\system32\inetsrv\aspnetcore.dll** failed to load. The data is the error.

Troubleshooting:

- Non-OS files in the **C:\Windows\SysWOW64\inetsrv** directory aren't preserved during an OS upgrade. If the ASP.NET Core Module is installed prior to an OS upgrade and then any AppPool is run in 32-bit mode

after an OS upgrade, this issue is encountered. After an OS upgrade, repair the ASP.NET Core Module. See [Install the .NET Core Hosting bundle](#). Select **Repair** when the installer is run.

## Platform conflicts with RID

- **Browser:** HTTP Error 502.5 - Process Failure
- **Application Log:** Application 'MACHINE/WEBROOT/APPHOST/{ASSEMBLY}' with physical root 'C:{PATH}' failed to start process with commandline '"C:\{PATH}\{assembly}.exe|dll"' , ErrorCode = '0x80004005 : ff.'
- **ASP.NET Core Module Log:** Unhandled Exception: System.BadImageFormatException: Could not load file or assembly '{assembly}.dll'. An attempt was made to load a program with an incorrect format.

Troubleshooting:

- Confirm that the app runs locally on Kestrel. A process failure might be the result of a problem within the app. For more information, see [Troubleshooting](#).
- Confirm that the `<PlatformTarget>` in the `.csproj` doesn't conflict with the RID. For example, don't specify a `<PlatformTarget>` of `x86` and publish with an RID of `win10-x64`, either by using `dotnet publish -c Release -r win10-x64` or by setting the `<RuntimeIdentifiers>` in the `.csproj` to `win10-x64`. The project publishes without warning or error but fails with the above logged exceptions on the system.
- If this exception occurs for an Azure Apps deployment when upgrading an app and deploying newer assemblies, manually delete all files from the prior deployment. Lingering incompatible assemblies can result in a `System.BadImageFormatException` exception when deploying an upgraded app.

## URI endpoint wrong or stopped website

- **Browser:** ERR\_CONNECTION\_REFUSED
- **Application Log:** No entry
- **ASP.NET Core Module Log:** Log file not created

Troubleshooting:

- Confirm the correct URI endpoint for the app is being used. Check the bindings.
- Confirm that the IIS website isn't in the *Stopped* state.

## CoreWebEngine or W3SVC server features disabled

- **OS Exception:** The IIS 7.0 CoreWebEngine and W3SVC features must be installed to use the ASP.NET Core Module.

Troubleshooting:

- Confirm that the proper role and features are enabled. See [IIS Configuration](#).

## Incorrect website physical path or app missing

- **Browser:** 403 Forbidden - Access is denied --OR-- 403.14 Forbidden - The Web server is configured to not list the contents of this directory.
- **Application Log:** No entry
- **ASP.NET Core Module Log:** Log file not created

Troubleshooting:

- Check the IIS website **Basic Settings** and the physical app folder. Confirm that the app is in the folder at the IIS website **Physical path**.

## Incorrect role, module not installed, or incorrect permissions

- **Browser:** 500.19 Internal Server Error - The requested page cannot be accessed because the related configuration data for the page is invalid.
- **Application Log:** No entry
- **ASP.NET Core Module Log:** Log file not created

Troubleshooting:

- Confirm that the proper role is enabled. See [IIS Configuration](#).
- Check **Programs & Features** and confirm that the **Microsoft ASP.NET Core Module** has been installed. If the **Microsoft ASP.NET Core Module** isn't present in the list of installed programs, install the module. See [Install the .NET Core Hosting Bundle](#).
- Make sure that the **Application Pool > Process Model > Identity** is set to **ApplicationPoolIdentity** or the custom identity has the correct permissions to access the app's deployment folder.

## Incorrect processPath, missing PATH variable, Hosting Bundle not installed, system/IIS not restarted, VC++ Redistributable not installed, or dotnet.exe access violation

- **Browser:** HTTP Error 502.5 - Process Failure
- **Application Log:** Application 'MACHINE/WEBROOT/APPHOST/{ASSEMBLY}' with physical root 'C:\{PATH}' failed to start process with commandline "{assembly}.exe", ErrorCode = '0x80070002 : 0'.
- **ASP.NET Core Module Log:** Log file created but empty

Troubleshooting:

- Confirm that the app runs locally on Kestrel. A process failure might be the result of a problem within the app. For more information, see [Troubleshooting](#).
- Check the *processPath* attribute on the `<aspNetCore>` element in `web.config` to confirm that it's `dotnet` for a framework-dependent deployment (FDD) or `{assembly}.exe` for a self-contained deployment (SCD).
- For an FDD, `dotnet.exe` might not be accessible via the PATH settings. Confirm that `*C:\Program Files\dotnet*` exists in the System PATH settings.
- For an FDD, `dotnet.exe` might not be accessible for the user identity of the Application Pool. Confirm that the AppPool user identity has access to the `C:\Program Files\dotnet` directory. Confirm that there are no deny rules configured for the AppPool user identity on the `C:\Program Files\dotnet` and app directories.
- An FDD may have been deployed and .NET Core installed without restarting IIS. Either restart the server or restart IIS by executing `net stop was /y` followed by `net start w3svc` from a command prompt.
- An FDD may have been deployed without installing the .NET Core runtime on the hosting system. If the .NET Core runtime hasn't been installed, run the **.NET Core Hosting Bundle installer** on the system. See [Install the .NET Core Hosting Bundle](#). If attempting to install the .NET Core runtime on a system without an Internet connection, obtain the runtime from [.NET All Downloads](#) and run the Hosting Bundle installer to install the ASP.NET Core Module. Complete the installation by restarting the system or

restarting IIS by executing **net stop was /y** followed by **net start w3svc** from a command prompt.

- An FDD may have been deployed and the *Microsoft Visual C++ 2015 Redistributable (x64)* isn't installed on the system. Obtain an installer from the [Microsoft Download Center](#).

## Incorrect arguments of <aspNetCore> element

- **Browser:** HTTP Error 502.5 - Process Failure
- **Application Log:** Application 'MACHINE/WEBROOT/APPHOST/{ASSEMBLY}' with physical root 'C:\{PATH}' failed to start process with commandline '"dotnet" .{assembly}.dll', ErrorCode = '0x80004005 : 80008081'.
- **ASP.NET Core Module Log:** The application to execute does not exist: 'PATH{assembly}.dll'

Troubleshooting:

- Confirm that the app runs locally on Kestrel. A process failure might be the result of a problem within the app. For more information, see [Troubleshooting](#).
- Examine the *arguments* attribute on the `<aspNetCore>` element in *web.config* to confirm that it's either (a) `{assembly}.dll` for a framework-dependent deployment (FDD); or (b) not present, an empty string (`arguments=""`), or a list of the app's arguments (`arguments="arg1, arg2, ..."`) for a self-contained deployment (SCD).

## Missing .NET Framework version

- **Browser:** 502.3 Bad Gateway - There was a connection error while trying to route the request.
- **Application Log:** ErrorCode = Application 'MACHINE/WEBROOT/APPHOST/{ASSEMBLY}' with physical root 'C:\{PATH}' failed to start process with commandline '"dotnet" .{assembly}.dll', ErrorCode = '0x80004005 : 80008081'.
- **ASP.NET Core Module Log:** Missing method, file, or assembly exception. The method, file, or assembly specified in the exception is a .NET Framework method, file, or assembly.

Troubleshooting:

- Install the .NET Framework version missing from the system.
- For a framework-dependent deployment (FDD), confirm that the correct runtime installed on the system. If the project is upgraded from 1.1 to 2.0, deployed to the hosting system, and this exception results, ensure that the 2.0 framework is on the hosting system.

## Stopped Application Pool

- **Browser:** 503 Service Unavailable
- **Application Log:** No entry
- **ASP.NET Core Module Log:** Log file not created

Troubleshooting

- Confirm that the Application Pool isn't in the *Stopped* state.

## IIS Integration middleware not implemented

- **Browser:** HTTP Error 502.5 - Process Failure

- **Application Log:** Application 'MACHINE/WEBROOT/APPHOST/{ASSEMBLY}' with physical root 'C:\{PATH}' created process with commandline '"C:\{PATH}\{assembly}.exe|dll"' but either crashed or did not respond or did not listen on the given port '{PORT}', ErrorCode = '0x800705b4'
- **ASP.NET Core Module Log:** Log file created and shows normal operation.

#### Troubleshooting

- Confirm that the app runs locally on Kestrel. A process failure might be the result of a problem within the app. For more information, see [Troubleshooting](#).
  - Confirm that either:
    - The IIS Integration middleware is referenced by calling the `UseIISIntegration` method on the app's `WebHostBuilder` (ASP.NET Core 1.x)
    - The app uses the `CreateDefaultBuilder` method (ASP.NET Core 2.x).
- See [Host in ASP.NET Core](#) for details.

## Sub-application includes a <handlers> section

- **Browser:** HTTP Error 500.19 - Internal Server Error
- **Application Log:** No entry
- **ASP.NET Core Module Log:** Log file created and shows normal operation for the root app. Log file not created for the sub-app.

#### Troubleshooting

- Confirm that the sub-app's `web.config` file doesn't include a `<handlers>` section.

## stdout log path incorrect

- **Browser:** The app responds normally.
- **Application Log:** Warning: Could not create stdoutLogFile \?  
`\C:_apps\app_folder\bin\Release\netcoreapp2.0\win10-x64\publish\logs\path_doesnt_exist\stdout_8748_201831835937.log`, ErrorCode = -2147024893.
- **ASP.NET Core Module Log:** Log file not created

#### Troubleshooting

- The `stdoutLogFile` path specified in the `<aspNetCore>` element of `web.config` doesn't exist. For more information, see the [Log creation and redirection](#) section of the ASP.NET Core Module configuration reference topic.

## Application configuration general issue

- **Browser:** HTTP Error 502.5 - Process Failure
- **Application Log:** Application 'MACHINE/WEBROOT/APPHOST/{ASSEMBLY}' with physical root 'C:\{PATH}' created process with commandline '"C:\{PATH}\{assembly}.exe|dll"' but either crashed or did not respond or did not listen on the given port '{PORT}', ErrorCode = '0x800705b4'
- **ASP.NET Core Module Log:** Log file created but empty

#### Troubleshooting

- This general exception indicates that the process failed to start, most likely due to an app configuration issue. Referring to [Directory Structure](#), confirm that the app's deployed files and folders are appropriate and that the app's configuration files are present and contain the correct settings for the app and environment. For more information, see [Troubleshooting](#).

# Overview of ASP.NET Core Security

6/21/2018 • 2 minutes to read • [Edit Online](#)

ASP.NET Core enables developers to easily configure and manage security for their apps. ASP.NET Core contains features for managing authentication, authorization, data protection, SSL enforcement, app secrets, anti-request forgery protection, and CORS management. These security features allow you to build robust yet secure ASP.NET Core apps.

## ASP.NET Core security features

ASP.NET Core provides many tools and libraries to secure your apps including built-in Identity providers but you can use 3rd party identity services such as Facebook, Twitter, or LinkedIn. With ASP.NET Core, you can easily manage app secrets, which are a way to store and use confidential information without having to expose it in the code.

## Authentication vs. Authorization

Authentication is a process in which a user provides credentials that are then compared to those stored in an operating system, database, app or resource. If they match, users authenticate successfully, and can then perform actions that they're authorized for, during an authorization process. The authorization refers to the process that determines what a user is allowed to do.

Another way to think of authentication is to consider it as a way to enter a space, such as a server, database, app or resource, while authorization is which actions the user can perform to which objects inside that space (server, database, or app).

## Common Vulnerabilities in software

ASP.NET Core and EF contain features that help you secure your apps and prevent security breaches. The following list of links takes you to documentation detailing techniques to avoid the most common security vulnerabilities in web apps:

- [Cross-site scripting attacks](#)
- [SQL injection attacks](#)
- [Cross-Site Request Forgery \(CSRF\)](#)
- [Open redirect attacks](#)

There are more vulnerabilities that you should be aware of. For more information, see the section in this document on *ASP.NET Security Documentation*.

## ASP.NET Security Documentation

- [Authentication](#)
  - [Introduction to Identity](#)
  - [Enable authentication using Facebook, Google, and other external providers](#)
  - [Enable authentication with WS-Federation](#)
  - [Configure Windows Authentication](#)
  - [Account confirmation and password recovery](#)
  - [Two-factor authentication with SMS](#)

- [Use cookie authentication without Identity](#)
  - [Azure Active Directory](#)
    - [Integrate Azure AD into an ASP.NET Core web app](#)
    - [Call an ASP.NET Core Web API from a WPF app using Azure AD](#)
    - [Call a Web API in an ASP.NET Core web app using Azure AD](#)
    - [An ASP.NET Core web app with Azure AD B2C](#)
  - [Secure ASP.NET Core apps with IdentityServer4](#)
- [Authorization](#)
  - [Introduction](#)
  - [Create an app with user data protected by authorization](#)
  - [Simple authorization](#)
  - [Role-based authorization](#)
  - [Claims-based authorization](#)
  - [Policy-based authorization](#)
  - [Dependency injection in requirement handlers](#)
  - [Resource-based authorization](#)
  - [View-based authorization](#)
  - [Limit identity by scheme](#)
- [Data protection](#)
  - [Introduction to data protection](#)
  - [Get started with the Data Protection APIs](#)
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    - [Purpose strings](#)
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    - [Hash passwords](#)
    - [Limit the lifetime of protected payloads](#)
    - [Unprotect payloads whose keys have been revoked](#)
  - [Configuration](#)
    - [Configure data protection](#)
    - [Default settings](#)
    - [Machine-wide policy](#)
    - [Non DI-aware scenarios](#)
  - [Extensibility APIs](#)
    - [Core cryptography extensibility](#)
    - [Key management extensibility](#)
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    - [Key immutability and settings](#)
    - [Key storage format](#)

- Ephemeral data protection providers
- Compatibility
- Replace in ASP.NET
- Create an app with user data protected by authorization
- Safe storage of app secrets in development
- Azure Key Vault configuration provider
- Enforce SSL
- Anti-Request Forgery
- Prevent open redirect attacks
- Prevent Cross-Site Scripting
- Enable Cross-Origin Requests (CORS)
- Share cookies among apps

# Authentication in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

- [Community OSS authentication options](#)
- [Introduction to Identity](#)
- [Enable authentication using Facebook, Google, and other external providers](#)
- [Enable authentication with WS-Federation](#)
- [Enable QR code generation in Identity](#)
- [Configure Windows Authentication](#)
- [Account confirmation and password recovery](#)
- [Two-factor authentication with SMS](#)
- [Use cookie authentication without Identity](#)
- [Azure Active Directory
  - \[Integrate Azure AD into an ASP.NET Core web app\]\(#\)
  - \[Integrate Azure AD B2C into a customer-facing ASP.NET Core web app\]\(#\)
  - \[Integrate Azure AD B2C into an ASP.NET Core web API\]\(#\)
  - \[Call an ASP.NET Core Web API from a WPF app using Azure AD\]\(#\)
  - \[Call a Web API in an ASP.NET Core web app using Azure AD\]\(#\)](#)
- [Secure ASP.NET Core apps with IdentityServer4](#)
- [Secure ASP.NET Core apps with Azure App Service Authentication \(Easy Auth\)](#)
- [Articles based on projects created with individual user accounts](#)

# Introduction to Identity on ASP.NET Core

7/5/2018 • 9 minutes to read • [Edit Online](#)

By [Pranav Rastogi](#), [Rick Anderson](#), [Tom Dykstra](#), [Jon Galloway](#), [Erik Reitan](#), and [Steve Smith](#)

ASP.NET Core Identity is a membership system which allows you to add login functionality to your application. Users can create an account and login with a user name and password or they can use an external login provider such as Facebook, Google, Microsoft Account, Twitter or others.

You can configure ASP.NET Core Identity to use a SQL Server database to store user names, passwords, and profile data. Alternatively, you can use your own persistent store, for example, an Azure Table Storage. This document contains instructions for Visual Studio and for using the CLI.

[View or download the sample code. \(How to download\)](#)

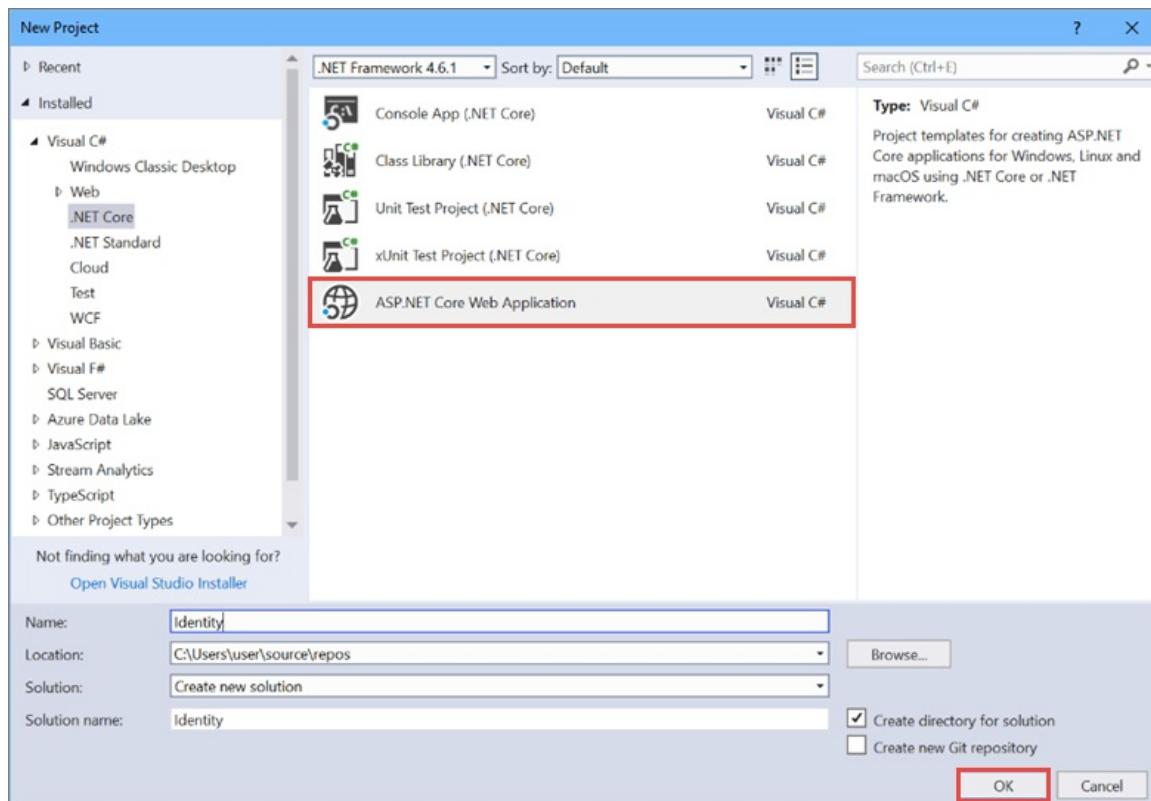
## Overview of Identity

In this topic, you'll learn how to use ASP.NET Core Identity to add functionality to register, log in, and log out a user. For more detailed instructions about creating apps using ASP.NET Core Identity, see the [Next Steps](#) section at the end of this article.

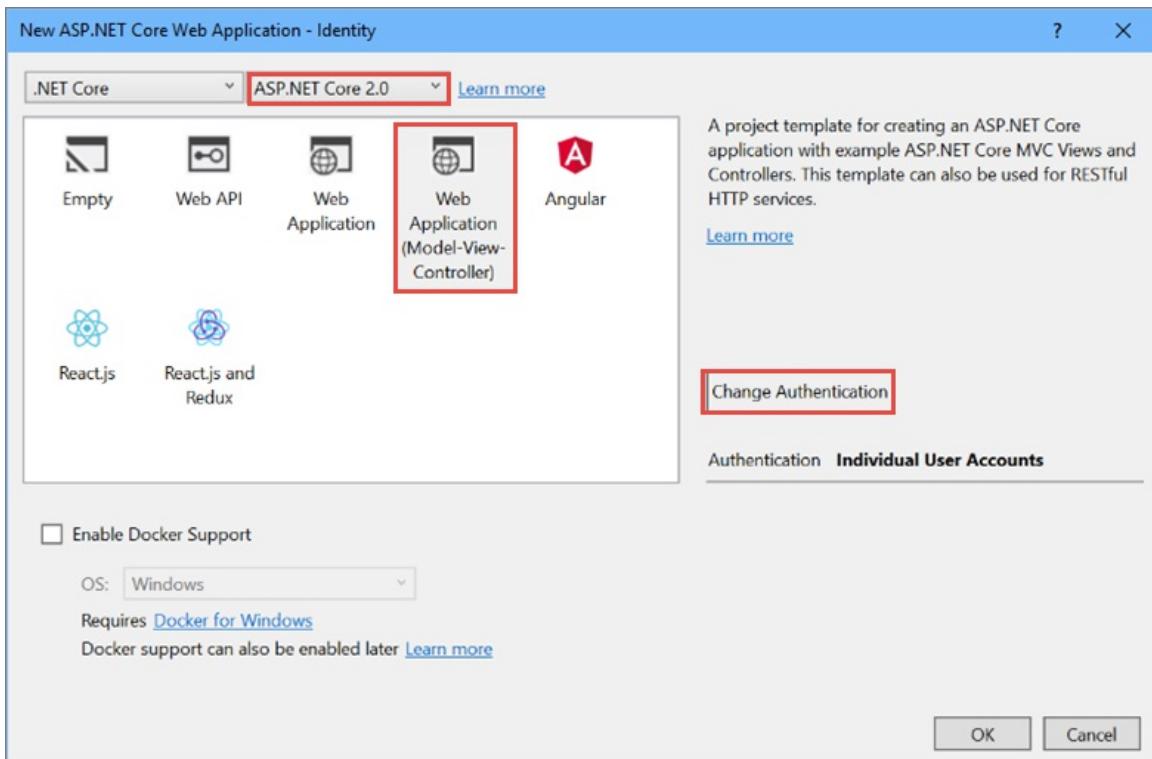
1. Create an ASP.NET Core Web Application project with Individual User Accounts.

- [Visual Studio](#)
- [.NET Core CLI](#)

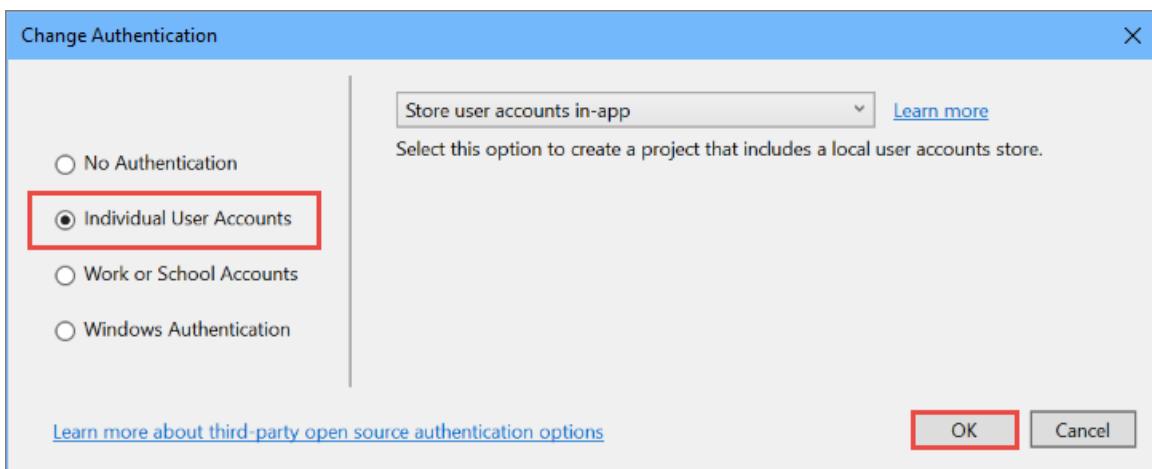
In Visual Studio, select **File > New > Project**. Select **ASP.NET Core Web Application** and click **OK**.



Select an ASP.NET Core **Web Application (Model-View-Controller)** for ASP.NET Core 2.x, then select **Change Authentication**.



A dialog appears offering authentication choices. Select **Individual User Accounts** and click **OK** to return to the previous dialog.



Selecting **Individual User Accounts** directs Visual Studio to create Models, ViewModels, Views, Controllers, and other assets required for authentication as part of the project template.

## 2. Configure Identity services and add middleware in `Startup`.

The Identity services are added to the application in the `ConfigureServices` method in the `Startup` class:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```

// This method gets called by the runtime. Use this method to add services to the container.
public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<ApplicationContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("DefaultConnection")));

    services.AddIdentity<ApplicationUser, IdentityRole>()
        .AddEntityFrameworkStores<ApplicationContext>()
        .AddDefaultTokenProviders();

    services.Configure<IdentityOptions>(options =>
    {
        // Password settings
        options.Password.RequireDigit = true;
        options.Password.RequiredLength = 8;
        options.Password.RequireNonAlphanumeric = false;
        options.Password.RequireUppercase = true;
        options.Password.RequireLowercase = false;
        options.Password.RequiredUniqueChars = 6;

        // Lockout settings
        options.Lockout.DefaultLockoutTimeSpan = TimeSpan.FromMinutes(30);
        options.Lockout.MaxFailedAccessAttempts = 10;
        options.Lockout.AllowedForNewUsers = true;

        // User settings
        options.User.RequireUniqueEmail = true;
    });

    services.ConfigureApplicationCookie(options =>
    {
        // Cookie settings
        options.Cookie.HttpOnly = true;
        options.ExpireTimeSpan = TimeSpan.FromMinutes(30);
        // If the LoginPath isn't set, ASP.NET Core defaults
        // the path to /Account/Login.
        options.LoginPath = "/Account/Login";
        // If the AccessDeniedPath isn't set, ASP.NET Core defaults
        // the path to /Account/AccessDenied.
        options.AccessDeniedPath = "/Account/AccessDenied";
        options SlidingExpiration = true;
    });

    // Add application services.
    services.AddTransient<IEmailSender, EmailSender>();

    services.AddMvc();
}

```

These services are made available to the application through [dependency injection](#).

Identity is enabled for the application by calling `UseAuthentication` in the `Configure` method. `UseAuthentication` adds authentication [middleware](#) to the request pipeline.

```

// This method gets called by the runtime. Use this method to configure the HTTP request pipeline.
public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
        app.UseBrowserLink();
        app.UseDatabaseErrorPage();
    }
    else
    {
        app.UseExceptionHandler("/Home/Error");
    }

    app.UseStaticFiles();

    app.UseAuthentication();

    app.UseMvc(routes =>
    {
        routes.MapRoute(
            name: "default",
            template: "{controller=Home}/{action=Index}/{id?}");
    });
}

```

For more information about the application start up process, see [Application Startup](#).

### 3. Create a user.

Launch the application and then click on the **Register** link.

If this is the first time you're performing this action, you may be required to run migrations. The application prompts you to **Apply Migrations**. Refresh the page if needed.

A database operation failed while processing the request.

SqlException: Cannot open database "aspnet-identityDemo-e5ecfa96-0c92-4175-a514-21049ad9d8b3" requested by the login. The login failed. Login failed for user 'OSIRIS\steve\_000'.

Applying existing migrations for ApplicationDbContext may resolve this issue

There are migrations for ApplicationDbContext that have not been applied to the database

- 000000000000\_CreatedIdentitySchema

[Apply Migrations](#)

In Visual Studio, you can use the Package Manager Console to apply pending migrations to the database:

PM> Update-Database

Alternatively, you can apply pending migrations from a command prompt at your project directory:

> dotnet ef database update

Alternately, you can test using ASP.NET Core Identity with your app without a persistent database by using an in-memory database. To use an in-memory database, add the

`Microsoft.EntityFrameworkCore.InMemory` package to your app and modify your app's call to

`AddDbContext` in `ConfigureServices` as follows:

```

services.AddDbContext<ApplicationDbContext>(options =>
    options.UseInMemoryDatabase(Guid.NewGuid().ToString()));

```

When the user clicks the **Register** link, the `Register` action is invoked on `AccountController`. The `Register` action creates the user by calling `CreateAsync` on the `_userManager` object (provided to `AccountController` by dependency injection):

```

// POST: /Account/Register
[HttpPost]
[AllowAnonymous]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Register(RegisterViewModel model)
{
    if (ModelState.IsValid)
    {
        var user = new ApplicationUser { UserName = model.Email, Email = model.Email };
        var result = await _userManager.CreateAsync(user, model.Password);
        if (result.Succeeded)
        {
            // For more information on how to enable account confirmation and password reset please
            // visit http://go.microsoft.com/fwlink/?LinkID=532713
            // Send an email with this link
            //var code = await _userManager.GenerateEmailConfirmationTokenAsync(user);
            //var callbackUrl = Url.Action("ConfirmEmail", "Account", new { userId = user.Id, code =
            code }, protocol: HttpContext.Request.Scheme);
            //await _emailSender.SendEmailAsync(model.Email, "Confirm your account",
            //    "Please confirm your account by clicking this link: <a href=\"" + callbackUrl +
            //">link</a>");
            await _signInManager.SignInAsync(user, isPersistent: false);
            _logger.LogInformation(3, "User created a new account with password.");
            return RedirectToAction(nameof(HomeController.Index), "Home");
        }
        AddErrors(result);
    }

    // If we got this far, something failed, redisplay form
    return View(model);
}

```

If the user was created successfully, the user is logged in by the call to `_signInManager.SignInAsync`.

**Note:** See [account confirmation](#) for steps to prevent immediate login at registration.

#### 4. Log in.

Users can sign in by clicking the **Log in** link at the top of the site, or they may be navigated to the Login page if they attempt to access a part of the site that requires authorization. When the user submits the form on the Login page, the `AccountController` `Login` action is called.

The `Login` action calls `PasswordSignInAsync` on the `_signInManager` object (provided to `AccountController` by dependency injection).

```

// POST: /Account/Login
[HttpPost]
[AllowAnonymous]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Login(LoginViewModel model, string returnUrl = null)
{
    ViewData["ReturnUrl"] = returnUrl;
    if (ModelState.IsValid)
    {
        // This doesn't count login failures towards account lockout
        // To enable password failures to trigger account lockout, set lockoutOnFailure: true
        var result = await _signInManager.PasswordSignInAsync(model.Email,
            model.Password, model.RememberMe, lockoutOnFailure: false);
        if (result.Succeeded)
        {
            _logger.LogInformation(1, "User logged in.");
            return RedirectToLocal(returnUrl);
        }
        if (result.RequiresTwoFactor)
        {
            return RedirectToAction(nameof(SendCode), new { ReturnUrl = returnUrl, RememberMe =
model.RememberMe });
        }
        if (result.IsLockedOut)
        {
            _logger.LogWarning(2, "User account locked out.");
            return View("Lockout");
        }
        else
        {
            ModelState.AddModelError(string.Empty, "Invalid login attempt.");
            return View(model);
        }
    }

    // If we got this far, something failed, redisplay form
    return View(model);
}

```

The base `Controller` class exposes a `User` property that you can access from controller methods. For instance, you can enumerate `User.Claims` and make authorization decisions. For more information, see [Authorization](#).

## 5. Log out.

Clicking the **Log out** link calls the `Logout` action.

```

// POST: /Account/Logout
[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> Logout()
{
    await _signInManager.SignOutAsync();
    _logger.LogInformation(4, "User logged out.");
    return RedirectToAction(nameof(HomeController.Index), "Home");
}

```

The preceding code above calls the `_signInManager.SignOutAsync` method. The `SignOutAsync` method clears the user's claims stored in a cookie.

## 6. Configuration.

Identity has some default behaviors that can be overridden in the app's startup class. `IdentityOptions` don't need to be configured when using the default behaviors. The following code sets several password strength options:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
// This method gets called by the runtime. Use this method to add services to the container.
public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<ApplicationContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("DefaultConnection")));

    services.AddIdentity<ApplicationUser, IdentityRole>()
        .AddEntityFrameworkStores<ApplicationContext>()
        .AddDefaultTokenProviders();

    services.Configure<IdentityOptions>(options =>
    {
        // Password settings
        options.Password.RequireDigit = true;
        options.Password.RequiredLength = 8;
        options.Password.RequireNonAlphanumeric = false;
        options.Password.RequireUppercase = true;
        options.Password.RequireLowercase = false;
        options.Password.RequiredUniqueChars = 6;

        // Lockout settings
        options.Lockout.DefaultLockoutTimeSpan = TimeSpan.FromMinutes(30);
        options.Lockout.MaxFailedAccessAttempts = 10;
        options.Lockout.AllowedForNewUsers = true;

        // User settings
        options.User.RequireUniqueEmail = true;
    });

    services.ConfigureApplicationCookie(options =>
    {
        // Cookie settings
        options.Cookie.HttpOnly = true;
        options.ExpireTimeSpan = TimeSpan.FromMinutes(30);
        // If the LoginPath isn't set, ASP.NET Core defaults
        // the path to /Account/Login.
        options.LoginPath = "/Account/Login";
        // If the AccessDeniedPath isn't set, ASP.NET Core defaults
        // the path to /Account/AccessDenied.
        options.AccessDeniedPath = "/Account/AccessDenied";
        options SlidingExpiration = true;
    });

    // Add application services.
    services.AddTransient<IEmailSender, EmailSender>();

    services.AddMvc();
}
```

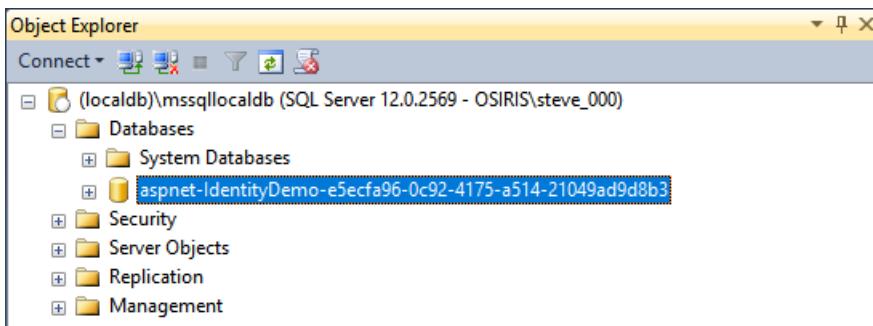
For more information about how to configure Identity, see [Configure Identity](#).

You also can configure the data type of the primary key, see [Configure Identity primary keys data type](#).

## 7. View the database.

If your app is using a SQL Server database (the default on Windows and for Visual Studio users), you can view the database the app created. You can use **SQL Server Management Studio**. Alternatively,

from Visual Studio, select **View > SQL Server Object Explorer**. Connect to **(localdb)\MSSQLLocalDB**. The database with a name matching `aspnet-<name of your project>-<guid>` is displayed.



Expand the database and its **Tables**, then right-click the **dbo.AspNetUsers** table and select **View Data**.

## 8. Verify Identity works

The default *ASP.NET Core Web Application* project template allows users to access any action in the application without having to login. To verify that ASP.NET Identity works, add an `[Authorize]` attribute to the `About` action of the `HomeController`.

```
[Authorize]
public IActionResult About()
{
    ViewData["Message"] = "Your application description page.";
    return View();
}
```

- [Visual Studio](#)
- [.NET Core CLI](#)

Run the project using **Ctrl + F5** and navigate to the **About** page. Only authenticated users may access the **About** page now, so ASP.NET redirects you to the login page to login or register.

## Identity Components

The primary reference assembly for the Identity system is `Microsoft.AspNetCore.Identity`. This package contains the core set of interfaces for ASP.NET Core Identity, and is included by `Microsoft.AspNetCore.Identity.EntityFrameworkCore`.

These dependencies are needed to use the Identity system in ASP.NET Core applications:

- `Microsoft.AspNetCore.Identity.EntityFrameworkCore` - Contains the required types to use Identity with Entity Framework Core.
- `Microsoft.EntityFrameworkCore.SqlServer` - Entity Framework Core is Microsoft's recommended data access technology for relational databases like SQL Server. For testing, you can use `Microsoft.EntityFrameworkCore.InMemory`.
- `Microsoft.AspNetCore.Authentication.Cookies` - Middleware that enables an app to use cookie-based authentication.

## Migrating to ASP.NET Core Identity

For additional information and guidance on migrating your existing Identity store see [Migrate Authentication and Identity](#).

## Setting password strength

See [Configuration](#) for a sample that sets the minimum password requirements.

## Next Steps

- [Migrate Authentication and Identity](#)
- [Account Confirmation and Password Recovery](#)
- [Two-factor authentication with SMS](#)
- [Facebook, Google, and external provider authentication](#)

# Scaffold Identity in ASP.NET Core projects

7/14/2018 • 11 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

ASP.NET Core 2.1 and later provides [ASP.NET Core Identity](#) as a [Razor Class Library](#). Applications that include Identity can apply the scaffolder to selectively add the source code contained in the Identity Razor Class Library (RCL). You might want to generate source code so you can modify the code and change the behavior. For example, you could instruct the scaffolder to generate the code used in registration. Generated code takes precedence over the same code in the Identity RCL. To gain full control of the UI and not use the default RCL, see the section [Create full identity UI source](#).

Applications that do **not** include authentication can apply the scaffolder to add the RCL Identity package. You have the option of selecting Identity code to be generated.

Although the scaffolder generates most of the necessary code, you'll have to update your project to complete the process. This document explains the steps needed to complete an Identity scaffolding update.

When the Identity scaffolder is run, a *ScaffoldingReadme.txt* file is created in the project directory. The *ScaffoldingReadme.txt* file contains general instructions on what's needed to complete the Identity scaffolding update. This document contains more complete instructions than the *ScaffoldingReadme.txt* file.

We recommend using a source control system that shows file differences and allows you to back out of changes. Inspect the changes after running the Identity scaffolder.

## Scaffold identity into an empty project

Run the Identity scaffolder:

- [Visual Studio](#)
- [.NET Core CLI](#)
- From **Solution Explorer**, right-click on the project > **Add** > **New Scaffolded Item**.
- From the left pane of the **Add Scaffold** dialog, select **Identity** > **ADD**.
- In the **ADD Identity** dialog, select the options you want.
  - Select your existing layout page, or your layout file will be overwritten with incorrect markup. For example `~/Pages/Shared/_Layout.cshtml` for Razor Pages `~/Views/Shared/_Layout.cshtml` for MVC projects
  - Select the + button to create a new **Data context class**.
- Select **ADD**.

Add the following highlighted calls to the `Startup` class:

```

public class Startup
{
    public void ConfigureServices(IServiceCollection services)
    {
        services.AddMvc();
    }

    // This method gets called by the runtime. Use this method to configure the HTTP request pipeline.
    public void Configure(IApplicationBuilder app, IHostingEnvironment env)
    {
        if (env.IsDevelopment())
        {
            app.UseDeveloperExceptionPage();
        }
        else
        {
            app.UseHsts();
        }

        app.UseHttpsRedirection();
        app.UseStaticFiles();
        app.UseAuthentication();
        app.UseMvc();
    }
}

```

`UseHsts` is recommended but not required. See [HTTP Strict Transport Security Protocol](#) for more information.

The generated Identity database code requires [Entity Framework Core Migrations](#). Create a migration and update the database. For example, run the following commands:

- [Visual Studio](#)
- [.NET Core CLI](#)

In the Visual Studio **Package Manager Console**:

```

Add-Migration CreateIdentitySchema
Update-Database

```

The "CreateIdentitySchema" name parameter for the `Add-Migration` command is arbitrary.

"`CreateIdentitySchema`" describes the migration.

## Scaffold identity into a Razor project without existing authorization

Run the Identity scaffolder:

- [Visual Studio](#)
- [.NET Core CLI](#)
- From **Solution Explorer**, right-click on the project > **Add** > **New Scaffolded Item**.
- From the left pane of the **Add Scaffold** dialog, select **Identity** > **ADD**.
- In the **ADD Identity** dialog, select the options you want.
  - Select your existing layout page, or your layout file will be overwritten with incorrect markup. For example `~/Pages/Shared/_Layout.cshtml` for Razor Pages `~/views/Shared/_Layout.cshtml` for MVC projects
  - Select the + button to create a new **Data context class**.
- Select **ADD**.

Identity is configured in `Areas/Identity/IdentityHostingStartup.cs`. for more information, see [IHostingStartup](#).

## Migrations, UseAuthentication, and layout

The generated Identity database code requires [Entity Framework Core Migrations](#). Create a migration and update the database. For example, run the following commands:

- [Visual Studio](#)
- [.NET Core CLI](#)

In the Visual Studio **Package Manager Console**:

```
Add-Migration CreateIdentitySchema  
Update-Database
```

The "CreateIdentitySchema" name parameter for the `Add-Migration` command is arbitrary.  
"CreateIdentitySchema" describes the migration.

## Enable authentication

In the `Configure` method of the `Startup` class, call [UseAuthentication](#) after `UseStaticFiles`:

```
public class Startup  
{  
    public Startup(IConfiguration configuration)  
    {  
        Configuration = configuration;  
    }  
  
    public IConfiguration Configuration { get; }  
  
    public void ConfigureServices(IServiceCollection services)  
    {  
        services.AddMvc();  
    }  
  
    public void Configure(IApplicationBuilder app, IHostingEnvironment env)  
    {  
        if (env.IsDevelopment())  
        {  
            app.UseDeveloperExceptionPage();  
        }  
        else  
        {  
            app.UseExceptionHandler("/Error");  
            app.UseHsts();  
        }  
  
        app.UseHttpsRedirection();  
        app.UseStaticFiles();  
        app.UseAuthentication();  
  
        app.UseMvc();  
    }  
}
```

`UseHsts` is recommended but not required. See [HTTP Strict Transport Security Protocol](#) for more information.

## Layout changes

Optional: Add the login partial (`_LoginPartial`) to the layout file:

```
<!DOCTYPE html>  
<html>
```

```

<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>@ViewData["Title"] - RazorNoAuth8</title>

    <environment include="Development">
        <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />
        <link rel="stylesheet" href="~/css/site.css" />
    </environment>
    <environment exclude="Development">
        <link rel="stylesheet" href="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/css/bootstrap.min.css"
              asp-fallback-href="~/lib/bootstrap/dist/css/bootstrap.min.css"
              asp-fallback-test-class="sr-only" asp-fallback-test-property="position" asp-fallback-test-
              value="absolute" />
        <link rel="stylesheet" href="~/css/site.min.css" asp-append-version="true" />
    </environment>
</head>
<body>
    <nav class="navbar navbar-inverse navbar-fixed-top">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-
collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a asp-page="/Index" class="navbar-brand">RazorNoAuth8</a>
            </div>
            <div class="navbar-collapse collapse">
                <ul class="nav navbar-nav">
                    <li><a asp-page="/Index">Home</a></li>
                    <li><a asp-page="/About">About</a></li>
                    <li><a asp-page="/Contact">Contact</a></li>
                </ul>
                <partial name="_LoginPartial" />
            </div>
        </div>
    </nav>

    <partial name="_CookieConsentPartial" />

    <div class="container body-content">
        @RenderBody()
        <hr />
        <footer>
            <p>&copy; 2018 - RazorNoAuth8</p>
        </footer>
    </div>

    <environment include="Development">
        <script src="~/lib/jquery/dist/jquery.js"></script>
        <script src="~/lib/bootstrap/dist/js/bootstrap.js"></script>
        <script src="~/js/site.js" asp-append-version="true"></script>
    </environment>
    <environment exclude="Development">
        <script src="https://ajax.aspnetcdn.com/ajax/jquery/jquery-3.3.1.min.js"
               asp-fallback-src="~/lib/jquery/dist/jquery.min.js"
               asp-fallback-test="window.jQuery"
               crossorigin="anonymous"
               integrity="sha384-K+ctZQ+LL8q6tP7I94W+qzQsfRV2a+AfhII9k8z8l9ggpc8X+Ytst4yBo/hH+8Fk">
        </script>
        <script src="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/bootstrap.min.js"
               asp-fallback-src="~/lib/bootstrap/dist/js/bootstrap.min.js"
               asp-fallback-test="window.jQuery && window.jQuery.fn && window.jQuery.fn.modal"
               crossorigin="anonymous"
               integrity="sha384-Tc5IQib027qvjSMfHj0MaLkfWVxZxUPnCJA712mCWNIPG9mGCD8wGNICPD7Txa">
        </script>
    </environment>
</body>

```

```
// Scripts
<script src="~/js/site.min.js" asp-append-version="true"></script>
</environment>

@RenderSection("Scripts", required: false)
</body>
</html>
```

## Scaffold identity into a Razor project with authorization

Run the Identity scaffolder:

- [Visual Studio](#)
- [.NET Core CLI](#)
- From **Solution Explorer**, right-click on the project > **Add** > **New Scaffolded Item**.
- From the left pane of the **Add Scaffold** dialog, select **Identity** > **ADD**.
- In the **ADD Identity** dialog, select the options you want.
  - Select your existing layout page, or your layout file will be overwritten with incorrect markup. When an existing `_Layout.cshtml` file is selected, it is **not** overwritten.

For example `~/Pages/Shared/_Layout.cshtml` for Razor Pages `~/Views/Shared/_Layout.cshtml` for MVC projects

- To use your existing data context, select at least one file to override. You must select at least one file to add your data context.
  - Select your data context class.
  - Select **ADD**.
- To create a new user context and possibly create a custom user class for Identity:
  - Select the + button to create a new **Data context class**.
  - Select **ADD**.

Note: If you're creating a new user context, you don't have to select a file to override.

Some Identity options are configured in `Areas/Identity/IdentityHostingStartup.cs`. For more information, see [IHostingStartup](#).

## Scaffold identity into an MVC project without existing authorization

Run the Identity scaffolder:

- [Visual Studio](#)
- [.NET Core CLI](#)
- From **Solution Explorer**, right-click on the project > **Add** > **New Scaffolded Item**.
- From the left pane of the **Add Scaffold** dialog, select **Identity** > **ADD**.
- In the **ADD Identity** dialog, select the options you want.
  - Select your existing layout page, or your layout file will be overwritten with incorrect markup. For example `~/Pages/Shared/_Layout.cshtml` for Razor Pages `~/views/Shared/_Layout.cshtml` for MVC projects
  - Select the + button to create a new **Data context class**.
- Select **ADD**.

Optional: Add the login partial (`_LoginPartial`) to the `Views/Shared/_Layout.cshtml` file:

```
<!DOCTYPE html>
<html>
```

```

<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>@ViewData["Title"] - MvcNoAuth3</title>

    <environment include="Development">
        <link rel="stylesheet" href="~/lib/bootstrap/dist/css/bootstrap.css" />
        <link rel="stylesheet" href="~/css/site.css" />
    </environment>
    <environment exclude="Development">
        <link rel="stylesheet" href="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/css/bootstrap.min.css"
              asp-fallback-href="~/lib/bootstrap/dist/css/bootstrap.min.css"
              asp-fallback-test-class="sr-only" asp-fallback-test-property="position" asp-fallback-test-
              value="absolute" />
        <link rel="stylesheet" href="~/css/site.min.css" asp-append-version="true" />
    </environment>
</head>
<body>
    <nav class="navbar navbar-inverse navbar-fixed-top">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-
collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a asp-area="" asp-controller="Home" asp-action="Index" class="navbar-brand">MvcNoAuth3</a>
            </div>
            <div class="navbar-collapse collapse">
                <ul class="nav navbar-nav">
                    <li><a asp-area="" asp-controller="Home" asp-action="Index">Home</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="About">About</a></li>
                    <li><a asp-area="" asp-controller="Home" asp-action="Contact">Contact</a></li>
                </ul>
                <partial name="_LoginPartial" />
            </div>
        </div>
    </nav>

    <partial name=" _CookieConsentPartial" />

    <div class="container body-content">
        @RenderBody()
        <hr />
        <footer>
            <p>&copy; 2018 - MvcNoAuth3</p>
        </footer>
    </div>

    <environment include="Development">
        <script src="~/lib/jquery/dist/jquery.js"></script>
        <script src="~/lib/bootstrap/dist/js/bootstrap.js"></script>
        <script src="~/js/site.js" asp-append-version="true"></script>
    </environment>
    <environment exclude="Development">
        <script src="https://ajax.aspnetcdn.com/ajax/jquery/jquery-3.3.1.min.js"
               asp-fallback-src="~/lib/jquery/dist/jquery.min.js"
               asp-fallback-test="window.jQuery"
               crossorigin="anonymous"
               integrity="sha384-K+ctZQ+LL8q6tP7I94W+qzQsfRV2a+AfhII9k8z8l9ggpc8X+Ytst4yBo/hH+8Fk">
        </script>
        <script src="https://ajax.aspnetcdn.com/ajax/bootstrap/3.3.7/bootstrap.min.js"
               asp-fallback-src="~/lib/bootstrap/dist/js/bootstrap.min.js"
               asp-fallback-test="window.jQuery && window.jQuery.fn && window.jQuery.fn.modal"
               crossorigin="anonymous"
               integrity="sha384-Tc5IQib027qvjSMfHj0MaLkfWVxZxUPnCJA712mCWNIPG9mGCD8wGNICPD7Txa">
        </script>
    </environment>

```

```

    </script>
<script src="~/js/site.min.js" asp-append-version="true"></script>
</environment>

@RenderSection("Scripts", required: false)
</body>
</html>

```

- Move the `Pages/Shared/_LoginPartial.cshtml` file to `Views/Shared/_LoginPartial.cshtml`

Identity is configured in `Areas/Identity/IdentityHostingStartup.cs`. For more information, see [IHostingStartup](#).

The generated Identity database code requires [Entity Framework Core Migrations](#). Create a migration and update the database. For example, run the following commands:

- [Visual Studio](#)
- [.NET Core CLI](#)

In the Visual Studio **Package Manager Console**:

```
Add-Migration CreateIdentitySchema
Update-Database
```

The "CreateIdentitySchema" name parameter for the `Add-Migration` command is arbitrary. "CreateIdentitySchema" describes the migration.

Call `UseAuthentication` after `UseStaticFiles`:

```

public class Startup
{
    public void ConfigureServices(IServiceCollection services)
    {
        services.AddMvc();
    }

    public void Configure(IApplicationBuilder app, IHostingEnvironment env)
    {
        if (env.IsDevelopment())
        {
            app.UseDeveloperExceptionPage();
        }
        else
        {
            app.UseExceptionHandler("/Home/Error");
            app.UseHsts();
        }

        app.UseHttpsRedirection();
        app.UseStaticFiles();
        app.UseAuthentication();
        app.UseMvcWithDefaultRoute();
    }
}

```

`UseHsts` is recommended but not required. See [HTTP Strict Transport Security Protocol](#) for more information.

## Scaffold identity into an MVC project with authorization

Run the Identity scaffolder:

- [Visual Studio](#)

- [.NET Core CLI](#)
- From **Solution Explorer**, right-click on the project > **Add > New Scaffolded Item**.
- From the left pane of the **Add Scaffold** dialog, select **Identity > ADD**.
- In the **ADD Identity** dialog, select the options you want.
  - Select your existing layout page, or your layout file will be overwritten with incorrect markup. When an existing `_Layout.cshtml` file is selected, it is **not** overwritten.

For example `~/Pages/Shared/_Layout.cshtml` for Razor Pages `~/Views/Shared/_Layout.cshtml` for MVC projects

- To use your existing data context, select at least one file to override. You must select at least one file to add your data context.
  - Select your data context class.
  - Select **ADD**.
- To create a new user context and possibly create a custom user class for Identity:
  - Select the **+** button to create a new **Data context class**.
  - Select **ADD**.

Note: If you're creating a new user context, you don't have to select a file to override.

Delete the *Pages/Shared* folder and the files in that folder.

## Create full identity UI source

To maintain full control of the Identity UI, run the Identity scaffolder and select **Override all files**.

The following highlighted code shows the changes to replace the default Identity UI with Identity in an ASP.NET Core 2.1 web app. You might want to do this to have full control of the Identity UI.

```

public void ConfigureServices(IServiceCollection services)
{
    services.Configure<CookiePolicyOptions>(options =>
    {
        options.CheckConsentNeeded = context => true;
        options.MinimumSameSitePolicy = SameSiteMode.None;
    });

    services.AddDbContext<ApplicationContext>(options =>
        options.UseSqlServer(
            Configuration.GetConnectionString("DefaultConnection")));
}

services.AddIdentity<IdentityUser, IdentityRole>()
    // services.AddDefaultIdentity<IdentityUser>()
    .AddEntityFrameworkStores<ApplicationContext>();

services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1)
    .AddRazorPagesOptions(options =>
{
    options.AllowAreas = true;
    options.Conventions.AuthorizeAreaFolder("Identity", "/Account/Manage");
    options.Conventions.AuthorizeAreaPage("Identity", "/Account/Logout");
});

services.ConfigureApplicationCookie(options =>
{
    options.LoginPath = $"/Identity/Account/Login";
    options.LogoutPath = $"/Identity/Account/Logout";
    options.AccessDeniedPath = $"/Identity/Account/AccessDenied";
});

// using Microsoft.AspNetCore.Identity.UI.Services;
services.AddSingleton<IEmailSender, EmailSender>();
}

```

The default Identity is replaced in the following code:

```

services.AddIdentity<IdentityUser, IdentityRole>()
    // services.AddDefaultIdentity<IdentityUser>()
    .AddEntityFrameworkStores<ApplicationContext>();

```

The following the code sets the [LoginPath](#), [LogoutPath](#), and [AccessDeniedPath](#):

```

services.ConfigureApplicationCookie(options =>
{
    options.LoginPath = $"/Identity/Account/Login";
    options.LogoutPath = $"/Identity/Account/Logout";
    options.AccessDeniedPath = $"/Identity/Account/AccessDenied";
});

```

Register an [IEmailSender](#) implementation, for example:

```

// using Microsoft.AspNetCore.Identity.UI.Services;
services.AddSingleton<IEmailSender, EmailSender>();

```

# Add, download, and delete custom user data to Identity in an ASP.NET Core project

6/21/2018 • 7 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

This article shows how to:

- Add custom user data to an ASP.NET Core web app.
- Decorate the custom user data model with the [PersonalData](#) attribute so it's automatically available for download and deletion. Making the data able to be downloaded and deleted helps meet [GDPR](#) requirements.

The project sample is created from a Razor Pages web app, but the instructions are similar for a ASP.NET Core MVC web app.

[View or download sample code \(how to download\)](#)

## Prerequisites

[.NET Core 2.1 SDK or later](#)

## Create a Razor web app

- [Visual Studio](#)
- [.NET Core CLI](#)
- From the Visual Studio **File** menu, select **New > Project**. Name the project **WebApp1** if you want to it match the namespace of the [download sample](#) code.
- Select **ASP.NET Core Web Application > OK**
- Select **ASP.NET Core 2.1** in the dropdown
- Select **Web Application > OK**
- Build and run the project.

## Run the Identity scaffolder

- [Visual Studio](#)
- [.NET Core CLI](#)
- From **Solution Explorer**, right-click on the project > **Add > New Scaffolded Item**.
- From the left pane of the **Add Scaffold** dialog, select **Identity > ADD**.
- In the **ADD Identity** dialog, the following options:
  - Select your existing layout file `~/Pages/Shared/_Layout.cshtml`
  - Select the following files to override:
    - **Account/Register**
    - **Account/Manage/Index**
  - Select the + button to create a new **Data context class**. Accept the type (**WebApp1.Models.WebApp1Context** if you named the project **WebApp1**).
  - Select the + button to create a new **User class**. Accept the type (**WebApp1User** if you named the project **WebApp1**) > **Add**.

- Select **ADD**.

Follow the instruction in [Migrations, UseAuthentication, and layout](#) to perform the following steps:

- Create a migration and update the database.
- Add `UseAuthentication` to `Startup.Configure`.
- Add `<partial name="_LoginPartial" />` to the layout file.
- Test the app:
  - Register a user
  - Select the new user name (next to the **Logout** link). You might need to expand the window or select the navigation bar icon to show the user name and other links.
  - Select the **Personal Data** tab.
  - Select the **Download** button and examined the *PersonalData.json* file.
  - Test the **Delete** button, which deletes the logged on user.

## Add custom user data to the Identity DB

Update the `IdentityUser` derived class with custom properties. If you named your project WebApp1, the file is named *Areas/Identity/Data/WebApp1User.cs*. Update the file with the following code:

```
using Microsoft.AspNetCore.Identity;
using System;

namespace WebApp1.Areas.Identity.Data
{
    public class WebApp1User : IdentityUser
    {
        [PersonalData]
        public string Name { get; set; }
        [PersonalData]
        public DateTime DOB { get; set; }
    }
}
```

Properties decorated with the `PersonalData` attribute are:

- Deleted when the *Areas/Identity/Pages/Account/Manage/DeletePersonalData.cshtml* Razor Page calls `UserManager.Delete`.
- Included in the downloaded data by the *Areas/Identity/Pages/Account/Manage/DownloadPersonalData.cshtml* Razor Page.

### Update the Account/Manage/Index.cshtml page

Update the `InputModel` in *Areas/Identity/Pages/Account/Manage/Index.cshtml.cs* with the following highlighted code:

```
public partial class IndexModel : PageModel
{
    private readonly UserManager<WebApp1User> _userManager;
    private readonly SignInManager<WebApp1User> _signInManager;
    private readonly IEmailSender _emailSender;

    public IndexModel(
        UserManager<WebApp1User> userManager,
        SignInManager<WebApp1User> signInManager,
        IEmailSender emailSender)
    {
        _userManager = userManager;
        _signInManager = signInManager;
    }
}
```

```

        _emailSender = emailSender;
    }

    public string Username { get; set; }

    public bool IsEmailConfirmed { get; set; }

    [TempData]
    public string StatusMessage { get; set; }
    [BindProperty]
    public InputModel Input { get; set; }

    public class InputModel
    {
        [Required]
        [DataType(DataType.Text)]
        [Display(Name = "Full name")]
        public string Name { get; set; }

        [Required]
        [Display(Name = "Birth Date")]
        [DataType(DataType.Date)]
        public DateTime DOB { get; set; }

        [Required]
        [EmailAddress]
        public string Email { get; set; }

        [Phone]
        [Display(Name = "Phone number")]
        public string PhoneNumber { get; set; }
    }

    public async Task<IActionResult> OnGetAsync()
    {
        var user = await _userManager.GetUserAsync(User);
        if (user == null)
        {
            return NotFound($"Unable to load user with ID '{_userManager.GetUserId(User)}'.");
        }

        var userName = await _userManager.GetUserNameAsync(user);
        var email = await _userManager.GetEmailAsync(user);
        var phoneNumber = await _userManager.GetPhoneNumberAsync(user);

        Username = userName;

        Input = new InputModel
        {
            Name = user.Name,
            DOB = user.DOB,
            Email = email,
            PhoneNumber = phoneNumber
        };

        IsEmailConfirmed = await _userManager.IsEmailConfirmedAsync(user);

        return Page();
    }

    public async Task<IActionResult> OnPostAsync()
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        var user = await _userManager.GetUserAsync(User);
        if (user == null)

```

```

    {
        return NotFound($"Unable to load user with ID '{_userManager.GetUserId(User)}'.");
    }

    if (Input.Name != user.Name)
    {
        user.Name = Input.Name;
    }

    if (Input.DOB != user.DOB)
    {
        user.DOB = Input.DOB;
    }

    var email = await _userManager.GetEmailAsync(user);
    if (Input.Email != email)
    {
        var setEmailResult = await _userManager.SetEmailAsync(user, Input.Email);
        if (!setEmailResult.Succeeded)
        {
            var userId = await _userManager.GetUserIdAsync(user);
            throw new InvalidOperationException($"Unexpected error occurred setting email for user with ID '{userId}'.");
        }
    }

    var phoneNumber = await _userManager.GetPhoneNumberAsync(user);
    if (Input.PhoneNumber != phoneNumber)
    {
        var setPhoneResult = await _userManager.SetPhoneNumberAsync(user, Input.PhoneNumber);
        if (!setPhoneResult.Succeeded)
        {
            var userId = await _userManager.GetUserIdAsync(user);
            throw new InvalidOperationException($"Unexpected error occurred setting phone number for user with ID '{userId}'.");
        }
    }

    await _userManager.UpdateAsync(user);

    await _signInManager.RefreshSignInAsync(user);
    StatusMessage = "Your profile has been updated";
    return RedirectToPage();
}

public async Task<IActionResult> OnPostSendVerificationEmailAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    var user = await _userManager.GetUserAsync(User);
    if (user == null)
    {
        return NotFound($"Unable to load user with ID '{_userManager.GetUserId(User)}'.");
    }

    var userId = await _userManager.GetUserIdAsync(user);
    var email = await _userManager.GetEmailAsync(user);
    var code = await _userManager.GenerateEmailConfirmationTokenAsync(user);
    var callbackUrl = Url.Page(
        "/Account/ConfirmEmail",
        pageHandler: null,
        values: new { userId = userId, code = code },
        protocol: Request.Scheme);
    await emailSender.SendEmailAsync(

```

```
        email,
        "Confirm your email",
        $"Please confirm your account by <a href='{HtmlEncoder.Default.Encode(callbackUrl)}'>clicking
here</a>.");

        StatusMessage = "Verification email sent. Please check your email.";
        return RedirectToPage();
    }
}
```

Update the *Areas/Identity/Pages/Account/Manage/Index.cshtml* with the following highlighted markup:

```

@page
@model IndexModel
 @{
     ViewData["Title"] = "Profile";
 }

<h4>@ViewData["Title"]</h4>
@Html.Partial("_StatusMessage", Model.StatusMessage)
<div class="row">
    <div class="col-md-6">
        <form id="profile-form" method="post">
            <div asp-validation-summary="All" class="text-danger"></div>
            <div class="form-group">
                <label asp-for="Username"></label>
                <input asp-for="Username" class="form-control" disabled />
            </div>
            <div class="form-group">
                <label asp-for="Input.Email"></label>
                @if (Model.IsEmailConfirmed)
                {
                    <div class="input-group">
                        <input asp-for="Input.Email" class="form-control" />
                        <span class="input-group-addon" aria-hidden="true"><span class="glyphicon glyphicon-ok text-success"></span></span>
                    </div>
                }
                else
                {
                    <input asp-for="Input.Email" class="form-control" />
                    <button id="email-verification" type="submit" asp-page-handler="SendVerificationEmail" class="btn btn-link">Send verification email</button>
                }
                <span asp-validation-for="Input.Email" class="text-danger"></span>
            </div>
            <div class="form-group">
                <div class="form-group">
                    <label asp-for="Input.Name"></label>
                    <input asp-for="Input.Name" class="form-control" />
                </div>
                <div class="form-group">
                    <label asp-for="Input.DOB"></label>
                    <input asp-for="Input.DOB" class="form-control" />
                </div>
                <label asp-for="Input.PhoneNumber"></label>
                <input asp-for="Input.PhoneNumber" class="form-control" />
                <span asp-validation-for="Input.PhoneNumber" class="text-danger"></span>
            </div>
            <button type="submit" class="btn btn-default">Save</button>
        </form>
    </div>
</div>

@section Scripts {
    <partial name="_ValidationScriptsPartial" />
}

```

## Update the Account/Register.cshtml page

Update the `InputModel` in `Areas/Identity/Pages/Account/Register.cshtml.cs` with the following highlighted code:

```

[BindProperty]
public InputModel Input { get; set; }

public string ReturnUrl { get; set; }

public class InputModel
{

```

```

{
    [Required]
    [DataType(DataType.Text)]
    [Display(Name = "Full name")]
    public string Name { get; set; }

    [Required]
    [Display(Name = "Birth Date")]
    [DataType(DataType.Date)]
    public DateTime DOB { get; set; }

    [Required]
    [EmailAddress]
    [Display(Name = "Email")]
    public string Email { get; set; }

    [Required]
    [StringLength(100, ErrorMessage = "The {0} must be at least {2} and at max {1} characters long.",
    MinimumLength = 6)]
    [DataType(DataType.Password)]
    [Display(Name = "Password")]
    public string Password { get; set; }

    [DataType(DataType.Password)]
    [Display(Name = "Confirm password")]
    [Compare("Password", ErrorMessage = "The password and confirmation password do not match.")]
    public string ConfirmPassword { get; set; }
}

public async Task<IActionResult> OnPostAsync(string returnUrl = null)
{
    returnUrl = returnUrl ?? Url.Content("~/");
    if (ModelState.IsValid)
    {
        var user = new WebApp1User {
            UserName = Input.Email,
            Email = Input.Email,
            Name = Input.Name,
            DOB = Input.DOB
        };
        var result = await _userManager.CreateAsync(user, Input.Password);
        if (result.Succeeded)
        {
            _logger.LogInformation("User created a new account with password.");
            var code = await _userManager.GenerateEmailConfirmationTokenAsync(user);
            var callbackUrl = Url.Page(
                "/Account/ConfirmEmail",
                pageHandler: null,
                values: new { userId = user.Id, code = code },
                protocol: Request.Scheme);

            await _emailSender.SendEmailAsync(Input.Email, "Confirm your email",
                $"Please confirm your account by <a href='{HtmlEncoder.Default.Encode(callbackUrl)}'>clicking here</a>.");
            await _signInManager.SignInAsync(user, isPersistent: false);
            return LocalRedirect(returnUrl);
        }
        foreach (var error in result.Errors)
        {
            ModelState.AddModelError(string.Empty, error.Description);
        }
    }
}

// If we got this far, something failed, redisplay form
return Page();
}

```

Update the `Areas/Identity/Pages/Account/Register.cshtml` with the following highlighted markup:

```
@page
@model RegisterModel
 @{
    ViewData["Title"] = "Register";
}

<h2>@ViewData["Title"]</h2>

<div class="row">
    <div class="col-md-4">
        <form asp-route-returnUrl="@Model.ReturnUrl" method="post">
            <h4>Create a new account.</h4>
            <hr />
            <div asp-validation-summary="All" class="text-danger"></div>

            <div class="form-group">
                <label asp-for="Input.Name"></label>
                <input asp-for="Input.Name" class="form-control" />
                <span asp-validation-for="Input.Name" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Input.DOB"></label>
                <input asp-for="Input.DOB" class="form-control" />
                <span asp-validation-for="Input.DOB" class="text-danger"></span>
            </div>

            <div class="form-group">
                <label asp-for="Input.Email"></label>
                <input asp-for="Input.Email" class="form-control" />
                <span asp-validation-for="Input.Email" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Input.Password"></label>
                <input asp-for="Input.Password" class="form-control" />
                <span asp-validation-for="Input.Password" class="text-danger"></span>
            </div>
            <div class="form-group">
                <label asp-for="Input.ConfirmPassword"></label>
                <input asp-for="Input.ConfirmPassword" class="form-control" />
                <span asp-validation-for="Input.ConfirmPassword" class="text-danger"></span>
            </div>
            <button type="submit" class="btn btn-default">Register</button>
        </form>
    </div>
</div>

@section Scripts {
    <partial name="_ValidationScriptsPartial" />
}
```

Build the project.

### Add a migration for the custom user data

- [Visual Studio](#)
- [.NET Core CLI](#)

In the Visual Studio **Package Manager Console**:

```
Add-Migration CustomUserData
Update-Database
```

## Test create, view, download, delete custom user data

Test the app:

- Register a new user.
- View the custom user data on the `/Identity/Account/Manage` page.
- Download and view the users personal data from the `/Identity/Account/Manage/PersonalData` page.

# Identity model customization

6/28/2018 • 16 minutes to read • [Edit Online](#)

By [Arthur Vickers](#)

ASP.NET Core Identity provides a framework for managing and storing user accounts in ASP.NET Core applications. Identity is added to your project when "Individual User Accounts" is selected as the authentication mechanism. By default, Identity makes use of an Entity Framework (EF) Core data model. This article describes how to customize the Identity model.

## Identity and EF Core Migrations

Before examining the model, it's useful to understand how Identity works with [EF Core Migrations](#) to create and update a database. At the top level, the process is:

1. Define or update a [data model in code](#).
2. Add a migration to translate this model into changes that can be applied to the database.
3. Check that the migration correctly represents your intentions.
4. Apply the migration to update the database to be in sync with the model.
5. Repeat steps 1-4 to further refine the model and keep the database in sync.

Migrations are added and applied using:

- The [Package Manager Console](#) (PMC) if you are using Visual Studio.
- The [dotnet commands](#) on the command line.
- Selecting the migrations link on the error page when the application is run.

ASP.NET Core has a development-time error page handler that can be used to apply migrations when the application is run. For production applications, it is often more appropriate to generate SQL scripts from the migrations and deploy these to the database as part of a controlled application and database deployment.

When a new application using Identity is created, steps 1 and 2 above have already been completed. That is, the initial data model already exists, and the initial migration has been added to the project. The initial migration still needs to be applied to the database. The initial migration can be done by running the Update-Database (PMC), the dotnet ef database update (.NET Core CLI) command, or by using the error page when the application is run.

The preceding steps need to be repeated as changes are made to the model.

## The Identity model

### Entity types

The Identity model consists of seven entity types:

- `User` - represents the user
- `Role` - represents a role
- `UserClaim` - represents a claim that a user possesses
- `UserToken` - represents an authentication token for a user
- `UserLogin` - associates a user with a login
- `RoleClaim` - represents a claim that is granted to all users within a role
- `UserRole` - join entity that associates users and roles

## Entity type relationships

These entity types are related to each other in the following ways:

- Each `User` can have many `UserClaims`
- Each `User` can have many `UserLogins`
- Each `User` can have many `UserTokens`
- Each `Role` can have many associated `RoleClaims`
- Each `User` can have many associated `Roles`, and each `Role` can be associated with many Users
  - This is a many-to-many relationship, which requires a join table in the database. The join table is represented by the `UserRole` entity.

## Default model configuration

Identity defines a variety of "context classes" which inherit from `DbContext` to configure and use the model. This configuration is done using the [EF Core Code First Fluent API](#) in the `OnModelCreating` method of the context class. The default configuration is:

```
builder.Entity<TUser>(b =>
{
    // Primary key
    b.HasKey(u => u.Id);

    // Indexes for "normalized" username and email, to allow efficient lookups
    b.HasIndex(u => u.NormalizedUserName).HasName("UserNameIndex").IsUnique();
    b.HasIndex(u => u.NormalizedEmail).HasName("EmailIndex");

    // Maps to the AspNetUsers table
    b.ToTable("AspNetUsers");

    // A concurrency token for use with the optimistic concurrency checking
    b.Property(u => uConcurrencyStamp).IsConcurrencyToken();

    // Limit the size of columns to use efficient database types
    b.Property(u => u.UserName).HasMaxLength(256);
    b.Property(u => u.NormalizedUserName).HasMaxLength(256);
    b.Property(u => u.Email).HasMaxLength(256);
    b.Property(u => u.NormalizedEmail).HasMaxLength(256);

    // The relationships between User and other entity types
    // Note that these relationships are configured with no navigation properties

    // Each User can have many UserClaims
    b.HasMany<TUserClaim>().WithOne().HasForeignKey(uc => uc.UserId).IsRequired();

    // Each User can have many UserLogins
    b.HasMany<TUserLogin>().WithOne().HasForeignKey(ul => ul.UserId).IsRequired();

    // Each User can have many UserTokens
    b.HasMany<TUserToken>().WithOne().HasForeignKey(ut => ut.UserId).IsRequired();

    // Each User can have many entries in the UserRole join table
    b.HasMany<TUserRole>().WithOne().HasForeignKey(ur => ur.UserId).IsRequired();
});

builder.Entity<TUserClaim>(b =>
{
    // Primary key
    b.HasKey(uc => uc.Id);

    // Maps to the AspNetUserClaims table
    b.ToTable("AspNetUserClaims");
});

builder.Entity<TUserLogin>(b =>
```

```

{
    // Composite primary key consisting of the LoginProvider and the key to use
    // with that provider
    b.HasKey(l => new { l.LoginProvider, l.ProviderKey });

    // Limit the size of the composite key columns due to common database restrictions
    b.Property(l => l.LoginProvider).HasMaxLength(128);
    b.Property(l => l.ProviderKey).HasMaxLength(128);

    // Maps to the AspNetUserLogins table
    b.ToTable("AspNetUserLogins");
};

builder.Entity<TUserToken>(b =>
{
    // Composite primary key consisting of the UserId, LoginProvider and Name
    b.HasKey(t => new { t.UserId, t.LoginProvider, t.Name });

    // Limit the size of the composite key columns due to common database restrictions
    b.Property(t => t.LoginProvider).HasMaxLength(maxKeyLength);
    b.Property(t => t.Name).HasMaxLength(maxKeyLength);

    // Maps to the AspNetUserTokens table
    b.ToTable("AspNetUserTokens");
});

builder.Entity<TRole>(b =>
{
    // Primary key
    b.HasKey(r => r.Id);

    // Index for "normalized" role name to allow efficient lookups
    b.HasIndex(r => r.NormalizedName).HasName("RoleNameIndex").IsUnique();

    // Maps to the AspNetRoles table
    b.ToTable("AspNetRoles");

    // A concurrency token for use with the optimistic concurrency checking
    b.Property(r => rConcurrencyStamp).IsConcurrencyToken();

    // Limit the size of columns to use efficient database types
    b.Property(u => u.Name).HasMaxLength(256);
    b.Property(u => u.NormalizedName).HasMaxLength(256);

    // The relationships between Role and other entity types
    // Note that these relationships are configured with no navigation properties

    // Each Role can have many entries in the UserRole join table
    b.HasMany<TUserRole>().WithOne().HasForeignKey(ur => ur.RoleId).IsRequired();

    // Each Role can have many associated RoleClaims
    b.HasMany<TRoleClaim>().WithOne().HasForeignKey(rc => rc.RoleId).IsRequired();
});

builder.Entity<TRoleClaim>(b =>
{
    // Primary key
    b.HasKey(rc => rc.Id);

    // Maps to the AspNetRoleClaims table
    b.ToTable("AspNetRoleClaims");
});

builder.Entity<TUserRole>(b =>
{
    // Primary key
    b.HasKey(r => new { r.UserId, r.RoleId });

    // Maps to the AspNetUserRoles table

```

```
b.ToTable("AspNetUserRoles");
});
```

## Model generic types

Identity defines default CLR types for each of the entity types listed above. These types are all prefixed with "Identity": `IdentityUser`, `IdentityRole`, `IdentityUserClaim`, `IdentityUserToken`, `IdentityUserLogin`, `IdentityRoleClaim`, and `IdentityUserRole`.

Rather than using these types directly, the types can be used as base classes for the application's own types. The `DbContext` classes defined by Identity are generic such that different CLR types can be used for one or more of the entity types in the model. These generic types also allow for the type of the User primary key to be changed.

When using Identity with support for roles, an `IdentityDbContext` class should be used:

```
// Uses all the built-in Identity types
// Uses `string` as the key type
public class IdentityDbContext
    : IdentityDbContext<IdentityUser, IdentityRole, string>
{
}

// Uses the built-in Identity types except with a custom User type
// Uses `string` as the key type
public class IdentityDbContext<TUser>
    : IdentityDbContext<TUser, IdentityRole, string>
    where TUser : IdentityUser
{
}

// Uses the built-in Identity types except with custom User and Role types
// The key type is defined by TKey
public class IdentityDbContext<TUser, TRole, TKey>
    : IdentityDbContext<TUser, TRole, TKey, IdentityUserClaim<TKey>, IdentityUserRole<TKey>,
        IdentityUserLogin<TKey>, IdentityRoleClaim<TKey>, IdentityUserToken<TKey>>
    where TUser : IdentityUser<TKey>
    where TRole : IdentityRole<TKey>
    where TKey : IEquatable<TKey>
{
}

// No built-in Identity types are used; all are specified by generic arguments
// The key type is defined by TKey
public abstract class IdentityDbContext<TUser, TRole, TKey, TUserClaim, TUserRole, TUserLogin, TRoleClaim,
TUserToken>
    : IdentityDbContext<TUser, TKey, TUserClaim, TUserLogin, TUserToken>
    where TUser : IdentityUser<TKey>
    where TRole : IdentityRole<TKey>
    where TKey : IEquatable<TKey>
    where TUserClaim : IdentityUserClaim<TKey>
    where TUserRole : IdentityUserRole<TKey>
    where TUserLogin : IdentityUserLogin<TKey>
    where TRoleClaim : IdentityRoleClaim<TKey>
    where TUserToken : IdentityUserToken<TKey>
```

It is also possible to use Identity without roles (only claims), in which case an `IdentityUserContext` class should be used:

```

// Uses the built-in non-role Identity types except with a custom User type
// Uses `string` as the key type
public class IdentityUserContext<TUser>
    : IdentityUserContext<TUser, string>
    where TUser : IdentityUser
{
}

// Uses the built-in non-role Identity types except with a custom User type
// The key type is defined by TKey
public class IdentityUserContext<TUser, TKey>
    : IdentityUserContext<TUser, TKey, IdentityUserClaim<TKey>, IdentityUserLogin<TKey>,
IdentityUserToken<TKey>>
    where TUser : IdentityUser<TKey>
    where TKey : IEquatable<TKey>
{
}

// No built-in Identity types are used; all are specified by generic arguments, with no roles
// The key type is defined by TKey
public abstract class IdentityUserContext<TUser, TKey, TUserClaim, TUserLogin, TUserToken>
    : DbContext
    where TUser : IdentityUser<TKey>
    where TKey : IEquatable<TKey>
    where TUserClaim : IdentityUserClaim<TKey>
    where TUserLogin : IdentityUserLogin<TKey>
    where TUserToken : IdentityUserToken<TKey>
{
}

```

## Customizing the model

The starting point for customizing the model is to derive from the appropriate context type; see the preceding section. This context type is customarily called `ApplicationDbContext` and is created by the ASP.NET Core templates.

The context is used to configure the model in two ways:

- By supplying entity and key types for the generic type parameters.
- By overriding `OnModelCreating` to modify the mapping of these types.

When overriding `OnModelCreating`, `base.OnModelCreating` should be called first, the overriding configuration should be called next. EF Core generally has a last-one-wins policy for configuration. For example, if the `ToTable` for an entity type is called first with one table name and then again later with a different table name, then the table name in the second call is the one that is used.

### Using a custom User type

To use a custom User type, create the type and have it inherit from `IdentityUser`. It is customary to name this type  `ApplicationUser`. This type will typically have additional properties not in the base type, otherwise there would be no value in creating it. For example:

```

public class ApplicationUser : IdentityUser
{
    public string CustomTag { get; set; }
}

```

Next use this type as a generic argument for the context:

```
public class ApplicationDbContext : IdentityDbContext<ApplicationUser>
{
    public ApplicationDbContext(DbContextOptions<ApplicationDbContext> options)
        : base(options)
    {
    }
}
```

Update `ConfigureServices` to use the new  `ApplicationUser`  class:

```
services.AddDefaultIdentity< ApplicationUser >()
    .AddEntityFrameworkStores< ApplicationDbContext >();
```

There is no need to override `OnModelCreating` here because EF Core will map the `CustomTag` property by convention. However, the database will need to be updated to get a new `CustomTag` column. To do this, add a migration, and then update the database as described in [Identity and EF Core Migrations](#).

### Changing the key type

Changing the type of a primary key (PK) column after the database has been created is problematic on many database systems. Changing the PK typically involves dropping and re-creating the table. Therefore, it is recommended that key types be specified in the initial migration such that the target key types are created when the database is created.

If the database has been created, then `Drop-Database` (PMC) or `dotnet ef database drop` (.NET Core CLI) can be used to delete it.

Once it is confirmed that the database doesn't exist, remove the initial migration with `Remove-Migration` (PMC) or `dotnet ef migrations remove` (.NET Core CLI).

Update the `ApplicationDbContext` to use a different base class, specifying the new key type for `TKey`. For example, to use a `Guid` key:

```
public class ApplicationDbContext : IdentityDbContext<IdentityUser<Guid>, IdentityRole<Guid>, Guid>
{
    public ApplicationDbContext(DbContextOptions<ApplicationDbContext> options)
        : base(options)
    {
    }
}
```

Notice that the generic classes `IdentityUser<TKey>` and `IdentityRole<TKey>` must also be specified to use the new key type. `ConfigureServices` must be updated to use the generic user:

```
services.AddDefaultIdentity<IdentityUser<Guid>>()
    .AddEntityFrameworkStores< ApplicationDbContext >();
```

If a custom  `ApplicationUser`  is being used, update it to inherit from  `IdentityUser<TKey>`. For example:

```

public class ApplicationUser : IdentityUser<Guid>
{
    public string CustomTag { get; set; }
}

public class ApplicationDbContext : IdentityDbContext<ApplicationUser, IdentityRole<Guid>, Guid>
{
    public ApplicationDbContext(DbContextOptions<ApplicationDbContext> options)
        : base(options)
    {
    }
}

```

```

services.AddDefaultIdentity< ApplicationUser >()
    .AddEntityFrameworkStores< ApplicationDbContext >();

```

## Adding navigation properties

Changing the model configuration for relationships can be more difficult than making other changes. Care must be taken to replace the existing relationships rather than create a new additional relationships. In particular, the changed relationship must specify the same foreign key property as the existing relationship. For example, the relationship between `Users` and `UserClaims` is by default specified as:

```

builder.Entity< TUser >(b =>
{
    // Each User can have many UserClaims
    b.HasMany< TUserClaim >()
        .WithOne()
        .HasForeignKey(uc => uc.UserId)
        .IsRequired();
});

```

The foreign key for this relationship is specified as the `UserClaim.UserId` property. `HasMany` and `WithOne` are called without arguments to create the relationship without navigation properties.

Add a navigation property to  `ApplicationUser` that will allow associated `UserClaims` to be referenced from the user:

```

public class ApplicationUser : IdentityUser
{
    public virtual ICollection< IdentityUserClaim< string > > Claims { get; set; }
}

```

Note that the `TKey` for `IdentityUserClaim< TKey >` is type specified for the primary key of users--in this case `string` since we're using the defaults. It is **not** the primary key type for the `UserClaim` entity type.

Now that the navigation property exists it must be configured in `OnModelCreating`:

```

public class ApplicationDbContext : IdentityDbContext<ApplicationUser>
{
    public ApplicationDbContext(DbContextOptions<ApplicationDbContext> options)
        : base(options)
    {
    }

    protected override void OnModelCreating(ModelBuilder modelBuilder)
    {
        base.OnModelCreating(modelBuilder);

        modelBuilder.Entity< ApplicationUser >(b =>
        {
            // Each User can have many UserClaims
            b.HasMany(e => e.Claims)
                .WithOne()
                .HasForeignKey(uc => uc.UserId)
                .IsRequired();
        });
    }
}

```

Notice that relationship is configured exactly as it was before, only with a navigation property specified in the call to `HasMany`.

The navigation properties only exist in the EF model, not the database. Because the foreign key for the relationship has not changed, this kind of model change does not require the database to be updated. This can be checked by adding a migration after making the change: the `Up` and `Down` methods are empty.

### Adding all User navigation properties

Using the section above as guidance, here is an example that configures unidirectional navigation properties for all relationships on User:

```

public class ApplicationUser : IdentityUser
{
    public virtual ICollection<IdentityUserClaim<string>> Claims { get; set; }
    public virtual ICollection<IdentityUserLogin<string>> Logins { get; set; }
    public virtual ICollection<IdentityUserToken<string>> Tokens { get; set; }
    public virtual ICollection<IdentityUserRole<string>> UserRoles { get; set; }
}

```

```

public class ApplicationDbContext : IdentityDbContext<ApplicationUser>
{
    public ApplicationDbContext(DbContextOptions<ApplicationDbContext> options)
        : base(options)
    {
    }

    protected override void OnModelCreating(ModelBuilder modelBuilder)
    {
        base.OnModelCreating(modelBuilder);

        modelBuilder.Entity< ApplicationUser >(b =>
        {
            // Each User can have many UserClaims
            b.HasMany(e => e.Claims)
                .WithOne()
                .HasForeignKey(uc => uc.UserId)
                .IsRequired();

            // Each User can have many UserLogins
            b.HasMany(e => e.Logins)
                .WithOne()
                .HasForeignKey(ul => ul.UserId)
                .IsRequired();

            // Each User can have many UserTokens
            b.HasMany(e => e.Tokens)
                .WithOne()
                .HasForeignKey(ut => ut.UserId)
                .IsRequired();

            // Each User can have many entries in the UserRole join table
            b.HasMany(e => e.UserRoles)
                .WithOne()
                .HasForeignKey(ur => ur.UserId)
                .IsRequired();
        });
    }
}

```

## Adding User and Role navigation properties

Using the section above as guidance, here is an example that configures navigation properties for all relationships on User and Role:

```

public class ApplicationUser : IdentityUser
{
    public virtual ICollection<IdentityUserClaim<string>> Claims { get; set; }
    public virtual ICollection<IdentityUserLogin<string>> Logins { get; set; }
    public virtual ICollection<IdentityUserToken<string>> Tokens { get; set; }
    public virtual ICollection<ApplicationUserRole> UserRoles { get; set; }
}

public class ApplicationRole : IdentityRole
{
    public virtual ICollection<ApplicationUserRole> UserRoles { get; set; }
}

public class ApplicationUserRole : IdentityUserRole<string>
{
    public virtual ApplicationUser User { get; set; }
    public virtual ApplicationRole Role { get; set; }
}

```

```

public class ApplicationDbContext
    : IdentityDbContext<
        ApplicationUser, ApplicationRole, string,
        IdentityUserClaim<string>, ApplicationUserRole, IdentityUserLogin<string>,
        IdentityRoleClaim<string>, IdentityUserToken<string>>
{
    public ApplicationDbContext(DbContextOptions<ApplicationDbContext> options)
        : base(options)
    {
    }

    protected override void OnModelCreating(ModelBuilder modelBuilder)
    {
        base.OnModelCreating(modelBuilder);

        modelBuilder.Entity< ApplicationUser >(b =>
        {
            // Each User can have many UserClaims
            b.HasMany(e => e.Claims)
                .WithOne()
                .HasForeignKey(uc => uc.UserId)
                .IsRequired();

            // Each User can have many UserLogins
            b.HasMany(e => e.Logins)
                .WithOne()
                .HasForeignKey(ul => ul.UserId)
                .IsRequired();

            // Each User can have many UserTokens
            b.HasMany(e => e.Tokens)
                .WithOne()
                .HasForeignKey(ut => ut.UserId)
                .IsRequired();

            // Each User can have many entries in the UserRole join table
            b.HasMany(e => e.UserRoles)
                .WithOne(e => e.User)
                .HasForeignKey(ur => ur.UserId)
                .IsRequired();
        });

        modelBuilder.Entity< ApplicationRole >(b =>
        {
            // Each Role can have many entries in the UserRole join table
            b.HasMany(e => e.UserRoles)
                .WithOne(e => e.Role)
                .HasForeignKey(ur => ur.RoleId)
                .IsRequired();
        });
    }
}

```

Notes:

- This example also includes the `UserRole` join entity, which is needed to navigate the many-to-many relationship from Users to Roles.
- Remember to change the types of the navigation properties to reflect that `ApplicationXXX` types are now being used instead of `IdentityXXX` types.
- Remember to use the `ApplicationXXX` in the generic `ApplicationContext` definition.

## Adding all navigation properties

Using the section above as guidance, here is an example that configures navigation properties for all relationships

on all entity types:

```
public class ApplicationUser : IdentityUser
{
    public virtual ICollection<ApplicationUserClaim> Claims { get; set; }
    public virtual ICollection<ApplicationUserLogin> Logins { get; set; }
    public virtual ICollection<ApplicationUserToken> Tokens { get; set; }
    public virtual ICollection<ApplicationUserRole> UserRoles { get; set; }
}

public class ApplicationRole : IdentityRole
{
    public virtual ICollection<ApplicationUserRole> UserRoles { get; set; }
    public virtual ICollection<ApplicationRoleClaim> RoleClaims { get; set; }
}

public class ApplicationUserRole : IdentityUserRole<string>
{
    public virtual ApplicationUser User { get; set; }
    public virtual ApplicationRole Role { get; set; }
}

public class ApplicationUserClaim : IdentityUserClaim<string>
{
    public virtual ApplicationUser User { get; set; }
}

public class ApplicationUserLogin : IdentityUserLogin<string>
{
    public virtual ApplicationUser User { get; set; }
}

public class ApplicationRoleClaim : IdentityRoleClaim<string>
{
    public virtual ApplicationRole Role { get; set; }
}

public class ApplicationUserToken : IdentityUserToken<string>
{
    public virtual ApplicationUser User { get; set; }
}
```

```

public class ApplicationDbContext
    : IdentityDbContext<
        ApplicationUser, ApplicationRole, string,
        ApplicationUserClaim, ApplicationUserRole, ApplicationUserLogin,
        ApplicationRoleClaim, ApplicationUserToken>
{
    public ApplicationDbContext(DbContextOptions<ApplicationDbContext> options)
        : base(options)
    {
    }

    protected override void OnModelCreating(ModelBuilder modelBuilder)
    {
        base.OnModelCreating(modelBuilder);

        modelBuilder.Entity<ApplicationUser>(b =>
        {
            // Each User can have many UserClaims
            b.HasMany(e => e.Claims)
                .WithOne(e => e.User)
                .HasForeignKey(uc => uc.UserId)
                .IsRequired();

            // Each User can have many UserLogins
            b.HasMany(e => e.Logins)
                .WithOne(e => e.User)
                .HasForeignKey(ul => ul.UserId)
                .IsRequired();

            // Each User can have many UserTokens
            b.HasMany(e => e.Tokens)
                .WithOne(e => e.User)
                .HasForeignKey(ut => ut.UserId)
                .IsRequired();

            // Each User can have many entries in the UserRole join table
            b.HasMany(e => e.UserRoles)
                .WithOne(e => e.User)
                .HasForeignKey(ur => ur.UserId)
                .IsRequired();
        });

        modelBuilder.Entity<ApplicationRole>(b =>
        {
            // Each Role can have many entries in the UserRole join table
            b.HasMany(e => e.UserRoles)
                .WithOne(e => e.Role)
                .HasForeignKey(ur => ur.RoleId)
                .IsRequired();

            // Each Role can have many associated RoleClaims
            b.HasMany(e => e.RoleClaims)
                .WithOne(e => e.Role)
                .HasForeignKey(rc => rc.RoleId)
                .IsRequired();
        });
    }
}

```

## Using composite keys

The preceding sections demonstrated changing the type of key used in the Identity model. Changing the Identity key model to use composite keys is not supported or recommended. Using a composite key with Identity would involve changing how the Identity manager code interacts with the model, which is an unsupported customization and beyond the scope of this document.

## Changing table/column names and facets

To change the names of tables and columns, call `base.OnModelCreating`, and then add configuration to override any of the defaults. For example, to change the name of all the identity tables:

```
protected override void OnModelCreating(ModelBuilder modelBuilder)
{
    base.OnModelCreating(modelBuilder);

    modelBuilder.Entity<IdentityUser>(b =>
    {
        b.ToTable("MyUsers");
    });

    modelBuilder.Entity<IdentityUserClaim<string>>(b =>
    {
        b.ToTable("MyUserClaims");
    });

    modelBuilder.Entity<IdentityUserLogin<string>>(b =>
    {
        b.ToTable("MyUserLogins");
    });

    modelBuilder.Entity<IdentityUserToken<string>>(b =>
    {
        b.ToTable("MyUserTokens");
    });

    modelBuilder.Entity<IdentityRole>(b =>
    {
        b.ToTable("MyRoles");
    });

    modelBuilder.Entity<IdentityRoleClaim<string>>(b =>
    {
        b.ToTable("MyRoleClaims");
    });

    modelBuilder.Entity<IdentityUserRole<string>>(b =>
    {
        b.ToTable("MyUserRoles");
    });
}
```

Note that these examples use the default Identity types. If you are using an application type, such as

`ApplicationUser` then configure that type instead of the default type.

Here is an example that changes some column names:

```

protected override void OnModelCreating(ModelBuilder modelBuilder)
{
    base.OnModelCreating(modelBuilder);

    modelBuilder.Entity<IdentityUser>(b =>
    {
        b.Property(e => e.Email).HasColumnName("EMail");
    });

    modelBuilder.Entity<IdentityUserClaim<string>>(b =>
    {
        b.Property(e => e.ClaimType).HasColumnName("CType");
        b.Property(e => e.ClaimValue).HasColumnName("CValue");
    });
}

```

Some types of database columns can be configured with certain *facets* such as the maximum string length allowed. Here is an example that sets column max lengths for several string properties in the model:

```

protected override void OnModelCreating(ModelBuilder modelBuilder)
{
    base.OnModelCreating(modelBuilder);

    modelBuilder.Entity<IdentityUser>(b =>
    {
        b.Property(u => u.UserName).HasMaxLength(128);
        b.Property(u => u.NormalizedUserName).HasMaxLength(128);
        b.Property(u => u.Email).HasMaxLength(128);
        b.Property(u => u.NormalizedEmail).HasMaxLength(128);
    });

    modelBuilder.Entity<IdentityUserToken<string>>(b =>
    {
        b.Property(t => t.LoginProvider).HasMaxLength(128);
        b.Property(t => t.Name).HasMaxLength(128);
    });
}

```

## Mapping to a different schema

Schemas can behave differently in different database providers, but for SQL Server, the default is to create all tables in the "dbo" schema. This can be changed to instead create the tables in a different schema. For example:

```

protected override void OnModelCreating(ModelBuilder modelBuilder)
{
    base.OnModelCreating(modelBuilder);

    modelBuilder.HasDefaultSchema("notdbo");
}

```

## Lazy loading

In this section support for lazy-loading proxies in the Identity model is added. Lazy-loading is useful since it allows navigation properties to be used without first ensuring they are loaded.

Entity types can be made suitable for lazy-loading in several ways, as described in the [EF Core documentation](#). For simplicity, we will use lazy-loading proxies, which requires:

- Installation of the [Microsoft.EntityFrameworkCore.Proxies](#) package.
- A call to `.UseLazyLoadingProxies()` inside `AddDbContext`.
- Public entity types with public virtual navigation properties.

Here is an example of calling `.UseLazyLoadingProxies()`:

```
services
    .AddDbContext<ApplicationDbContext>(
        b => b.UseSqlServer(connectionString)
              .UseLazyLoadingProxies())
    .AddDefaultIdentity<ApplicationUser>()
    .AddEntityFrameworkStores<ApplicationDbContext>();
```

Refer back to the examples above for adding navigation properties to the entity types.

# Community OSS authentication options for ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

This page contains community-provided, open source authentication options for ASP.NET Core. This page is periodically updated as new providers become available.

## OSS authentication providers

The list below is sorted alphabetically.

NAME	DESCRIPTION
<a href="#">AspNet.Security.OpenIdConnect.Server (ASOS)</a>	ASOS is a low-level, protocol-first OpenID Connect server framework for ASP.NET Core and OWIN/Katana.
<a href="#">Cierge</a>	Cierge is an OpenID Connect server that handles user signup, login, profiles, management, and social logins.
<a href="#">Gluu Server</a>	Enterprise ready, open source software for identity, access management (IAM), and single sign-on (SSO). For more information, see the <a href="#">Gluu Product Documentation</a> .
<a href="#">IdentityServer</a>	IdentityServer is an OpenID Connect and OAuth 2.0 framework for ASP.NET Core, officially certified by the OpenID Foundation and under governance of the .NET Foundation. For more information, see <a href="#">Welcome to IdentityServer4 (Documentation)</a> .
<a href="#">OpenIddict</a>	OpenIddict is an easy-to-use OpenID Connect server for ASP.NET Core.

To add a provider, [edit this page](#).

# Configure ASP.NET Core Identity

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ASP.NET Core Identity uses default configuration for settings such as password policy, lockout time, and cookie settings. These settings can be overridden in the app's `Startup` class.

## Identity options

The `IdentityOptions` class represents the options that can be used to configure the Identity system.

### Claims Identity

`IdentityOptions.ClaimsIdentity` specifies the `ClaimsIdentityOptions` with the properties shown in the table.

PROPERTY	DESCRIPTION	DEFAULT
<code>RoleClaimType</code>	Gets or sets the claim type used for a role claim.	<code>ClaimTypes.Role</code>
<code>SecurityStampClaimType</code>	Gets or sets the claim type used for the security stamp claim.	<code>AspNet.Identity.SecurityStamp</code>
<code>UserIdClaimType</code>	Gets or sets the claim type used for the user identifier claim.	<code>ClaimTypes.NameIdentifier</code>
<code>UserNameClaimType</code>	Gets or sets the claim type used for the user name claim.	<code>ClaimTypes.Name</code>

### Lockout

Locks out the user for a period of time after a given number of failed access attempts (default: 5 minute lockout after 5 failed access attempts). A successful authentication resets the failed access attempts count and resets the clock.

The following example shows the default values:

```
services.AddIdentity<ApplicationUser, IdentityRole>(options =>
{
    // Lockout settings
    options.Lockout.AllowedForNewUsers = true;
    options.Lockout.DefaultLockoutTimeSpan = TimeSpan.FromMinutes(5);
    options.Lockout.MaxFailedAccessAttempts = 5;
})
.AddEntityFrameworkStores<ApplicationContext>()
.AddDefaultTokenProviders();
```

Confirm that `PasswordSignInAsync` sets `lockoutOnFailure` to `true`:

```
var result = await _signInManager.PasswordSignInAsync(
    Input.Email, Input.Password, Input.RememberMe, lockoutOnFailure: true);
```

`IdentityOptions.Lockout` specifies the `LockoutOptions` with the properties shown in the table.

PROPERTY	DESCRIPTION	DEFAULT
AllowedForNewUsers	Determines if a new user can be locked out.	true
DefaultLockoutTimeSpan	The amount of time a user is locked out when a lockout occurs.	5 minutes
MaxFailedAccessAttempts	The number of failed access attempts until a user is locked out, if lockout is enabled.	5

## Password

By default, Identity requires that passwords contain an uppercase character, lowercase character, a digit, and a non-alphanumeric character. Passwords must be at least six characters long. [PasswordOptions](#) can be changed in `Startup.ConfigureServices`.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

ASP.NET Core 2.0 added the [RequiredUniqueChars](#) property. Otherwise, the options are the same as ASP.NET Core 1.x.

```
services.AddIdentity<ApplicationUser, IdentityRole>(options =>
{
    // Password settings
    options.Password.RequireDigit = true;
    options.Password.RequiredLength = 8;
    options.Password.RequiredUniqueChars = 2;
    options.Password.RequireLowercase = true;
    options.Password.RequireNonAlphanumeric = true;
    options.Password.RequireUppercase = true;
})
.AddEntityFrameworkStores<ApplicationContext>()
.AddDefaultTokenProviders();
```

`IdentityOptions.Password` specifies the [PasswordOptions](#) with the properties shown in the table.

PROPERTY	DESCRIPTION	DEFAULT
RequireDigit	Requires a number between 0-9 in the password.	true
RequiredLength	The minimum length of the password.	6
RequiredUniqueChars	Only applies to ASP.NET Core 2.0 or later.  Requires the number of distinct characters in the password.	1
RequireLowercase	Requires a lowercase character in the password.	true
RequireNonAlphanumeric	Requires a non-alphanumeric character in the password.	true

PROPERTY	DESCRIPTION	DEFAULT
RequireUppercase	Requires an uppercase character in the password.	true

## Sign-in

```
services.AddIdentity<ApplicationUser, IdentityRole>(options =>
{
    // Signin settings
    options.SignIn.RequireConfirmedEmail = true;
    options.SignIn.RequireConfirmedPhoneNumber = false;
})
.AddEntityFrameworkStores<ApplicationContext>()
.AddDefaultTokenProviders();
```

`IdentityOptions.SignIn` specifies the `SignInOptions` with the properties shown in the table.

PROPERTY	DESCRIPTION	DEFAULT
RequireConfirmedEmail	Requires a confirmed email to sign in.	false
RequireConfirmedPhoneNumber	Requires a confirmed phone number to sign in.	false

## Tokens

`IdentityOptions.Tokens` specifies the `TokenOptions` with the properties shown in the table.

PROPERTY	DESCRIPTION
AuthenticatorTokenProvider	Gets or sets the <code>AuthenticatorTokenProvider</code> used to validate two-factor sign-ins with an authenticator.
ChangeEmailTokenProvider	Gets or sets the <code>ChangeEmailTokenProvider</code> used to generate tokens used in email change confirmation emails.
ChangePhoneNumberTokenProvider	Gets or sets the <code>ChangePhoneNumberTokenProvider</code> used to generate tokens used when changing phone numbers.
EmailConfirmationTokenProvider	Gets or sets the token provider used to generate tokens used in account confirmation emails.
PasswordResetTokenProvider	Gets or sets the <code>IUserTwoFactorTokenProvider</code> used to generate tokens used in password reset emails.
ProviderMap	Used to construct a <code>User Token Provider</code> with the key used as the provider's name.

## User

```

services.AddIdentity<ApplicationUser, IdentityRole>(options =>
{
    // User settings
    options.User.RequireUniqueEmail = true;
})
.AddEntityFrameworkStores<ApplicationContext>()
.AddDefaultTokenProviders();

```

`IdentityOptions.User` specifies the `UserOptions` with the properties shown in the table.

PROPERTY	DESCRIPTION	DEFAULT
<code>AllowedUserNameCharacters</code>	Allowed characters in the username.	abcdefghijklmnopqrstuvwxyz ABCDEFGHIJKLMNOPQRSTUVWXYZ 0123456789 -_@+
<code>RequireUniqueEmail</code>	Requires each user to have a unique email.	false

## Cookie settings

Configure the app's cookie in `Startup.ConfigureServices`:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```

services.ConfigureApplicationCookie(options =>
{
    options.AccessDeniedPath = "/Account/AccessDenied";
    options.Cookie.Name = "YourAppCookieName";
    options.Cookie.HttpOnly = true;
    options.ExpireTimeSpan = TimeSpan.FromMinutes(60);
    options.LoginPath = "/Account/Login";
    // ReturnUrlParameter requires `using Microsoft.AspNetCore.Authentication.Cookies;` 
    options.ReturnUrlParameter = CookieAuthenticationDefaults.ReturnUrlParameter;
    options SlidingExpiration = true;
});

```

`CookieAuthenticationOptions` has the following properties:

PROPERTY	DESCRIPTION
<code>AccessDeniedPath</code>	Informs the handler that it should change an outgoing <code>403 Forbidden</code> status code into a <code>302 Redirect</code> onto the given path.  The default value is <code>/Account/AccessDenied</code> .
<code>AuthenticationScheme</code>	Only applies to ASP.NET Core 1.x.  The logical name for a particular authentication scheme.

PROPERTY	DESCRIPTION
AutomaticAuthenticate	<p>Only applies to ASP.NET Core 1.x.</p> <p>When true, cookie authentication should run on every request and attempt to validate and reconstruct any serialized principal it created.</p>
AutomaticChallenge	<p>Only applies to ASP.NET Core 1.x.</p> <p>If true, the authentication middleware handles automatic challenges. If false, the authentication middleware only alters responses when explicitly indicated by the <code>AuthenticationScheme</code>.</p>
ClaimsIssuer	Gets or sets the issuer that should be used for any claims that are created (inherited from <a href="#">AuthenticationSchemeOptions</a> ).
Cookie.Domain	The domain to associate the cookie with.
Cookie.Expiration	Gets or sets the lifespan of the HTTP cookie (not the authentication cookie). This property is overridden by <code>ExpireTimeSpan</code> . It shouldn't be used in the context of <code>CookieAuthentication</code> .
Cookie.HttpOnly	<p>Indicates whether a cookie is accessible by client-side script.</p> <p>The default value is <code>true</code>.</p>
Cookie.Name	<p>The name of the cookie.</p> <p>The default value is <code>.AspNetCore.Cookies</code>.</p>
Cookie.Path	The cookie path.
Cookie.SameSite	<p>The <code>SameSite</code> attribute of the cookie.</p> <p>The default value is <code>SameSiteMode.Lax</code>.</p>
Cookie.SecurePolicy	<p>The <code>CookieSecurePolicy</code> configuration.</p> <p>The default value is <code>CookieSecurePolicy.SameAsRequest</code>.</p>
CookieDomain	<p>Only applies to ASP.NET Core 1.x.</p> <p>The domain name where the cookie is served.</p>
CookieHttpOnly	<p>Only applies to ASP.NET Core 1.x.</p> <p>A flag indicating if the cookie should be accessible only to servers.</p> <p>The default value is <code>true</code>.</p>
CookiePath	<p>Only applies to ASP.NET Core 1.x.</p> <p>Used to isolate apps running on the same host name.</p>

PROPERTY	DESCRIPTION
CookieSecure	<p>Only applies to ASP.NET Core 1.x.</p> <p>A flag indicating if the cookie created should be limited to HTTPS ( <code>CookieSecurePolicy.Always</code> ), HTTP or HTTPS ( <code>CookieSecurePolicy.None</code> ), or the same protocol as the request ( <code>CookieSecurePolicy.SameAsRequest</code> ).</p> <p>The default value is <code>CookieSecurePolicy.SameAsRequest</code>.</p>
CookieManager	The component used to get cookies from the request or set them on the response.
DataProtectionProvider	If set, the provider used by the <code>CookieAuthenticationHandler</code> for data protection.
Description	<p>Only applies to ASP.NET Core 1.x.</p> <p>Additional information about the authentication type which is made available to the app.</p>
Events	The handler calls methods on the provider which give the app control at certain points where processing is occurring.
EventsType	If set, the service type to get the <code>Events</code> instance instead of the property (inherited from <code>AuthenticationSchemeOptions</code> ).
ExpireTimeSpan	<p>Controls how much time the authentication ticket stored in the cookie remains valid from the point it's created.</p> <p>The default value is 14 days.</p>
LoginPath	<p>When a user is unauthorized, they're redirected to this path to login.</p> <p>The default value is <code>/Account/Login</code>.</p>
LogoutPath	<p>When a user is logged out, they're redirected to this path.</p> <p>The default value is <code>/Account/Logout</code>.</p>
ReturnUrlParameter	<p>Determines the name of the query string parameter which is appended by the middleware when a <i>401 Unauthorized</i> status code is changed to a <i>302 Redirect</i> onto the login path.</p> <p>The default value is <code>ReturnUrl</code>.</p>
SessionStore	An optional container in which to store the identity across requests.
SlidingExpiration	<p>When true, a new cookie is issued with a new expiration time when the current cookie is more than halfway through the expiration window.</p> <p>The default value is <code>true</code>.</p>

PROPERTY	DESCRIPTION
<code>TicketDataFormat</code>	The <code>TicketDataFormat</code> is used to protect and unprotect the identity and other properties which are stored in the cookie value.

# Configure Windows authentication in ASP.NET Core

6/21/2018 • 4 minutes to read • [Edit Online](#)

By [Steve Smith](#) and [Scott Addie](#)

Windows authentication can be configured for ASP.NET Core apps hosted with IIS, [HTTP.sys](#), or [WebListener](#).

## What is Windows authentication?

Windows authentication relies on the operating system to authenticate users of ASP.NET Core apps. You can use Windows authentication when your server runs on a corporate network using Active Directory domain identities or other Windows accounts to identify users. Windows authentication is best suited to intranet environments in which users, client applications, and web servers belong to the same Windows domain.

[Learn more about Windows authentication and installing it for IIS.](#)

## Enable Windows authentication in an ASP.NET Core app

The Visual Studio Web Application template can be configured to support Windows authentication.

### Use the Windows authentication app template

In Visual Studio:

1. Create a new ASP.NET Core Web Application.
2. Select Web Application from the list of templates.
3. Select the **Change Authentication** button and select **Windows Authentication**.

Run the app. The username appears in the top right of the app.

Application uses

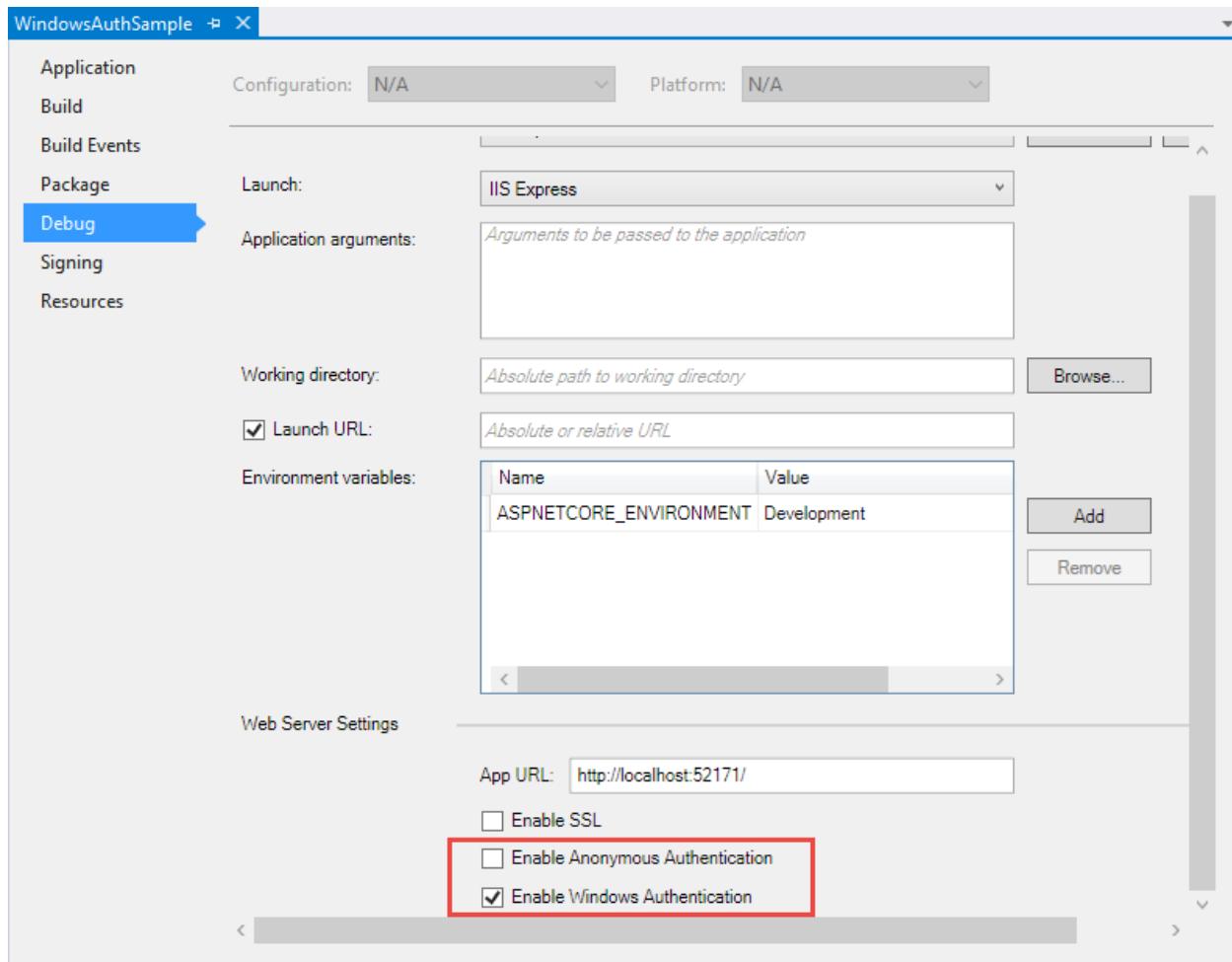
- Sample pages using ASP.NET Core MVC
- Bower for managing client-side libraries
- Theming using Bootstrap

## How to

For development work using IIS Express, the template provides all the configuration necessary to use Windows authentication. The following section shows how to manually configure an ASP.NET Core app for Windows authentication.

## Visual Studio settings for Windows and anonymous authentication

The Visual Studio project **Properties** page's **Debug** tab provides check boxes for Windows authentication and anonymous authentication.



Alternatively, these two properties can be configured in the *launchSettings.json* file:

```
{  
  "iisSettings": {  
    "windowsAuthentication": true,  
    "anonymousAuthentication": false,  
    "iisExpress": {  
      "applicationUrl": "http://localhost:52171/",  
      "sslPort": 0  
    }  
  } // additional options trimmed  
}
```

## Enable Windows authentication with IIS

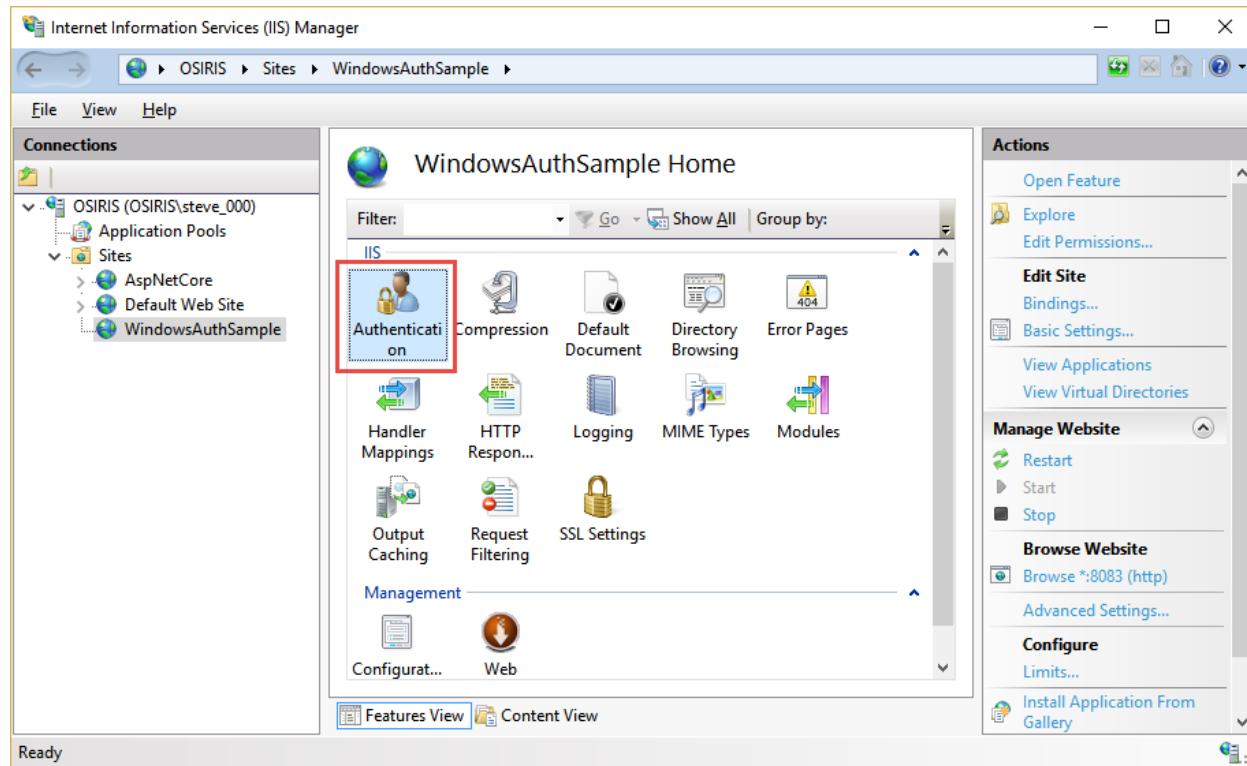
IIS uses the [ASP.NET Core Module](#) to host ASP.NET Core apps. The module allows Windows authentication to flow to IIS by default. Windows authentication is configured in IIS, not the app. The following sections show how to use IIS Manager to configure an ASP.NET Core app to use Windows authentication.

### Create a new IIS site

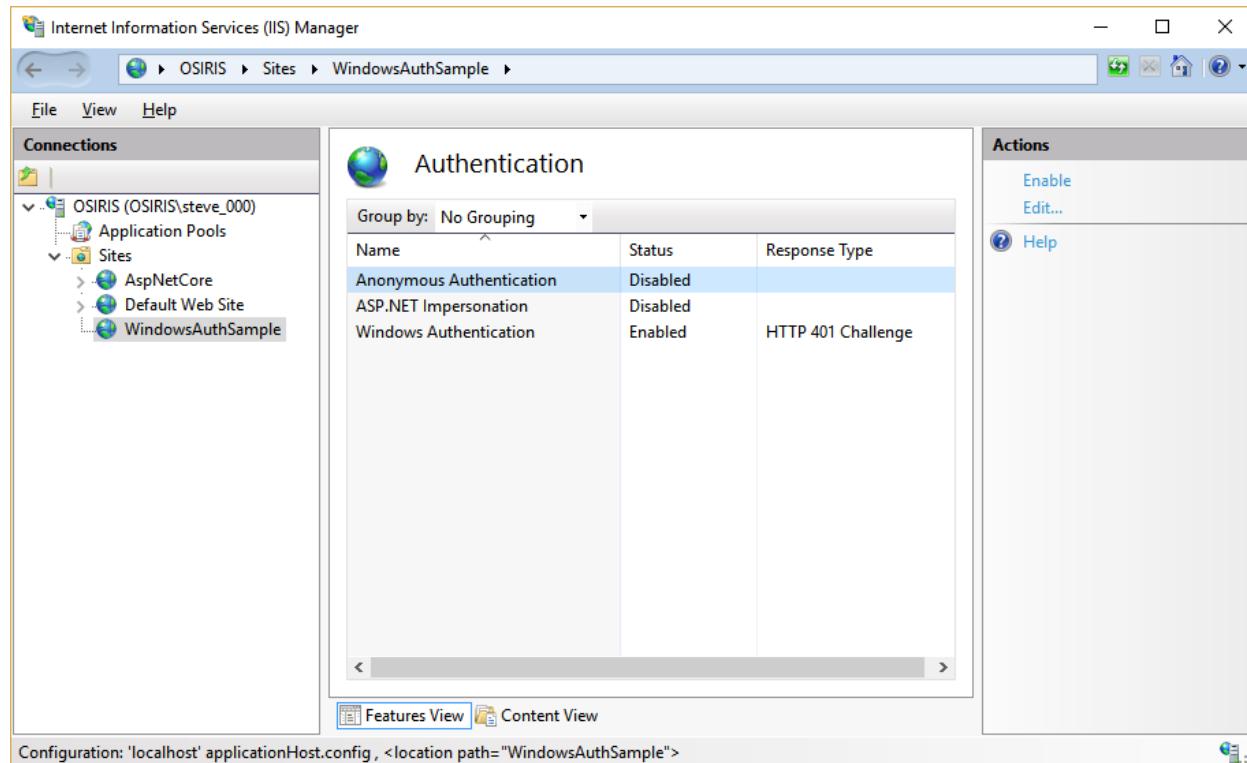
Specify a name and folder and allow it to create a new application pool.

## Customize authentication

Open the Authentication menu for the site.

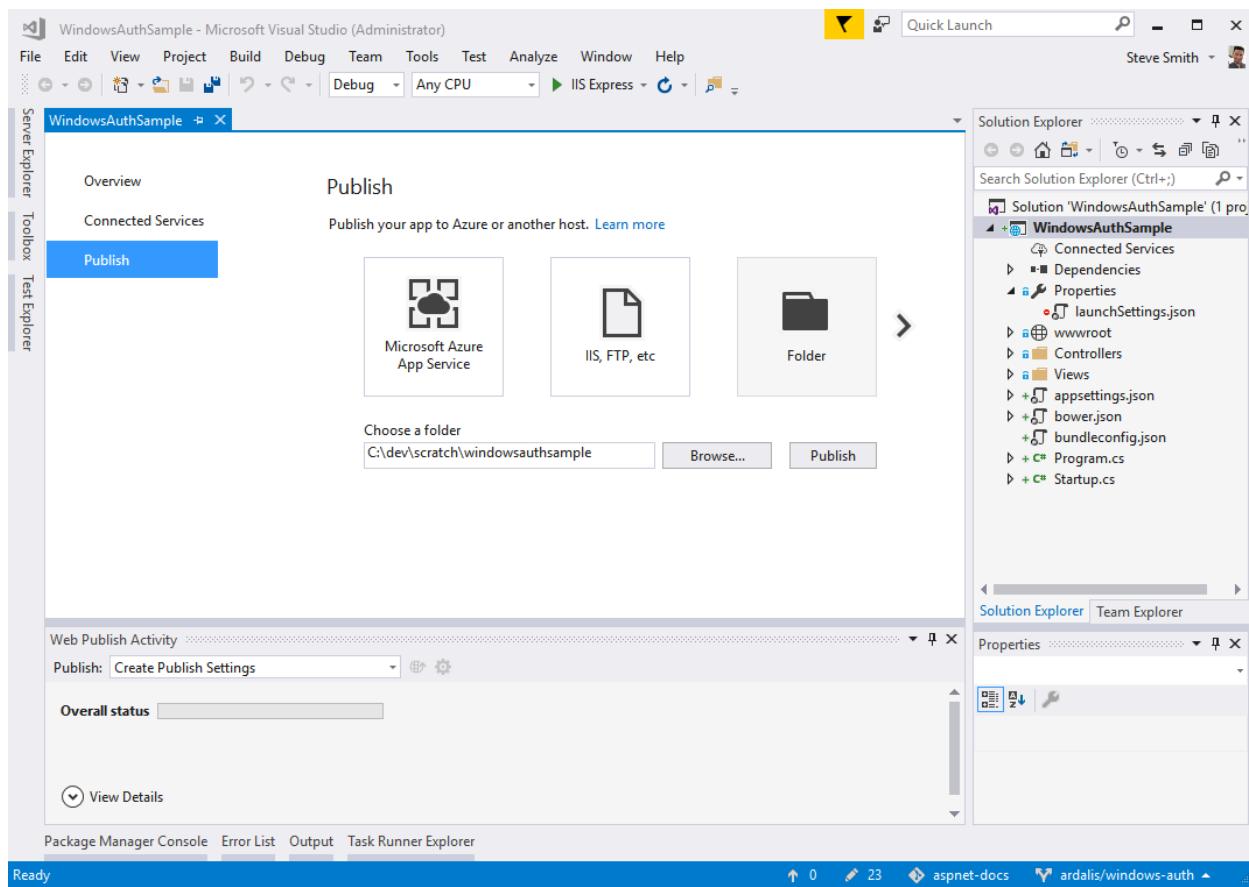


Disable Anonymous Authentication and enable Windows Authentication.



## Publish your project to the IIS site folder

Using Visual Studio or the .NET Core CLI, publish the app to the destination folder.



Learn more about [publishing to IIS](#).

Launch the app to verify Windows authentication is working.

## Enable Windows authentication with HTTP.sys or WebListener

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

Although Kestrel doesn't support Windows authentication, you can use [HTTP.sys](#) to support self-hosted scenarios on Windows. The following example configures the app's web host to use HTTP.sys with Windows authentication:

```
public class Program
{
    public static void Main(string[] args) =>
        BuildWebHost(args).Run();

    public static IWebHost BuildWebHost(string[] args) =>
        WebHost.CreateDefaultBuilder(args)
            .UseStartup<Startup>()
            .UseHttpSys(options =>
            {
                options.Authentication.Schemes =
                    AuthenticationSchemes.NTLM | AuthenticationSchemes.Negotiate;
                options.Authentication.AllowAnonymous = false;
            })
            .Build();
}
```

## Work with Windows authentication

The configuration state of anonymous access determines the way in which the `[Authorize]` and

`[AllowAnonymous]` attributes are used in the app. The following two sections explain how to handle the disallowed and allowed configuration states of anonymous access.

## Disallow anonymous access

When Windows authentication is enabled and anonymous access is disabled, the `[Authorize]` and `[AllowAnonymous]` attributes have no effect. If the IIS site (or HTTP.sys or WebListener server) is configured to disallow anonymous access, the request never reaches your app. For this reason, the `[AllowAnonymous]` attribute isn't applicable.

## Allow anonymous access

When both Windows authentication and anonymous access are enabled, use the `[Authorize]` and `[AllowAnonymous]` attributes. The `[Authorize]` attribute allows you to secure pieces of the app which truly do require Windows authentication. The `[AllowAnonymous]` attribute overrides `[Authorize]` attribute usage within apps which allow anonymous access. See [Simple Authorization](#) for attribute usage details.

In ASP.NET Core 2.x, the `[Authorize]` attribute requires additional configuration in *Startup.cs* to challenge anonymous requests for Windows authentication. The recommended configuration varies slightly based on the web server being used.

### NOTE

By default, users who lack authorization to access a page are presented with an empty HTTP 403 response. The [StatusCodePages middleware](#) can be configured to provide users with a better "Access Denied" experience.

## IIS

If using IIS, add the following to the `ConfigureServices` method:

```
// IISDefaults requires the following import:  
// using Microsoft.AspNetCore.Server.IISIntegration;  
services.AddAuthentication(IISDefaults.AuthenticationScheme);
```

## HTTP.sys

If using HTTP.sys, add the following to the `ConfigureServices` method:

```
// HttpSysDefaults requires the following import:  
// using Microsoft.AspNetCore.Server.HttpSys;  
services.AddAuthentication(HttpSysDefaults.AuthenticationScheme);
```

## Impersonation

ASP.NET Core doesn't implement impersonation. Apps run with the application identity for all requests, using app pool or process identity. If you need to explicitly perform an action on behalf of a user, use `WindowsIdentity.RunImpersonated`. Run a single action in this context and then close the context.

```
app.Run(async (context) =>
{
    try
    {
        var user = (WindowsIdentity)context.User.Identity;

        await context.Response
            .WriteAsync($"User: {user.Name}\tState: {user.ImpersonationLevel}\n");

        WindowsIdentity.RunImpersonated(user.AccessToken, () =>
        {
            var impersonatedUser = WindowsIdentity.GetCurrent();
            var message =
                $"User: {impersonatedUser.Name}\tState: {impersonatedUser.ImpersonationLevel}";

            var bytes = Encoding.UTF8.GetBytes(message);
            context.Response.Body.Write(bytes, 0, bytes.Length);
        });
    }
    catch (Exception e)
    {
        await context.Response.WriteAsync(e.ToString());
    }
});
```

Note that `RunImpersonated` doesn't support asynchronous operations and shouldn't be used for complex scenarios. For example, wrapping entire requests or middleware chains isn't supported or recommended.

---

# Configure Identity primary key data type in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

ASP.NET Core Identity allows you to configure the data type used to represent a primary key. Identity uses the `string` data type by default. You can override this behavior.

## Customize the primary key data type

1. Create a custom implementation of the `IdentityUser` class. It represents the type to be used for creating user objects. In the following example, the default `string` type is replaced with `Guid`.

```
namespace webapptemplate.Models
{
    // Add profile data for application users by adding properties to the ApplicationUser class
    public class ApplicationUser : IdentityUser<Guid>
    {
    }
}
```

2. Create a custom implementation of the `IdentityRole` class. It represents the type to be used for creating role objects. In the following example, the default `string` type is replaced with `Guid`.

```
namespace webapptemplate.Models
{
    public class ApplicationRole : IdentityRole<Guid>
    {
    }
}
```

3. Create a custom database context class. It inherits from the Entity Framework database context class used for Identity. The `TUser` and `TRole` arguments reference the custom user and role classes created in the previous step, respectively. The `Guid` data type is defined for the primary key.

```
namespace webapptemplate.Data
{
    public class ApplicationDbContext : IdentityDbContext<ApplicationUser, ApplicationRole, Guid>
    {
        public ApplicationDbContext(DbContextOptions<ApplicationContext> options)
            : base(options)
        {
        }

        protected override void OnModelCreating(ModelBuilder builder)
        {
            base.OnModelCreating(builder);
            // Customize the ASP.NET Identity model and override the defaults if needed.
            // For example, you can rename the ASP.NET Identity table names and more.
            // Add your customizations after calling base.OnModelCreating(builder);
        }
    }
}
```

4. Register the custom database context class when adding the Identity service in the app's startup class.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

The `AddEntityFrameworkStores` method doesn't accept a `TKey` argument as it did in ASP.NET Core 1.x. The primary key's data type is inferred by analyzing the `DbContext` object.

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<ApplicationDbContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("DefaultConnection")));

    services.AddIdentity< ApplicationUser, ApplicationRole>()
        .AddEntityFrameworkStores<ApplicationDbContext>()
        .AddDefaultTokenProviders();

    // Add application services.
    services.AddTransient< IEmailSender, EmailSender >();

    services.AddMvc();
}
```

## Test the changes

Upon completion of the configuration changes, the property representing the primary key reflects the new data type. The following example demonstrates accessing the property in an MVC controller.

```
[HttpGet]
[AllowAnonymous]
public async Task< Guid > GetCurrentUserId()
{
    ApplicationUser user = await _userManager.GetUserAsync(HttpContext.User);
    return user.Id; // No need to cast here because user.Id is already a Guid, and not a string
}
```

# Custom storage providers for ASP.NET Core Identity

7/6/2018 • 9 minutes to read • [Edit Online](#)

By [Steve Smith](#)

ASP.NET Core Identity is an extensible system which enables you to create a custom storage provider and connect it to your app. This topic describes how to create a customized storage provider for ASP.NET Core Identity. It covers the important concepts for creating your own storage provider, but isn't a step-by-step walkthrough.

[View or download sample from GitHub.](#)

## Introduction

By default, the ASP.NET Core Identity system stores user information in a SQL Server database using Entity Framework Core. For many apps, this approach works well. However, you may prefer to use a different persistence mechanism or data schema. For example:

- You use [Azure Table Storage](#) or another data store.
- Your database tables have a different structure.
- You may wish to use a different data access approach, such as [Dapper](#).

In each of these cases, you can write a customized provider for your storage mechanism and plug that provider into your app.

ASP.NET Core Identity is included in project templates in Visual Studio with the "Individual User Accounts" option.

When using the .NET Core CLI, add `-au Individual`:

```
dotnet new mvc -au Individual  
dotnet new webapi -au Individual
```

## The ASP.NET Core Identity architecture

ASP.NET Core Identity consists of classes called managers and stores. *Managers* are high-level classes which an app developer uses to perform operations, such as creating an Identity user. *Stores* are lower-level classes that specify how entities, such as users and roles, are persisted. Stores follow the [repository pattern](#) and are closely coupled with the persistence mechanism. Managers are decoupled from stores, which means you can replace the persistence mechanism without changing your application code (except for configuration).

The following diagram shows how a web app interacts with the managers, while stores interact with the data access layer.



Identity Manager

Example: `UserManager`, `RoleManager`

Identity Store

Example: `UserStore`, `RoleStore`

Data Access Layer

Data Source

Example: SQL Server Database, Azure Table Storage

To create a custom storage provider, create the data source, the data access layer, and the store classes that interact with this data access layer (the green and grey boxes in the diagram above). You don't need to customize the managers or your app code that interacts with them (the blue boxes above).

When creating a new instance of `UserManager` or `RoleManager` you provide the type of the user class and pass an instance of the store class as an argument. This approach enables you to plug your customized classes into ASP.NET Core.

[Reconfigure app to use new storage provider](#) shows how to instantiate `UserManager` and `RoleManager` with a customized store.

## ASP.NET Core Identity stores data types

ASP.NET Core Identity data types are detailed in the following sections:

### Users

Registered users of your web site. The `IdentityUser` type may be extended or used as an example for your own custom type. You don't need to inherit from a particular type to implement your own custom identity storage solution.

### User Claims

A set of statements (or [Claims](#)) about the user that represent the user's identity. Can enable greater expression of the user's identity than can be achieved through roles.

### User Logins

Information about the external authentication provider (like Facebook or a Microsoft account) to use when logging in a user. [Example](#)

### Roles

Authorization groups for your site. Includes the role Id and role name (like "Admin" or "Employee"). [Example](#)

## The data access layer

This topic assumes you are familiar with the persistence mechanism that you are going to use and how to create entities for that mechanism. This topic doesn't provide details about how to create the repositories or data access classes; it provides some suggestions about design decisions when working with ASP.NET Core Identity.

You have a lot of freedom when designing the data access layer for a customized store provider. You only need to create persistence mechanisms for features that you intend to use in your app. For example, if you are not using roles in your app, you don't need to create storage for roles or user role associations. Your technology and existing infrastructure may require a structure that's very different from the default implementation of ASP.NET Core Identity. In your data access layer, you provide the logic to work with the structure of your storage implementation.

The data access layer provides the logic to save the data from ASP.NET Core Identity to a data source. The data access layer for your customized storage provider might include the following classes to store user and role information.

### Context class

Encapsulates the information to connect to your persistence mechanism and execute queries. Several data classes require an instance of this class, typically provided through dependency injection. [Example](#).

### User Storage

Stores and retrieves user information (such as user name and password hash). [Example](#)

### Role Storage

Stores and retrieves role information (such as the role name). [Example](#)

### UserClaims Storage

Stores and retrieves user claim information (such as the claim type and value). [Example](#)

### UserLogins Storage

Stores and retrieves user login information (such as an external authentication provider). [Example](#)

### UserRole Storage

Stores and retrieves which roles are assigned to which users. [Example](#)

**TIP:** Only implement the classes you intend to use in your app.

In the data access classes, provide code to perform data operations for your persistence mechanism. For example, within a custom provider, you might have the following code to create a new user in the `store` class:

```
public async Task<IdentityResult> CreateAsync(ApplicationUser user,
    CancellationToken cancellationToken = default(CancellationToken))
{
    cancellationToken.ThrowIfCancellationRequested();
    if (user == null) throw new ArgumentNullException(nameof(user));

    return await _usersTable.CreateAsync(user);
}
```

The implementation logic for creating the user is in the `_usersTable.CreateAsync` method, shown below.

## Customize the user class

When implementing a storage provider, create a user class which is equivalent to the [IdentityUser](#) class.

At a minimum, your user class must include an `Id` and a `UserName` property.

The `IdentityUser` class defines the properties that the `UserManager` calls when performing requested operations. The default type of the `Id` property is a string, but you can inherit from `IdentityUser< TKey, TUserClaim, TUserRole, TUserLogin, TUserToken>` and specify a different type. The framework expects the storage implementation to handle data type conversions.

## Customize the user store

Create a `UserStore` class that provides the methods for all data operations on the user. This class is equivalent to the `UserStore< TUser>` class. In your `UserStore` class, implement `IUserStore< TUser>` and the optional interfaces required. You select which optional interfaces to implement based on the functionality provided in your app.

### Optional interfaces

- [IUserRoleStore](#)
- [IUserClaimStore](#)
- [IUserPasswordStore](#)
- [IUserSecurityStampStore](#)
- [IUserEmailStore](#)
- [IPhoneNumberStore](#)
- [IQueryableUserStore](#)
- [IUserLoginStore](#)
- [IUserTwoFactorStore](#)
- [IUserLockoutStore](#)

The optional interfaces inherit from `IUserStore< TUser>`. You can see a partially implemented sample user store in the [sample app](#).

Within the `UserStore` class, you use the data access classes that you created to perform operations. These are passed in using dependency injection. For example, in the SQL Server with Dapper implementation, the `UserStore` class has the `CreateAsync` method which uses an instance of `DapperUsersTable` to insert a new record:

```
public async Task<IdentityResult> CreateAsync(ApplicationUser user)
{
    string sql = "INSERT INTO dbo.CustomUser " +
        "VALUES (@id, @Email, @EmailConfirmed, @PasswordHash, @UserName)";

    int rows = await _connection.ExecuteAsync(sql, new { user.Id, user.Email, user.EmailConfirmed,
        user.PasswordHash, user.UserName });

    if(rows > 0)
    {
        return IdentityResult.Success;
    }
    return IdentityResult.Failed(new IdentityError { Description = $"Could not insert user {user.Email}." });
}
```

### Interfaces to implement when customizing user store

- **IUserStore**

The `IUserStore< TUser>` interface is the only interface you must implement in the user store. It defines methods for creating, updating, deleting, and retrieving users.

- **IUserClaimStore**

The `IUserClaimStore< TUser>` interface defines the methods you implement to enable user claims. It contains methods for adding, removing and retrieving user claims.

- **IUserLoginStore**

The [IUserLoginStore<TUser>](#) defines the methods you implement to enable external authentication providers. It contains methods for adding, removing and retrieving user logins, and a method for retrieving a user based on the login information.

- **IUserRoleStore**

The [IUserRoleStore<TUser>](#) interface defines the methods you implement to map a user to a role. It contains methods to add, remove, and retrieve a user's roles, and a method to check if a user is assigned to a role.

- **IUserPasswordStore**

The [IUserPasswordStore<TUser>](#) interface defines the methods you implement to persist hashed passwords. It contains methods for getting and setting the hashed password, and a method that indicates whether the user has set a password.

- **IUserSecurityStampStore**

The [IUserSecurityStampStore<TUser>](#) interface defines the methods you implement to use a security stamp for indicating whether the user's account information has changed. This stamp is updated when a user changes the password, or adds or removes logins. It contains methods for getting and setting the security stamp.

- **IUserTwoFactorStore**

The [IUserTwoFactorStore<TUser>](#) interface defines the methods you implement to support two factor authentication. It contains methods for getting and setting whether two factor authentication is enabled for a user.

- **IUserPhoneNumberStore**

The [IUserPhoneNumberStore<TUser>](#) interface defines the methods you implement to store user phone numbers. It contains methods for getting and setting the phone number and whether the phone number is confirmed.

- **IUserEmailStore**

The [IUserEmailStore<TUser>](#) interface defines the methods you implement to store user email addresses. It contains methods for getting and setting the email address and whether the email is confirmed.

- **IUserLockoutStore**

The [IUserLockoutStore<TUser>](#) interface defines the methods you implement to store information about locking an account. It contains methods for tracking failed access attempts and lockouts.

- **IQueryableUserStore**

The [IQueryableUserStore<TUser>](#) interface defines the members you implement to provide a queryable user store.

You implement only the interfaces that are needed in your app. For example:

```
public class UserStore : IUserStore<IdentityUser>,
    IUserClaimStore<IdentityUser>,
    IUserLoginStore<IdentityUser>,
    IUserRoleStore<IdentityUser>,
    IUserPasswordStore<IdentityUser>,
    IUserSecurityStampStore<IdentityUser>
{
    // interface implementations not shown
}
```

### IdentityUserClaim, IdentityUserLogin, and IdentityUserRole

The [Microsoft.AspNet.Identity.EntityFramework](#) namespace contains implementations of the [IdentityUserClaim](#), [IdentityUserLogin](#), and [IdentityUserRole](#) classes. If you are using these features, you may want to create your own versions of these classes and define the properties for your app. However, sometimes it's more efficient to not load these entities into memory when performing basic operations (such as adding or removing a user's claim). Instead, the backend store classes can execute these operations directly on the data source. For example, the [UserStore.GetClaimsAsync](#) method can call the [userClaimTable.FindByUserId\(user.Id\)](#) method to execute a query

on that table directly and return a list of claims.

## Customize the role class

When implementing a role storage provider, you can create a custom role type. It need not implement a particular interface, but it must have an `Id` and typically it will have a `Name` property.

The following is an example role class:

```
using System;

namespace CustomIdentityProviderSample.CustomProvider
{
    public class ApplicationRole
    {
        public Guid Id { get; set; } = Guid.NewGuid();
        public string Name { get; set; }
    }
}
```

## Customize the role store

You can create a `RoleStore` class that provides the methods for all data operations on roles. This class is equivalent to the `RoleStore<TRole>` class. In the `RoleStore` class, you implement the `IRoleStore<TRole>` and optionally the `IQueryableRoleStore<TRole>` interface.

- **`IRoleStore<TRole>`**

The `IRoleStore<TRole>` interface defines the methods to implement in the role store class. It contains methods for creating, updating, deleting, and retrieving roles.

- **`RoleStore<TRole>`**

To customize `RoleStore`, create a class that implements the `IRoleStore<TRole>` interface.

## Reconfigure app to use a new storage provider

Once you have implemented a storage provider, you configure your app to use it. If your app used the default provider, replace it with your custom provider.

1. Remove the `Microsoft.AspNetCore.Identity` NuGet package.
2. If the storage provider resides in a separate project or package, add a reference to it.
3. Replace all references to `Microsoft.AspNetCore.Identity` with a using statement for the namespace of your storage provider.
4. In the `ConfigureServices` method, change the `AddIdentity` method to use your custom types. You can create your own extension methods for this purpose. See [IdentityServiceCollectionExtensions](#) for an example.
5. If you are using Roles, update the `RoleManager` to use your `RoleStore` class.
6. Update the connection string and credentials to your app's configuration.

Example:

```
public void ConfigureServices(IServiceCollection services)
{
    // Add identity types
    services.AddIdentity<ApplicationUser, ApplicationRole>()
        .AddDefaultTokenProviders();

    // Identity Services
    services.AddTransient<IUserStore<ApplicationUser>, CustomUserStore>();
    services.AddTransient<IRoleStore<ApplicationRole>, CustomRoleStore>();
    string connectionString = Configuration.GetConnectionString("DefaultConnection");
    services.AddTransient<SqlConnection>(e => new SqlConnection(connectionString));
    services.AddTransient<DapperUsersTable>();

    // additional configuration
}
```

## References

- [Custom Storage Providers for ASP.NET Identity](#)
- [ASP.NET Core Identity](#) - This repository includes links to community maintained store providers.

# Facebook, Google, and external provider authentication in ASP.NET Core

7/14/2018 • 3 minutes to read • [Edit Online](#)

By [Valeriy Novytskyy](#) and [Rick Anderson](#)

This tutorial demonstrates how to build an ASP.NET Core 2.x app that enables users to log in using OAuth 2.0 with credentials from external authentication providers.

[Facebook](#), [Twitter](#), [Google](#), and [Microsoft](#) providers are covered in the following sections. Other providers are available in third-party packages such as [AspNet.Security.OAuth.Providers](#) and [AspNet.Security.OpenId.Providers](#).

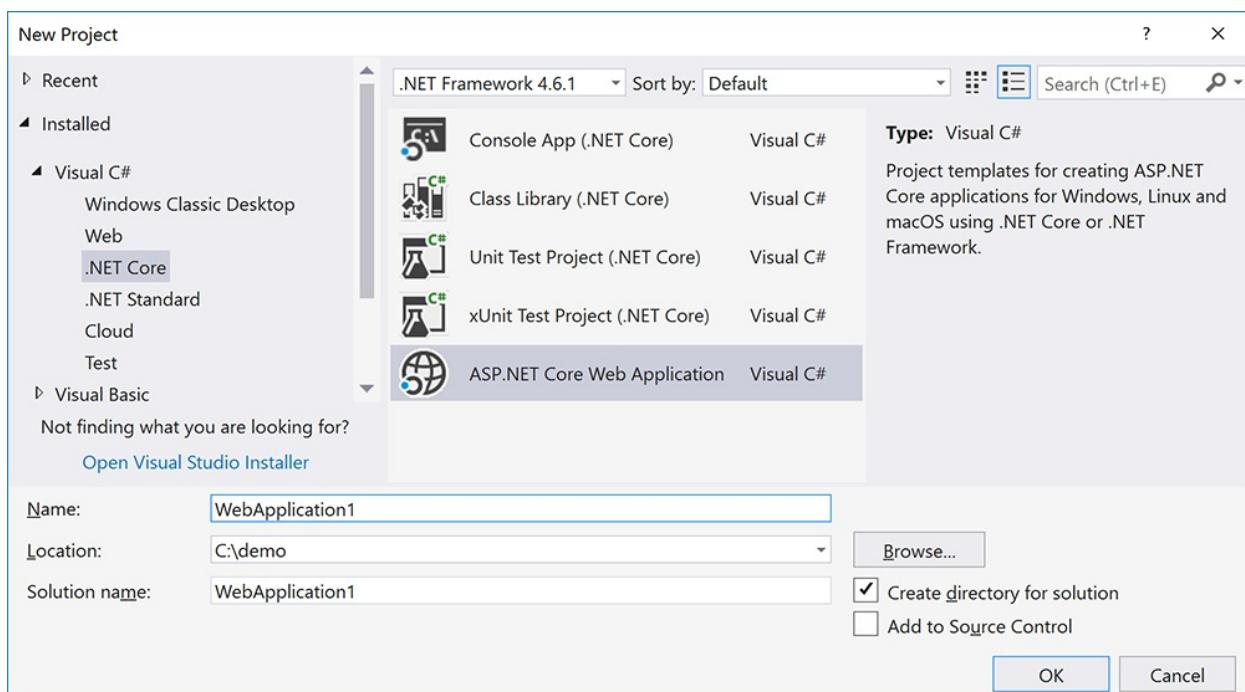


Enabling users to sign in with their existing credentials is convenient for the users and shifts many of the complexities of managing the sign-in process onto a third party. For examples of how social logins can drive traffic and customer conversions, see case studies by [Facebook](#) and [Twitter](#).

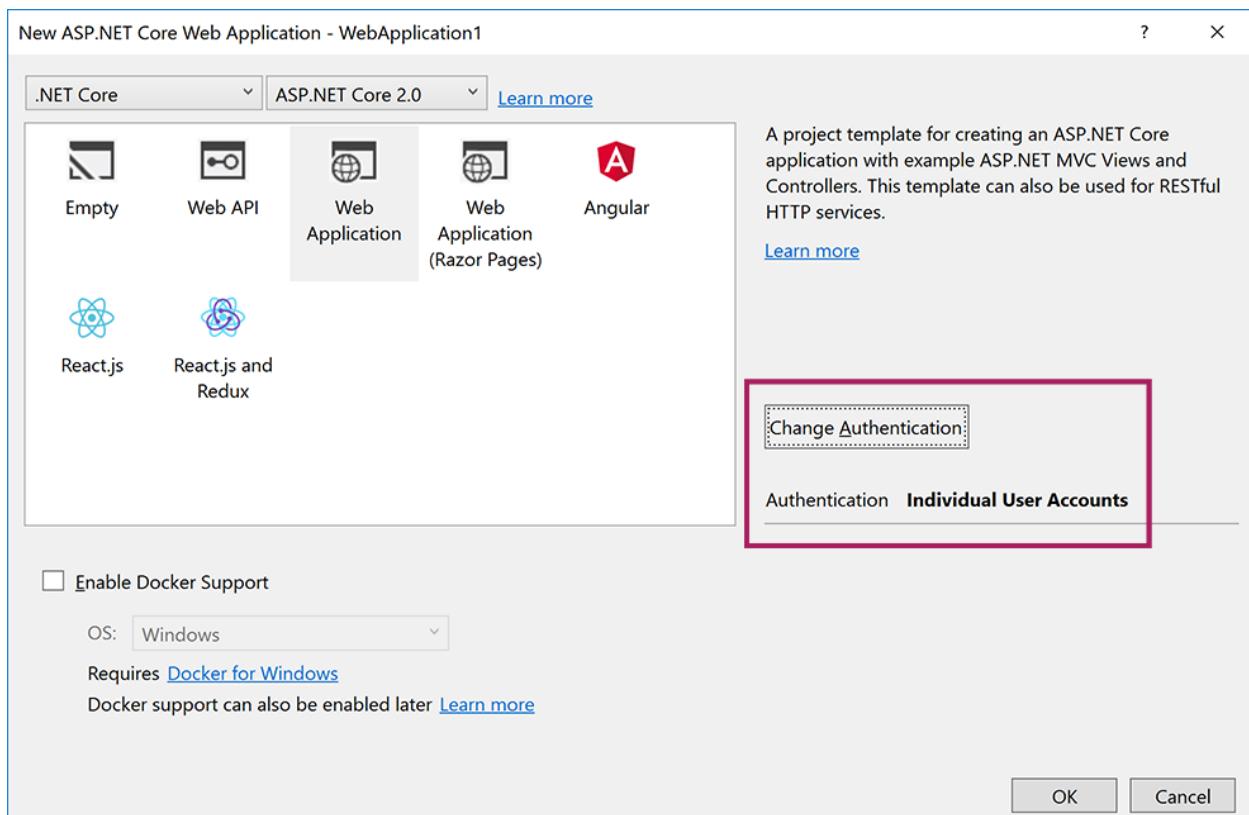
Note: Packages presented here abstract a great deal of complexity of the OAuth authentication flow, but understanding the details may become necessary when troubleshooting. Many resources are available; for example, see [Introduction to OAuth 2](#) or [Understanding OAuth 2](#). Some issues can be resolved by looking at the [ASP.NET Core source code for the provider packages](#).

## Create a New ASP.NET Core Project

- In Visual Studio 2017, create a new project from the Start Page, or via **File > New > Project**.
- Select the **ASP.NET Core Web Application** template available in **Visual C# > .NET Core** category:



- Tap **Web Application** and verify **Authentication** is set to **Individual User Accounts**:



Note: This tutorial applies to ASP.NET Core 2.0 SDK version which can be selected at the top of the wizard.

## Apply migrations

- Run the app and select the **Log in** link.
- Select the **Register as a new user** link.
- Enter the email and password for the new account, and then select **Register**.
- Follow the instructions to apply migrations.

## Require SSL

OAuth 2.0 requires the use of SSL for authentication over the HTTPS protocol.

Note: Projects created using **Web Application** or **Web API** project templates for ASP.NET Core 2.x are automatically configured to enable SSL and launch with https URL if the **Individual User Accounts** option was selected on **Change Authentication dialog** in the project wizard as shown above.

- Require SSL on your site by following the steps in [Enforce SSL in an ASP.NET Core app](#) topic.

## Use SecretManager to store tokens assigned by login providers

Social login providers assign **Application Id** and **Application Secret** tokens during the registration process. The exact token names vary by provider. These tokens represent the credentials your app uses to access their API. The tokens constitute the "secrets" that can be linked to your app configuration with the help of [Secret Manager](#). Secret Manager is a more secure alternative to storing the tokens in a configuration file, such as `appsettings.json`.

### IMPORTANT

Secret Manager is for development purposes only. You can store and protect Azure test and production secrets with the [Azure Key Vault configuration provider](#).

Follow the steps in [Safe storage of app secrets in development in ASP.NET Core](#) topic to store tokens assigned by each login provider below.

## Setup login providers required by your application

Use the following topics to configure your application to use the respective providers:

- [Facebook](#) instructions
- [Twitter](#) instructions
- [Google](#) instructions
- [Microsoft](#) instructions
- [Other provider](#) instructions

When the app requires multiple providers, chain the provider extension methods behind [AddAuthentication](#):

```
services.AddAuthentication()
    .AddMicrosoftAccount(microsoftOptions => { ... })
    .AddGoogle(googleOptions => { ... })
    .AddTwitter(twitterOptions => { ... })
    .AddFacebook/facebookOptions => { ... });
```

## Optionally set password

When you register with an external login provider, you don't have a password registered with the app. This alleviates you from creating and remembering a password for the site, but it also makes you dependent on the external login provider. If the external login provider is unavailable, you won't be able to log in to the web site.

To create a password and sign in using your email that you set during the sign in process with external providers:

- Tap the **Hello <email alias>** link at the top right corner to navigate to the **Manage** view.

The screenshot shows a web application interface titled "WebApplication224". At the top, there is a navigation bar with links for "Home", "About", and "Contact". On the far right of the top bar, there is a red-bordered box containing the text "Hello raspranav@gmail.com!" and a "Log off" link. Below the navigation bar, the main content area has a heading "Manage your account." and a sub-heading "Change your account settings". There are several sections with status information:

- Password:** [Create] (The "[Create]" button is highlighted with a red border).
- External Logins:** 1 [Manage]
- Phone Number:** Phone Numbers can be used as a second factor of verification in two-factor authentication. See [this article](#) for details on setting up this ASP.NET application to support two-factor authentication using SMS.
- Two-Factor Authentic...** There are no two-factor authentication providers configured. See [this article](#) for setting up this application to support two-factor authentication.

- Tap **Create**

You do not have a local username/password for this site. Add a local account so you can log in without an external login.

### Set your password

New password

•••••••

Confirm new password

•••••••

**Set password**

© 2015 - WebApplication224

- Set a valid password and you can use this to sign in with your email.

### Next steps

- This article introduced external authentication and explained the prerequisites required to add external logins to your ASP.NET Core app.
- Reference provider-specific pages to configure logins for the providers required by your app.

# Facebook external login setup in ASP.NET Core

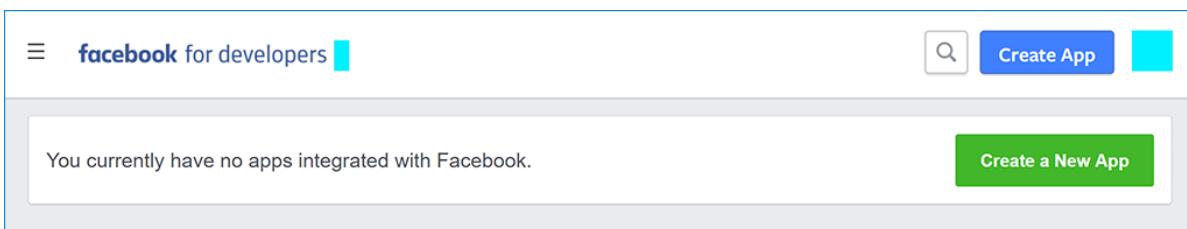
6/21/2018 • 4 minutes to read • [Edit Online](#)

By [Valeriy Novytskyy](#) and [Rick Anderson](#)

This tutorial shows you how to enable your users to sign in with their Facebook account using a sample ASP.NET Core 2.0 project created on the [previous page](#). Facebook authentication requires the [Microsoft.AspNetCore.Authentication.Facebook](#) NuGet package. We start by creating a Facebook App ID by following the [official steps](#).

## Create the app in Facebook

- Navigate to the [Facebook Developers app](#) page and sign in. If you don't already have a Facebook account, use the **Sign up for Facebook** link on the login page to create one.
- Tap the **Add a New App** button in the upper right corner to create a new App ID.



- Fill out the form and tap the **Create App ID** button.

A screenshot of the "Create a New App ID" form. The title is "Create a New App ID" with the subtitle "Get started integrating Facebook into your app or website". There are two input fields: "Display Name" (with placeholder "The name you want to associate with this App ID") and "Contact Email" (with placeholder "Used for important communication about your app"). At the bottom, there's a checkbox for agreeing to the "Facebook Platform Policies" and a row with "Cancel" and "Create App ID" buttons.

- On the **Select a product** page, click **Set Up** on the **Facebook Login** card.

The screenshot shows the SocialLogins dashboard. In the top left, there's a logo and the text "SocialLogins ▾". To its right are "APP ID: 1477249092352739" and "View Analytics". Further right are "Tools & Support" and "Docs". A blue square icon is in the top right corner.

The left sidebar has several menu items: "Dashboard", "Settings", "Roles", "Alerts", "App Review", "PRODUCTS", and "+ Add Product". The "+ Add Product" item is highlighted with a grey background.

The main content area has a heading "Select a product". It contains two cards:

- Account Kit**: Features a teal circular icon with a user icon and the text "Seamless account creation. No more passwords." Below it are "Read Docs" and "Set Up" buttons.
- Facebook Login**: Features a blue circular icon with a cursor icon and the text "The world's number one social login product." Below it are "Read Docs" and "Set Up" buttons.

- The **Quickstart** wizard will launch with **Choose a Platform** as the first page. Bypass the wizard for now by clicking the **Settings** link in the menu on the left:

This is a screenshot of the "Facebook Login" settings page. The top navigation bar says "PRODUCTS". Below it, "Facebook Login" is selected. The sidebar on the left lists "Settings" (which is highlighted in cyan), "Quickstart", and "+ Add Product".

- You are presented with the **Client OAuth Settings** page:

## Client OAuth Settings

Yes

### Client OAuth Login

Enables the standard OAuth client token flow. Secure your application and prevent abuse by locking down which token redirect URIs are allowed with the options below. Disable globally if not used. [?]

Yes

### Web OAuth Login

Enables web based OAuth client login for building custom login flows. [?]

No

### Force Web OAuth Reauthentication

When on, prompts people to enter their Facebook password in order to log in on the web. [?]

No

### Embedded Browser OAuth Login

Enables browser control redirect uri for OAuth client login. [?]

### Valid OAuth redirect URIs

`https://localhost:44320/signin-facebook` 

No

### Login from Devices

Enables the OAuth client login flow for devices like a smart TV [?]

[Deauthorize](#)

[Discard](#)

[Save Changes](#)

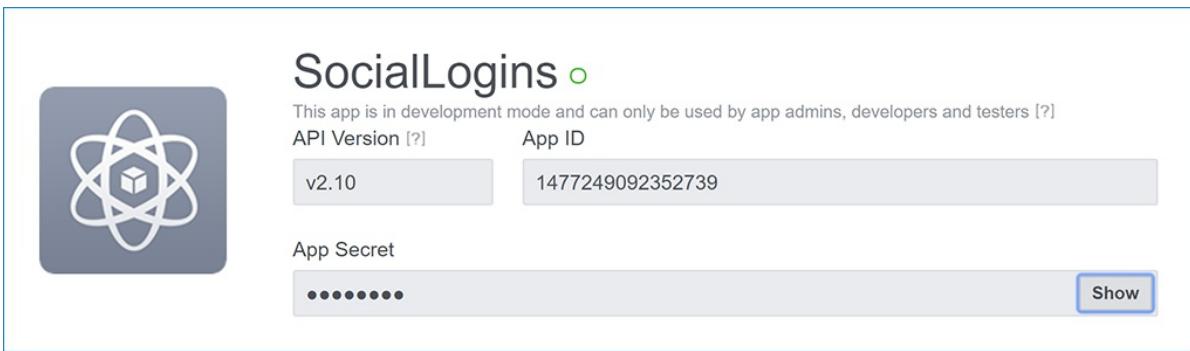
- Enter your development URI with `/signin-facebook` appended into the **Valid OAuth Redirect URIs** field (for example: `https://localhost:44320/signin-facebook`). The Facebook authentication configured later in this tutorial will automatically handle requests at `/signin-facebook` route to implement the OAuth flow.

#### NOTE

The URI `/signin-facebook` is set as the default callback of the Facebook authentication provider. You can change the default callback URI while configuring the Facebook authentication middleware via the inherited `RemoteAuthenticationOptions.CallbackPath` property of the `FacebookOptions` class.

- Click **Save Changes**.
- Click the **Dashboard** link in the left navigation.

On this page, make a note of your `App ID` and your `App Secret`. You will add both into your ASP.NET Core application in the next section:



SocialLogins

This app is in development mode and can only be used by app admins, developers and testers [?]

API Version [?] App ID

v2.10 1477249092352739

App Secret

\*\*\*\*\* Show

- When deploying the site you need to revisit the **Facebook Login** setup page and register a new public URI.

## Store Facebook App ID and App Secret

Link sensitive settings like Facebook `App ID` and `App Secret` to your application configuration using the [Secret Manager](#). For the purposes of this tutorial, name the tokens `Authentication:Facebook:AppId` and `Authentication:Facebook:AppSecret`.

Execute the following commands to securely store `App ID` and `App Secret` using Secret Manager:

```
dotnet user-secrets set Authentication:Facebook:AppId <app-id>
dotnet user-secrets set Authentication:Facebook:AppSecret <app-secret>
```

## Configure Facebook Authentication

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

Add the Facebook service in the `ConfigureServices` method in the `Startup.cs` file:

```
services.AddIdentity<ApplicationUser, IdentityRole>()
    .AddEntityFrameworkStores<ApplicationDbContext>()
    .AddDefaultTokenProviders();

services.AddAuthentication().AddFacebook(facebookOptions =>
{
    facebookOptions.AppId = Configuration["Authentication:Facebook:AppId"];
    facebookOptions.AppSecret = Configuration["Authentication:Facebook:AppSecret"];
});
```

The call to `AddIdentity` configures the default scheme settings. The `AddAuthentication(String)` overload sets the `DefaultScheme` property. The `AddAuthentication(Action<AuthenticationOptions>)` overload allows configuring authentication options, which can be used to set up default authentication schemes for different purposes. Subsequent calls to `AddAuthentication` override previously configured `AuthenticationOptions` properties.

`AuthenticationBuilder` extension methods that register an authentication handler may only be called once per authentication scheme. Overloads exist that allow configuring the scheme properties, scheme name, and display name.

When the app requires multiple providers, chain the provider extension methods behind `AddAuthentication`:

```
services.AddAuthentication()
    .AddMicrosoftAccount(microsoftOptions => { ... })
    .AddGoogle(googleOptions => { ... })
    .AddTwitter(twitterOptions => { ... })
    .AddFacebook(facebookOptions => { ... });
```

See the [FacebookOptions](#) API reference for more information on configuration options supported by Facebook authentication. Configuration options can be used to:

- Request different information about the user.
- Add query string arguments to customize the login experience.

## Sign in with Facebook

Run your application and click **Log in**. You see an option to sign in with Facebook.

The screenshot shows a login page for 'WebApplication3'. At the top, there's a navigation bar with links for 'Home', 'About', 'Contact', 'Register', and 'Log in'. Below the navigation, the main content area has a heading 'Log in.' followed by two sections: 'Use a local account to log in.' and 'Use another service to log in.'. The local account section contains fields for 'Email' and 'Password', a 'Remember me?' checkbox, and a 'Log in' button. The service provider section contains a single 'Facebook' button. At the bottom of the page, there are links for 'Register as a new user?' and 'Forgot your password?'. A copyright notice at the very bottom reads '© 2016 - WebApplication3'.

When you click on **Facebook**, you are redirected to Facebook for authentication:

[Sign Up](#)

## Log into Facebook

or

[Create New Account](#)[Forgot account?](#)[Not now](#)

Facebook authentication requests public profile and email address by default:



**SocialLogins** will receive:

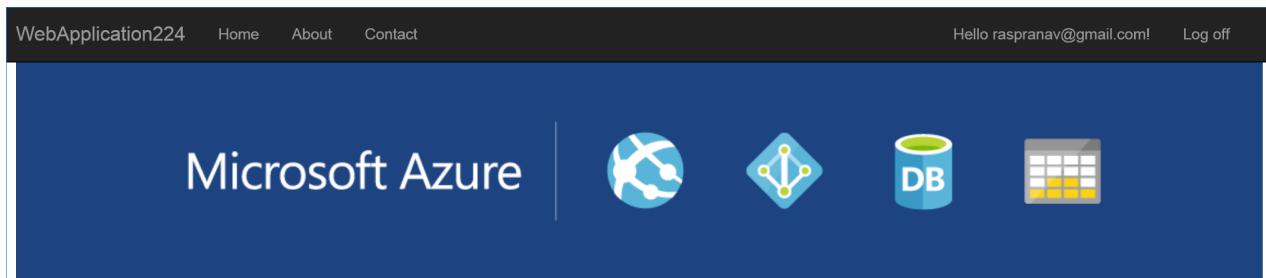
your public profile and email address. [?](#)

 [Edit This](#)[Cancel](#)

This doesn't let the app post to Facebook

Once you enter your Facebook credentials you are redirected back to your site where you can set your email.

You are now logged in using your Facebook credentials:



## Troubleshooting

- **ASP.NET Core 2.x only:** If Identity isn't configured by calling `services.AddIdentity` in `ConfigureServices`, attempting to authenticate will result in *ArgumentException: The 'SignInScheme' option must be provided*. The project template used in this tutorial ensures that this is done.
- If the site database has not been created by applying the initial migration, you get *A database operation failed while processing the request* error. Tap **Apply Migrations** to create the database and refresh to continue past the error.

## Next steps

- This article showed how you can authenticate with Facebook. You can follow a similar approach to authenticate with other providers listed on the [previous page](#).
- Once you publish your web site to Azure web app, you should reset the `AppSecret` in the Facebook developer portal.
- Set the `Authentication:Facebook:AppId` and `Authentication:Facebook:AppSecret` as application settings in the Azure portal. The configuration system is set up to read keys from environment variables.

# Twitter external login setup with ASP.NET Core

6/21/2018 • 3 minutes to read • [Edit Online](#)

By [Valeriy Novytskyy](#) and [Rick Anderson](#)

This tutorial shows you how to enable your users to [sign in with their Twitter account](#) using a sample ASP.NET Core 2.0 project created on the [previous page](#).

## Create the app in Twitter

- Navigate to <https://apps.twitter.com/> and sign in. If you don't already have a Twitter account, use the [Sign up now](#) link to create one. After signing in, the **Application Management** page is shown:

The screenshot shows the Twitter Application Management interface. At the top, there's a navigation bar with the Twitter logo and the text "Application Management". Below this is a blue header bar with the text "Twitter Apps". The main content area contains a message: "You don't currently have any Twitter Apps." followed by a "Create New App" button. At the bottom of the page, there are links for "About", "Terms", "Privacy", and "Cookies", along with a copyright notice: "© 2017 Twitter, Inc.".

- Tap **Create New App** and fill out the application **Name**, **Description** and public **Website** URI (this can be temporary until you register the domain name):

# Create an application

## Application Details

Name \*

Your application name. This is used to attribute the source of a tweet and in user-facing authorization screens. 32 characters max.

Description \*

Your application description, which will be shown in user-facing authorization screens. Between 10 and 200 characters max.

Website \*

Your application's publicly accessible home page, where users can go to download, make use of, or find out more information about your application. This fully-qualified URL is used in the source attribution for tweets created by your application and will be shown in user-facing authorization screens.  
(If you don't have a URL yet, just put a placeholder here but remember to change it later.)

Callback URL

Where should we return after successfully authenticating? OAuth 1.0a applications should explicitly specify their oauth\_callback URL on the request token step, regardless of the value given here. To restrict your application from using callbacks, leave this field blank.

## Developer Agreement

Yes, I have read and agree to the [Twitter Developer Agreement](#).

[Create your Twitter application](#)

- Enter your development URI with `/signin-twitter` appended into the **Valid OAuth Redirect URIs** field (for example: `https://localhost:44320/signin-twitter`). The Twitter authentication scheme configured later in this tutorial will automatically handle requests at `/signin-twitter` route to implement the OAuth flow.

### NOTE

The URI segment `/signin-twitter` is set as the default callback of the Twitter authentication provider. You can change the default callback URI while configuring the Twitter authentication middleware via the inherited `RemoteAuthenticationOptions.CallbackPath` property of the `TwitterOptions` class.

- Fill out the rest of the form and tap **Create your Twitter application**. New application details are displayed:

Your application has been created. Please take a moment to review and adjust your application's settings.

# SocialLogins

[Test OAuth](#)[Details](#)[Settings](#)[Keys and Access Tokens](#)[Permissions](#)

Social login demo

<https://www.mysite.com/>

## Organization

Information about the organization or company associated with your application. This information is optional.

Organization None

Organization website None

## Application Settings

Your application's Consumer Key and Secret are used to **authenticate** requests to the Twitter Platform.

Access level Read and write ([modify app permissions](#))[Consumer Key \(API Key\)](#)[\(manage keys and access\)](#)

- When deploying the site you'll need to revisit the **Application Management** page and register a new public URI.

## Storing Twitter ConsumerKey and ConsumerSecret

Link sensitive settings like Twitter `Consumer Key` and `Consumer Secret` to your application configuration using the **Secret Manager**. For the purposes of this tutorial, name the tokens `Authentication:Twitter:ConsumerKey` and `Authentication:Twitter:ConsumerSecret`.

These tokens can be found on the **Keys and Access Tokens** tab after creating your new Twitter application:

The screenshot shows the Application Management interface with the Twitter logo in the top left. The main title is "SocialLogins". Below it are tabs: "Details", "Settings", "Keys and Access Tokens" (which is selected), and "Permissions". A "Test OAuth" button is in the top right. The "Application Settings" section contains fields for "Consumer Key (API Key)" and "Consumer Secret (API Secret)". It also shows "Access Level" as "Read and write (modify app permissions)", "Owner" (with a placeholder), and "Owner ID" as "890753103795859456". The "Application Actions" section includes "Regenerate Consumer Key and Secret" and "Change App Permissions" buttons.

## Configure Twitter Authentication

The project template used in this tutorial ensures that [Microsoft.AspNetCore.Authentication.Twitter](#) package is already installed.

- To install this package with Visual Studio 2017, right-click on the project and select **Manage NuGet Packages**.
- To install with .NET Core CLI, execute the following in your project directory:

```
dotnet add package Microsoft.AspNetCore.Authentication.Twitter
```

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

Add the Twitter service in the `ConfigureServices` method in `Startup.cs` file:

```
services.AddIdentity<ApplicationUser, IdentityRole>()
    .AddEntityFrameworkStores<ApplicationContext>()
    .AddDefaultTokenProviders();

services.AddAuthentication().AddTwitter(twitterOptions =>
{
    twitterOptions.ConsumerKey = Configuration["Authentication:Twitter:ConsumerKey"];
    twitterOptions.ConsumerSecret = Configuration["Authentication:Twitter:ConsumerSecret"];
});
```

The call to `AddIdentity` configures the default scheme settings. The `AddAuthentication(String)` overload sets the

`DefaultScheme` property. The `AddAuthentication(Action<AuthenticationOptions>)` overload allows configuring authentication options, which can be used to set up default authentication schemes for different purposes. Subsequent calls to `AddAuthentication` override previously configured `AuthenticationOptions` properties.

`AuthenticationBuilder` extension methods that register an authentication handler may only be called once per authentication scheme. Overloads exist that allow configuring the scheme properties, scheme name, and display name.

When the app requires multiple providers, chain the provider extension methods behind `AddAuthentication`:

```
services.AddAuthentication()
    .AddMicrosoftAccount(microsoftOptions => { ... })
    .AddGoogle(googleOptions => { ... })
    .AddTwitter(twitterOptions => { ... })
    .AddFacebook(facebookOptions => { ... });
```

See the [TwitterOptions](#) API reference for more information on configuration options supported by Twitter authentication. This can be used to request different information about the user.

## Sign in with Twitter

Run your application and click **Log in**. An option to sign in with Twitter appears:

The screenshot shows a login page for a web application named "WebApplication3". The top navigation bar includes links for "Home", "About", "Contact", "Register", and "Log in". The main content area has a heading "Log in." and two sections: "Use a local account to log in." and "Use another service to log in.". The local account section contains fields for "Email" and "Password", a "Remember me?" checkbox, and a "Log in" button. The service section contains a "Twitter" button. Below the login form are links for "Register as a new user?", "Forgot your password?", and the copyright notice "© 2016 - WebApplication3".

Clicking on **Twitter** redirects to Twitter for authentication:


[Sign up for Twitter >](#)

## Authorize SocialLogins to use your account?



**SocialLogins**  
[www.mysite.com](http://www.mysite.com)  
 Social login demo

Remember me · [Forgot password?](#)

Sign In
Cancel

**This application will be able to:**

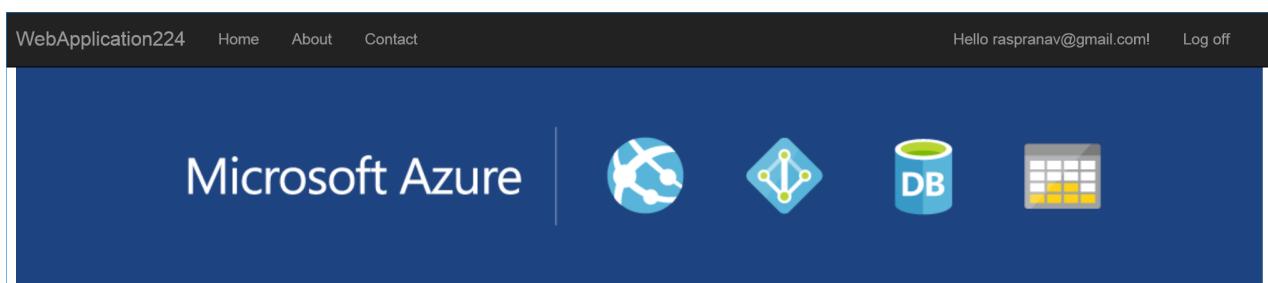
- Read Tweets from your timeline.
- See who you follow.

**Will not be able to:**

- Follow new people.
- Update your profile.
- Post Tweets for you.
- Access your direct messages.
- See your email address.
- See your Twitter password.

After entering your Twitter credentials, you are redirected back to the web site where you can set your email.

You are now logged in using your Twitter credentials:



## Troubleshooting

- **ASP.NET Core 2.x only:** If Identity isn't configured by calling `services.AddIdentity` in `ConfigureServices`, attempting to authenticate will result in *ArgumentException: The 'SignInScheme' option must be provided*. The project template used in this tutorial ensures that this is done.
- If the site database has not been created by applying the initial migration, you will get *A database operation failed while processing the request* error. Tap **Apply Migrations** to create the database and refresh to continue past the error.

## Next steps

- This article showed how you can authenticate with Twitter. You can follow a similar approach to authenticate with other providers listed on the [previous page](#).
- Once you publish your web site to Azure web app, you should reset the `consumerSecret` in the Twitter developer portal.
- Set the `Authentication:Twitter:ConsumerKey` and `Authentication:Twitter:ConsumerSecret` as application settings in the Azure portal. The configuration system is set up to read keys from environment variables.

# Google external login setup in ASP.NET Core

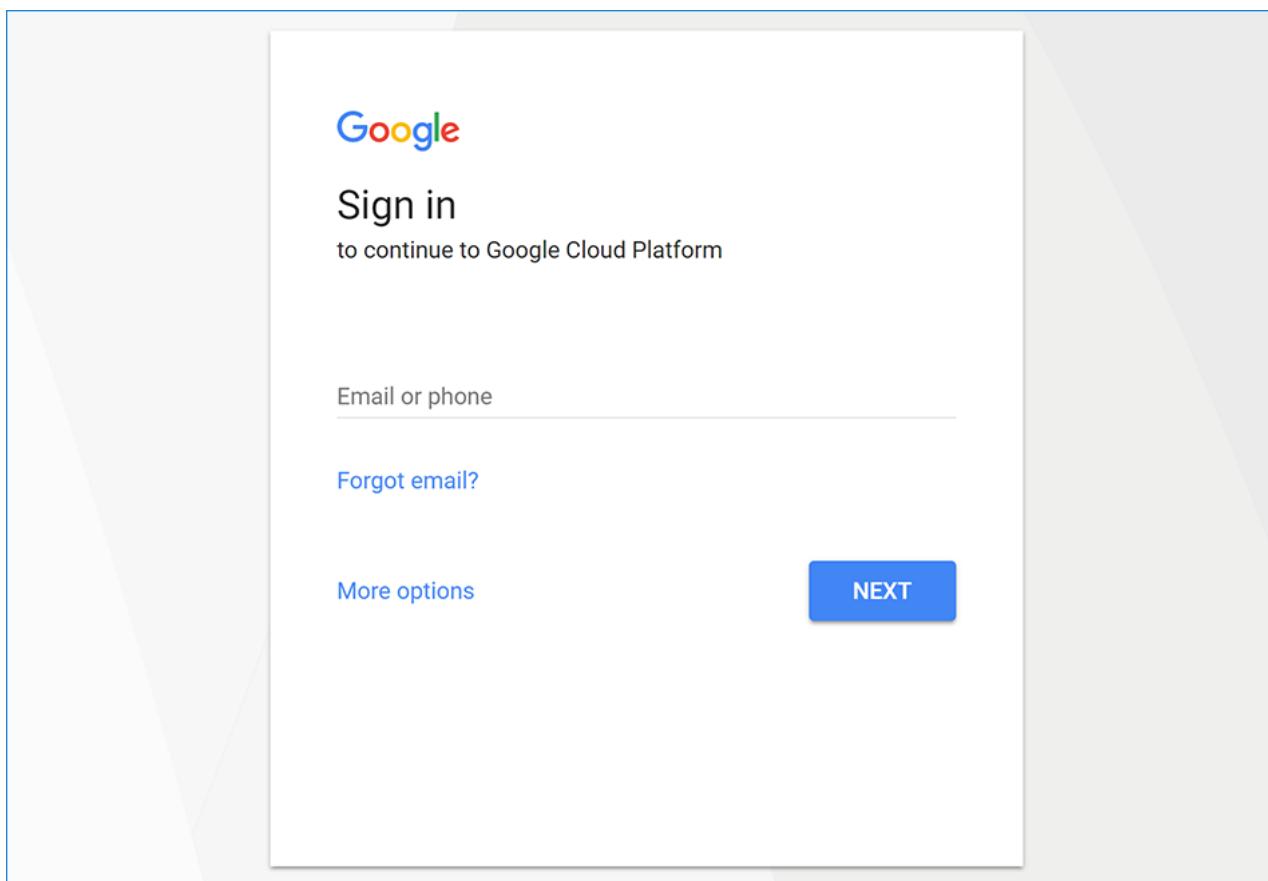
6/21/2018 • 4 minutes to read • [Edit Online](#)

By [Valeriy Novytskyy](#) and [Rick Anderson](#)

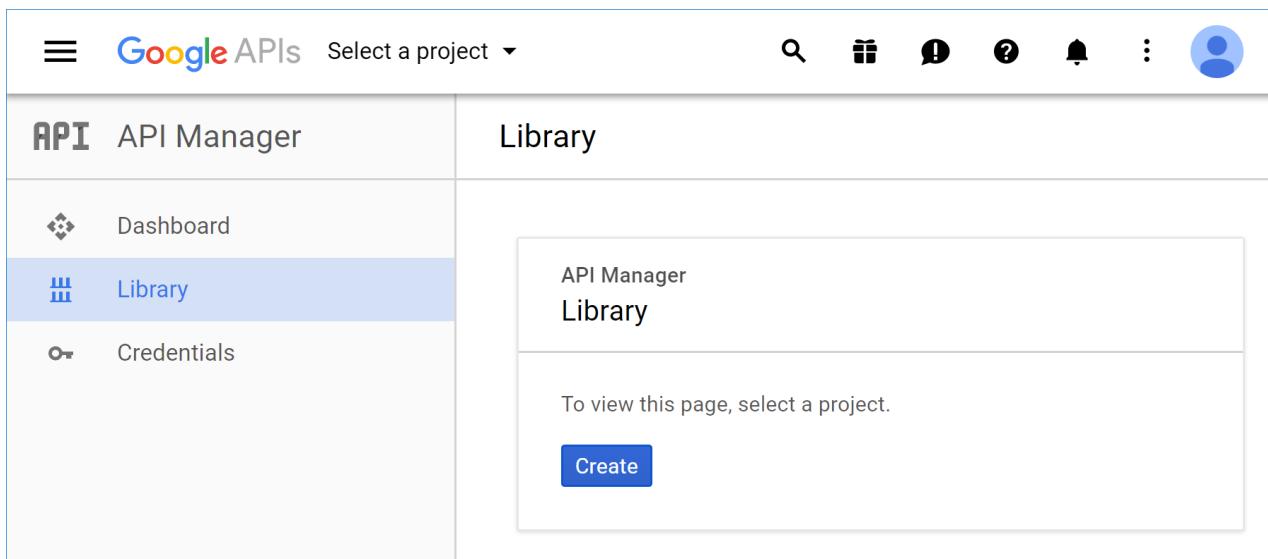
This tutorial shows you how to enable your users to sign in with their Google+ account using a sample ASP.NET Core 2.0 project created on the [previous page](#). We start by following the [official steps](#) to create a new app in Google API Console.

## Create the app in Google API Console

- Navigate to <https://console.developers.google.com/projectselector/apis/library> and sign in. If you don't already have a Google account, use **More options** > **Create account** link to create one:

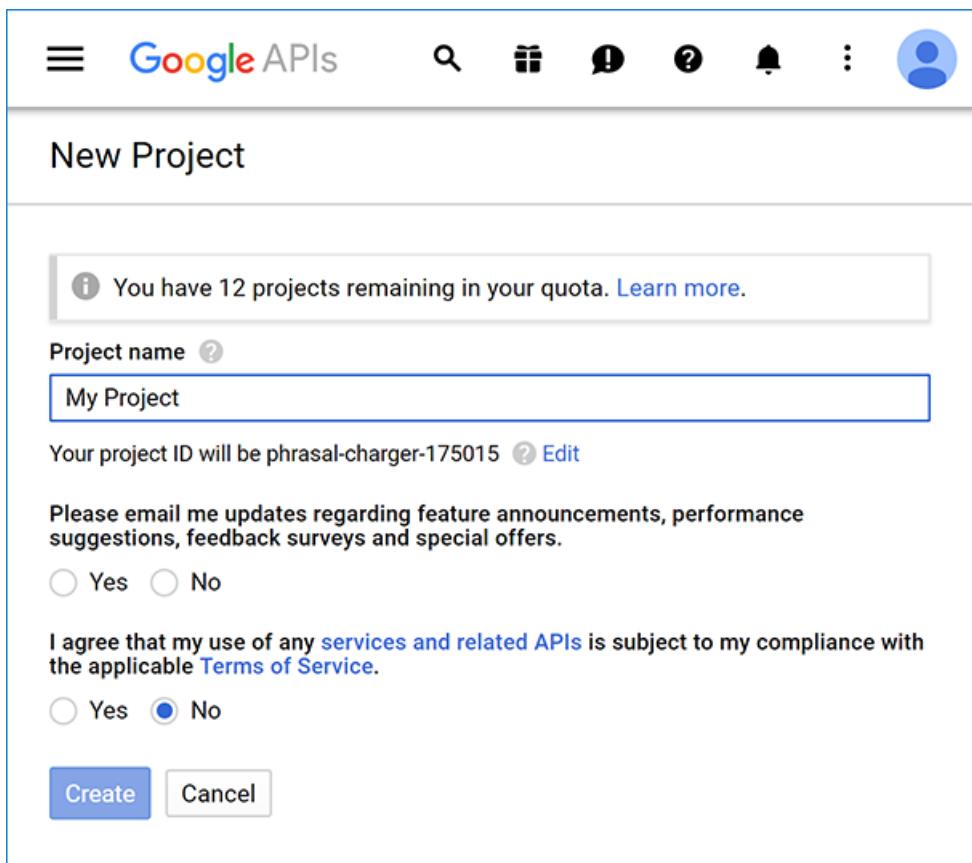


- You are redirected to **API Manager Library** page:



The screenshot shows the Google APIs Library page. On the left, there's a sidebar with 'API Manager' selected. The main area is titled 'Library' and contains a message: 'To view this page, select a project.' Below it is a 'Create' button.

- Tap **Create** and enter your **Project name**:



The screenshot shows the 'New Project' dialog. It includes a message about remaining projects, a 'Project name' field containing 'My Project', a note about the project ID, an email preference section, an agreement checkbox, and two buttons at the bottom: 'Create' and 'Cancel'.

- After accepting the dialog, you are redirected back to the Library page allowing you to choose features for your new app. Find **Google+ API** in the list and click on its link to add the API feature:

**Google APIs** SocialLogins ▾

**API Manager**

- Dashboard
- Library**
- Credentials

**Library**

**Google APIs**

Google+ API

Back to popular APIs

Name	Description
Google+ API	The Google+ API enables developers to build on top of the Google+ platform.
Google+ Domains API	The Google+ Domains API enables developers to build on top of the Google+ platform for Google Apps

- The page for the newly added API is displayed. Tap **Enable** to add Google+ sign in feature to your app:

**Google+ API** **ENABLE**

### About this API

The Google+ API enables developers to build on top of the Google+ platform.

**Using credentials with this API**

**Accessing user data with OAuth 2.0**

You can access user data with this API. On the Credentials page, create an OAuth 2.0 client ID. A client ID requests user consent so that your app can access user data. Include that client ID when making your API call to Google. [Learn more](#)

**Server-to-server interaction**

You can use this API to perform server-to-server interaction, for example between a web application and a Google service. You'll need a service account, which enables app-level authentication. You'll also need a service account key, which is used to authorize your API call to Google. [Learn more](#)

- After enabling the API, tap **Create credentials** to configure the secrets:

**Google APIs** SocialLogins ▾

**API Manager**

- Dashboard
- Library**
- Credentials

**Google+ API** **DISABLE**

To use this API, you may need credentials. Click "Create credentials" to get started.

**Create credentials**

Overview Quotas

- Choose:
  - Google+ API**
  - Web server (e.g. node.js, Tomcat)**, and
  - User data**:

**API** API Manager

Dashboard

Library

Credentials

## Credentials

## Add credentials to your project

## 1 Find out what kind of credentials you need

We'll help you set up the correct credentials

If you wish you can skip this step and create an [API key](#), [client ID](#), or [service account](#)

## Which API are you using?

Determines what kind of credentials you need.

Google+ API

## Where will you be calling the API from?

Determines which settings you'll need to configure.

Web server (e.g. node.js, Tomcat)

## What data will you be accessing?

 User data

Access data belonging to a Google user, with their permission

 Application data

Access data belonging to your own application

**What credentials do I need?**

## 2 Get your credentials

**Cancel**

- Tap **What credentials do I need?** which takes you to the second step of app configuration, **Create an OAuth 2.0 client ID**:

**Add credentials to your project**

**1 Find out what kind of credentials you need**  
Calling Google+ API from a web server

**2 Create an OAuth 2.0 client ID**

**Name**  
Web client 1

**Restrictions**  
Enter JavaScript origins, redirect URLs, or both

**Authorized JavaScript origins**  
For use with requests from a browser. This is the origin URI of the client application. It can't contain a wildcard (`http://*.example.com`) or a path (`http://example.com/subdir`). If you're using a nonstandard port, you must include it in the origin URI.  
`http://www.example.com`

**Authorized redirect URLs**  
For use with requests from a web server. This is the path in your application that users are redirected to after they have authenticated with Google. The path will be appended with the authorization code for access. Must have a protocol. Cannot contain URL fragments or relative paths. Cannot be a public IP address.  
`http://www.example.com/oauth2callback`

**Create client ID**

- Because we are creating a Google+ project with just one feature (sign in), we can enter the same **Name** for the OAuth 2.0 client ID as the one we used for the project.
- Enter your development URI with `/signin-google` appended into the **Authorized redirect URLs** field (for example: `https://localhost:44320/signin-google`). The Google authentication configured later in this tutorial will automatically handle requests at `/signin-google` route to implement the OAuth flow.

#### NOTE

The URI segment `/signin-google` is set as the default callback of the Google authentication provider. You can change the default callback URI while configuring the Google authentication middleware via the inherited `RemoteAuthenticationOptions.CallbackPath` property of the `GoogleOptions` class.

- Press TAB to add the **Authorized redirect URLs** entry.
- Tap **Create client ID**, which takes you to the third step, **Set up the OAuth 2.0 consent screen**:

**API** API Manager

Dashboard

Library

Credentials

## Credentials

## Add credentials to your project

- Find out what kind of credentials you need

Calling Google+ API from a web server

- Create an OAuth 2.0 client ID

Created OAuth client 'Web client 1'

## 3 Set up the OAuth 2.0 consent screen

Email address

Product name shown to users

 Product name

More customization options

Continue



The consent screen will be shown to users whenever you request access to their private data using your client ID. It will be shown for all applications registered in this project.



- Enter your public facing **Email address** and the **Product name** shown for your app when Google+ prompts the user to sign in. Additional options are available under **More customization options**.
- Tap **Continue** to proceed to the last step, **Download credentials**:

The screenshot shows the Google APIs console interface. On the left, there's a sidebar with 'API Manager' selected. The main area is titled 'Credentials' and has a sub-section 'Add credentials to your project'. It lists four steps: 'Find out what kind of credentials you need' (Calling Google+ API from a web server), 'Create an OAuth 2.0 client ID' (Created OAuth client 'Web client 1'), 'Set up the OAuth 2.0 consent screen', and 'Download credentials'. Below the steps, a 'Client ID' field contains '114882279233-bqsm444d7tcd4gkm3gb46qd32653fjcb.apps.googleusercontent.com'. A note says 'Download this credential information in JSON format. This is always available for you on the credentials page.' There are 'Download' and 'I'll do this later' buttons. At the bottom are 'Done' and 'Cancel' buttons.

- Tap **Download** to save a JSON file with application secrets, and **Done** to complete creation of the new app.
- When deploying the site you'll need to revisit the **Google Console** and register a new public url.

## Store Google ClientID and ClientSecret

Link sensitive settings like Google `client_id` and `client_secret` to your application configuration using the [Secret Manager](#). For the purposes of this tutorial, name the tokens `Authentication:Google:ClientId` and `Authentication:Google:ClientSecret`.

The values for these tokens can be found in the JSON file downloaded in the previous step under `web.client_id` and `web.client_secret`.

## Configure Google Authentication

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

Add the Google service in the `ConfigureServices` method in `Startup.cs` file:

```
services.AddIdentity<ApplicationUser, IdentityRole>()
    .AddEntityFrameworkStores<ApplicationContext>()
    .AddDefaultTokenProviders();

services.AddAuthentication().AddGoogle(googleOptions =>
{
    googleOptions.ClientId = Configuration["Authentication:Google:ClientId"];
    googleOptions.ClientSecret = Configuration["Authentication:Google:ClientSecret"];
});
```

The call to `AddIdentity` configures the default scheme settings. The `AddAuthentication(String)` overload sets the `DefaultScheme` property. The `AddAuthentication(Action<AuthenticationOptions>)` overload allows configuring authentication options, which can be used to set up default authentication schemes for different purposes.

Subsequent calls to `AddAuthentication` override previously configured `AuthenticationOptions` properties.

`AuthenticationBuilder` extension methods that register an authentication handler may only be called once per authentication scheme. Overloads exist that allow configuring the scheme properties, scheme name, and display name.

When the app requires multiple providers, chain the provider extension methods behind `AddAuthentication`:

```
services.AddAuthentication()
    .AddMicrosoftAccount(microsoftOptions => { ... })
    .AddGoogle(googleOptions => { ... })
    .AddTwitter(twitterOptions => { ... })
    .AddFacebook(facebookOptions => { ... });
```

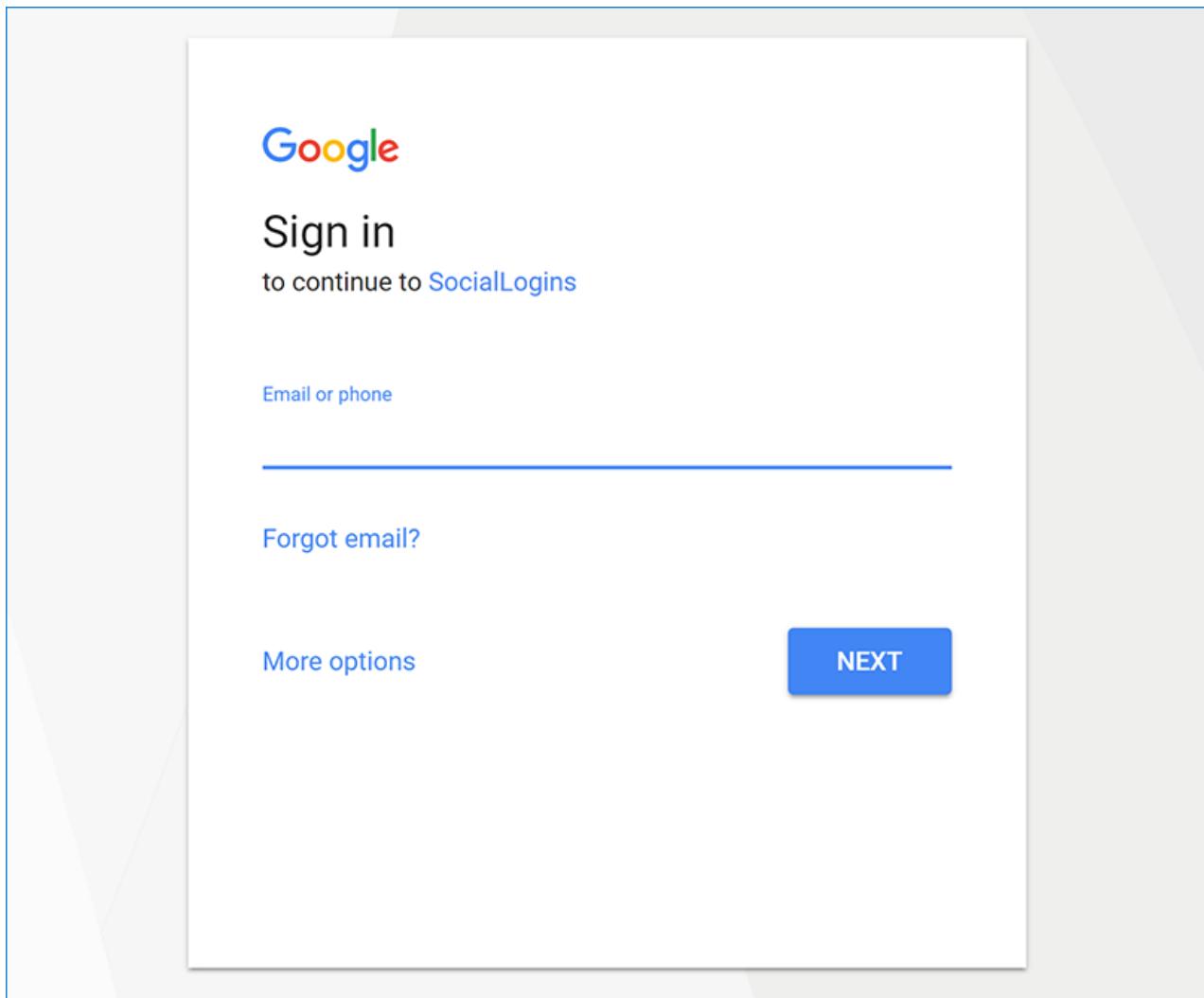
See the [GoogleOptions](#) API reference for more information on configuration options supported by Google authentication. This can be used to request different information about the user.

## Sign in with Google

Run your application and click **Log in**. An option to sign in with Google appears:

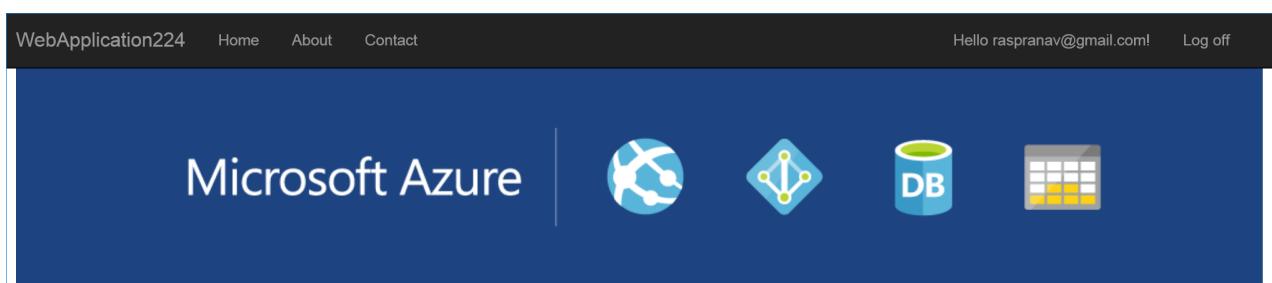
The screenshot shows a login page for "WebApplication3". At the top, there is a navigation bar with links for "Home", "About", "Contact", "Register", and "Log in". Below the navigation bar, the page title "Log in." is displayed. The page is divided into two sections: "Use a local account to log in." and "Use another service to log in.". The "Use a local account" section contains fields for "Email" and "Password", a "Remember me?" checkbox, and a "Log in" button. The "Use another service" section contains a "Google" button. At the bottom of the page, there are links for "Register as a new user?" and "Forgot your password?". A copyright notice "© 2016 - WebApplication3" is at the very bottom.

When you click on Google, you are redirected to Google for authentication:



After entering your Google credentials, then you are redirected back to the web site where you can set your email.

You are now logged in using your Google credentials:



## Troubleshooting

- If you receive a `403 (Forbidden)` error page from your own app when running in development mode (or break into the debugger with the same error), ensure that **Google+ API** has been enabled in the **API Manager Library** by following the steps listed [earlier on this page](#). If the sign in doesn't work and you aren't getting any errors, switch to development mode to make the issue easier to debug.
- ASP.NET Core 2.x only:** If Identity isn't configured by calling `services.AddIdentity` in `ConfigureServices`, attempting to authenticate will result in *ArgumentException: The 'SignInScheme' option must be provided*. The project template used in this tutorial ensures that this is done.
- If the site database has not been created by applying the initial migration, you will get *A database operation failed while processing the request* error. Tap **Apply Migrations** to create the database and refresh to continue past the error.

## Next steps

- This article showed how you can authenticate with Google. You can follow a similar approach to authenticate with other providers listed on the [previous page](#).
- Once you publish your web site to Azure web app, you should reset the `clientSecret` in the Google API Console.
- Set the `Authentication:Google:ClientId` and `Authentication:Google:ClientSecret` as application settings in the Azure portal. The configuration system is set up to read keys from environment variables.

# Microsoft Account external login setup with ASP.NET Core

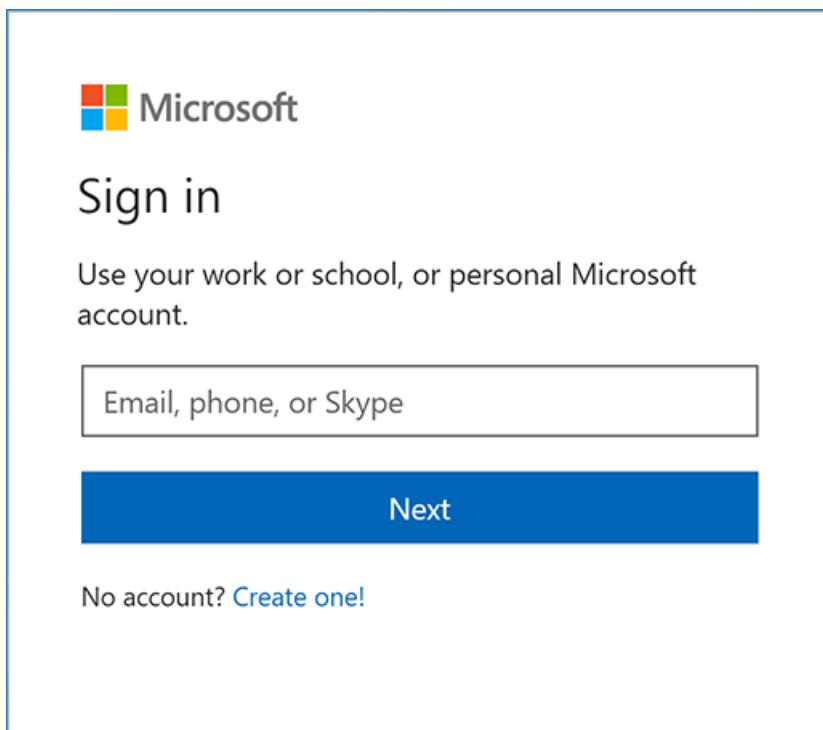
6/21/2018 • 4 minutes to read • [Edit Online](#)

By [Valeriy Novytskyy](#) and [Rick Anderson](#)

This tutorial shows you how to enable your users to sign in with their Microsoft account using a sample ASP.NET Core 2.0 project created on the [previous page](#).

## Create the app in Microsoft Developer Portal

- Navigate to <https://apps.dev.microsoft.com> and create or sign into a Microsoft account:



If you don't already have a Microsoft account, tap [Create one!](#) After signing in you are redirected to **My applications** page:

A screenshot of the Microsoft Application Registration Portal - My applications page. The top navigation bar includes the Microsoft logo, "Application Registration Portal", "Docs", "Feedback", and a user profile icon. The main heading is "My applications" with a "Learn More" link and a "Add an app" button. Below the heading is a table showing application details. The table has columns for "Name" and "App ID / Client Id". One row is shown, with "TestApp" in the Name column and "b7e887c6-23e7-48fa-802a-c528e47cf02a" in the App ID / Client Id column. To the right of the App ID is a "Delete" button.

- Tap **Add an app** in the upper right corner and enter your **Application Name** and **Contact Email**:



# Register your application

Application Name

Contact Email

Used for important communications about your application

Guided Setup

Let us help you get started

---

By proceeding, you agree to the [Microsoft Platform Policies](#)

**Create**

- For the purposes of this tutorial, clear the **Guided Setup** check box.
- Tap **Create** to continue to the **Registration** page. Provide a **Name** and note the value of the **Application Id**, which you use as `clientId` later in the tutorial:



[My applications](#) / SocialLogins

# SocialLogins Registration

[Click here for help integrating your application with Microsoft.](#)

## Properties

Name

SocialLogins

Application Id

4d519acd-6a8c-4df4-a246-fe5ea741c9db

## Application Secrets

[Generate New Password](#)

[Generate New Key Pair](#)

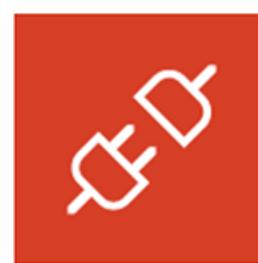
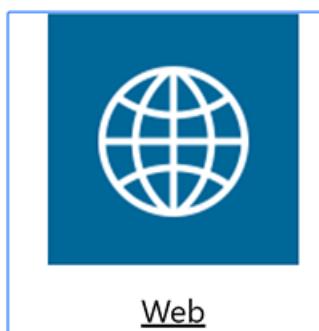
[Upload Public Key](#)

## Platforms

[Add Platform](#)

- Tap **Add Platform** in the **Platforms** section and select the **Web** platform:

### Add Platform



[Cancel](#)

- In the new **Web** platform section, enter your development URL with `/signin-microsoft` appended into the **Redirect URLs** field (for example: `https://localhost:44320/signin-microsoft`). The Microsoft authentication scheme configured later in this tutorial will automatically handle requests at `/signin-microsoft` route to implement the OAuth flow:

The screenshot shows a 'Platforms' configuration page. A single 'Web' platform entry is listed. The entry includes a checkbox for 'Allow Implicit Flow', which is checked. Below it, there's a 'Redirect URLs' section with an 'Add URL' button and a text input field containing the URL `https://localhost:44320/signin-microsoft`. There is also a 'Logout URL' section with a placeholder 'e.g. https://myapp.com/end-session'.

#### NOTE

The URI segment `/signin-microsoft` is set as the default callback of the Microsoft authentication provider. You can change the default callback URI while configuring the Microsoft authentication middleware via the inherited `RemoteAuthenticationOptions.CallbackPath` property of the `MicrosoftAccountOptions` class.

- Tap **Add URL** to ensure the URL was added.
- Fill out any other application settings if necessary and tap **Save** at the bottom of the page to save changes to app configuration.
- When deploying the site you'll need to revisit the **Registration** page and set a new public URL.

## Store Microsoft Application Id and Password

- Note the `Application Id` displayed on the **Registration** page.
- Tap **Generate New Password** in the **Application Secrets** section. This displays a box where you can copy the application password:

## New password generated

This is the only time when it will be displayed. Please store it securely.

bae

Ok

Link sensitive settings like Microsoft `Application ID` and `Password` to your application configuration using the [Secret Manager](#). For the purposes of this tutorial, name the tokens `Authentication:Microsoft:ApplicationId` and `Authentication:Microsoft:Password`.

## Configure Microsoft Account Authentication

The project template used in this tutorial ensures that `Microsoft.AspNetCore.Authentication.MicrosoftAccount` package is already installed.

- To install this package with Visual Studio 2017, right-click on the project and select **Manage NuGet Packages**.
- To install with .NET Core CLI, execute the following in your project directory:

```
dotnet add package Microsoft.AspNetCore.Authentication.MicrosoftAccount
```

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

Add the Microsoft Account service in the `ConfigureServices` method in `Startup.cs` file:

```
services.AddIdentity<ApplicationUser, IdentityRole>()
    .AddEntityFrameworkStores<ApplicationContext>()
    .AddDefaultTokenProviders();

services.AddAuthentication().AddMicrosoftAccount(microsoftOptions =>
{
    microsoftOptions.ClientId = Configuration["Authentication:Microsoft:ApplicationId"];
    microsoftOptions.ClientSecret = Configuration["Authentication:Microsoft:Password"];
});
```

The call to `AddIdentity` configures the default scheme settings. The `AddAuthentication(String)` overload sets the `DefaultScheme` property. The `AddAuthentication(Action<AuthenticationOptions>)` overload allows configuring authentication options, which can be used to set up default authentication schemes for different purposes.

Subsequent calls to `AddAuthentication` override previously configured `AuthenticationOptions` properties.

`AuthenticationBuilder` extension methods that register an authentication handler may only be called once per authentication scheme. Overloads exist that allow configuring the scheme properties, scheme name, and display name.

When the app requires multiple providers, chain the provider extension methods behind `AddAuthentication`:

```
services.AddAuthentication()
    .AddMicrosoftAccount(microsoftOptions => { ... })
    .AddGoogle(googleOptions => { ... })
    .AddTwitter(twitterOptions => { ... })
    .AddFacebook(facebookOptions => { ... });
```

Although the terminology used on Microsoft Developer Portal names these tokens `ApplicationId` and `Password`, they're exposed as `ClientId` and `ClientSecret` to the configuration API.

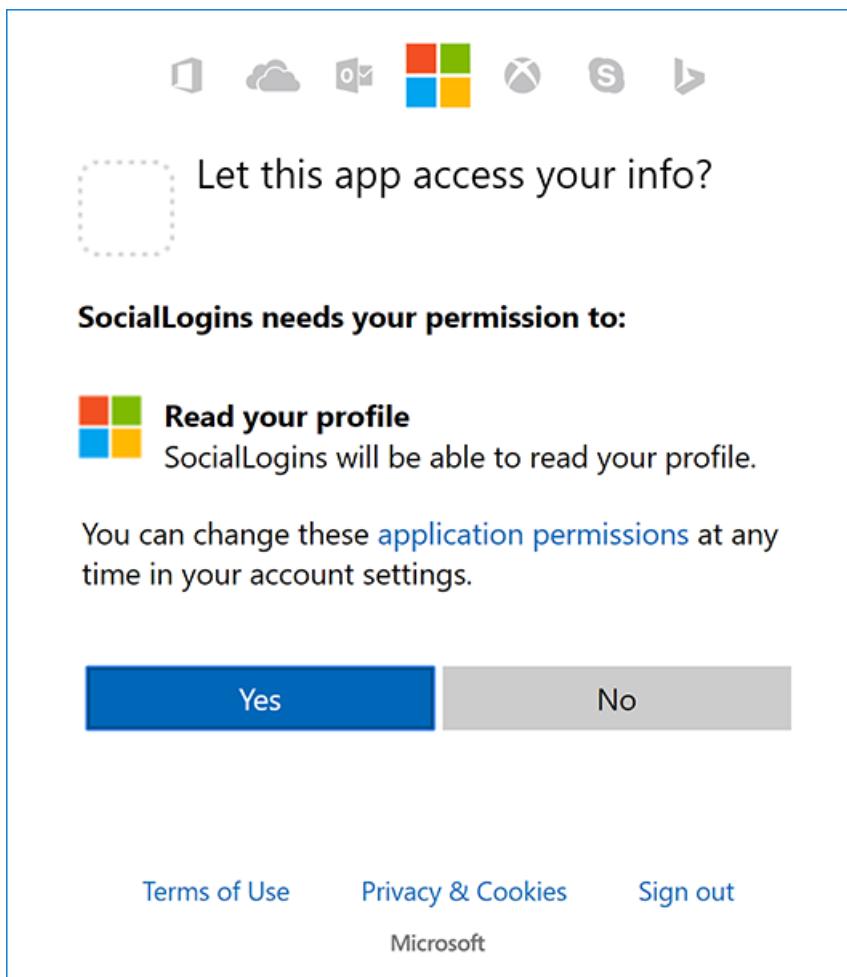
See the [MicrosoftAccountOptions](#) API reference for more information on configuration options supported by Microsoft Account authentication. This can be used to request different information about the user.

## Sign in with Microsoft Account

Run your application and click **Log in**. An option to sign in with Microsoft appears:

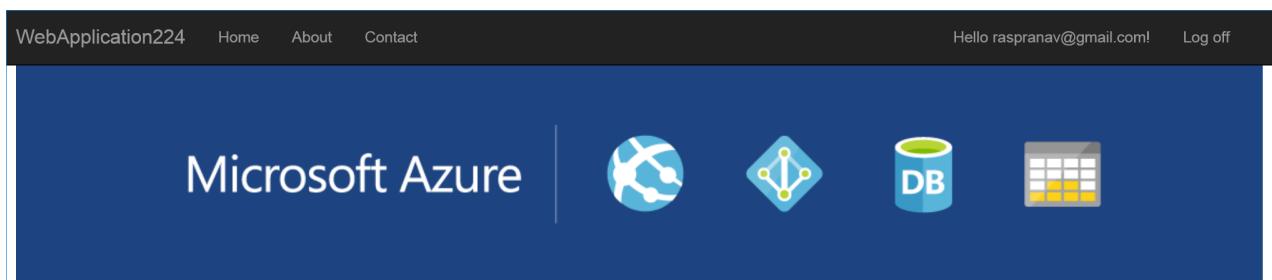
The screenshot shows a login interface for a web application named "WebApplication3". At the top, there is a navigation bar with links for "Home", "About", "Contact", "Register", and "Log in". Below the navigation bar, the main content area has a heading "Log in.". It contains two sections: "Use a local account to log in." and "Use another service to log in.". The "Use a local account" section includes fields for "Email" and "Password", and a "Remember me?" checkbox. The "Use another service" section includes a "Microsoft" button. At the bottom of the page, there are links for "Register as a new user?", "Forgot your password?", and a copyright notice "© 2016 - WebApplication3".

When you click on Microsoft, you are redirected to Microsoft for authentication. After signing in with your Microsoft Account (if not already signed in) you will be prompted to let the app access your info:



Tap **Yes** and you will be redirected back to the web site where you can set your email.

You are now logged in using your Microsoft credentials:



## Troubleshooting

- If the Microsoft Account provider redirects you to a sign in error page, note the error title and description query string parameters directly following the `#` (hashtag) in the Uri.  
Although the error message seems to indicate a problem with Microsoft authentication, the most common cause is your application Uri not matching any of the **Redirect URIs** specified for the **Web** platform.
- ASP.NET Core 2.x only:** If Identity isn't configured by calling `services.AddIdentity` in `ConfigureServices`, attempting to authenticate will result in *ArgumentException: The 'SignInScheme' option must be provided.* The project template used in this tutorial ensures that this is done.
- If the site database has not been created by applying the initial migration, you will get *A database operation failed while processing the request* error. Tap **Apply Migrations** to create the database and refresh to continue past the error.

## Next steps

- This article showed how you can authenticate with Microsoft. You can follow a similar approach to authenticate with other providers listed on the [previous page](#).
- Once you publish your web site to Azure web app, you should create a new `Password` in the Microsoft Developer Portal.
- Set the `Authentication:Microsoft:ApplicationId` and `Authentication:Microsoft:Password` as application settings in the Azure portal. The configuration system is set up to read keys from environment variables.

# Short survey of other authentication providers

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [Pranav Rastogi](#), and [Valeriy Novytskyy](#)

Here are set up instructions for some other common OAuth providers. Third-party NuGet packages such as the ones maintained by [aspnet-contrib](#) can be used to complement authentication providers implemented by the ASP.NET Core team.

- Set up **LinkedIn** sign in: <https://www.linkedin.com/developer/apps>. See [official steps](#).
- Set up **Instagram** sign in: <https://www.instagram.com/developer/register/>. See [official steps](#).
- Set up **Reddit** sign in: <https://www.reddit.com/login?dest=https%3A%2F%2Fwww.reddit.com%2Fprefs%2Fapps>. See [official steps](#).
- Set up **Github** sign in: [https://github.com/login?return\\_to=https%3A%2F%2Fgithub.com%2Fsettings%2Fapplications%2Fnew](https://github.com/login?return_to=https%3A%2F%2Fgithub.com%2Fsettings%2Fapplications%2Fnew). See [official steps](#).
- Set up **Yahoo** sign in: <https://login.yahoo.com/config/login?src=devnet&.done=http%3A%2F%2Fdeveloper.yahoo.com%2Fapps%2Fcreate%2F>. See [official steps](#).
- Set up **Tumblr** sign in: <https://www.tumblr.com/oauth/apps>. See [official steps](#).
- Set up **Pinterest** sign in: <https://www.pinterest.com/login/?next=http%3A%2F%2Fdevsite%2Fapps%2F>. See [official steps](#).
- Set up **Pocket** sign in: <https://getpocket.com/developer/apps/new>. See [official steps](#).
- Set up **Flickr** sign in: <https://www.flickr.com/services/apps/create>. See [official steps](#).
- Set up **Dribbble** sign in: <https://dribbble.com/signup>. See [official steps](#).
- Set up **Vimeo** sign in: <https://vimeo.com/join>. See [official steps](#).
- Set up **SoundCloud** sign in: <https://soundcloud.com/you/apps/new>. See [official steps](#).
- Set up **VK** sign in: <https://vk.com/apps?act=manage>. See [official steps](#).

## Multiple authentication providers

When the app requires multiple providers, chain the provider extension methods behind `AddAuthentication`:

```
services.AddAuthentication()
    .AddMicrosoftAccount(microsoftOptions => { ... })
    .AddGoogle(googleOptions => { ... })
    .AddTwitter(twitterOptions => { ... })
    .AddFacebook(facebookOptions => { ... });
```

# Authenticate users with WS-Federation in ASP.NET Core

6/21/2018 • 3 minutes to read • [Edit Online](#)

This tutorial demonstrates how to enable users to sign in with a WS-Federation authentication provider like Active Directory Federation Services (ADFS) or [Azure Active Directory](#) (AAD). It uses the ASP.NET Core 2.0 sample app described in [Facebook, Google, and external provider authentication](#).

For ASP.NET Core 2.0 apps, WS-Federation support is provided by [Microsoft.AspNetCore.Authentication.WsFederation](#). This component is ported from [Microsoft.Owin.Security.WsFederation](#) and shares many of that component's mechanics. However, the components differ in a couple of important ways.

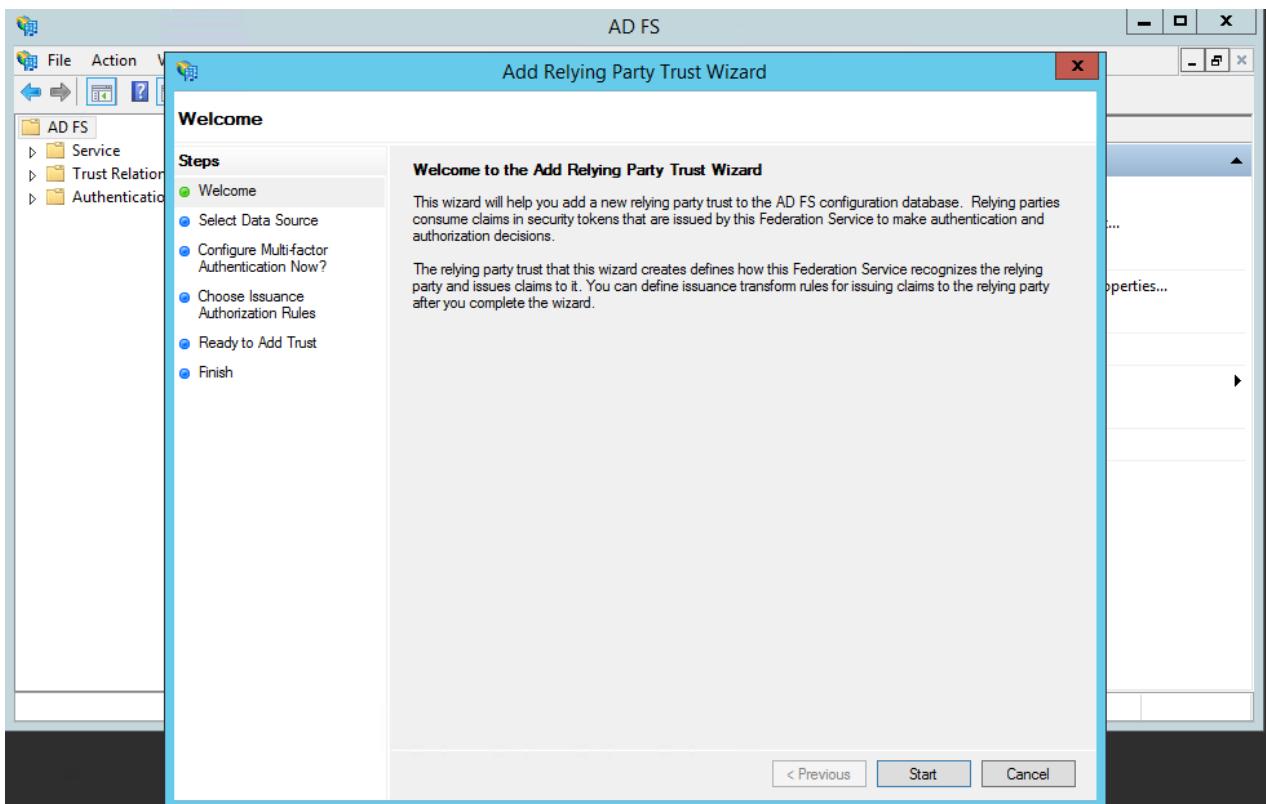
By default, the new middleware:

- Doesn't allow unsolicited logins. This feature of the WS-Federation protocol is vulnerable to XSS attacks. However, it can be enabled with the `AllowUnsolicitedLogins` option.
- Doesn't check every form post for sign-in messages. Only requests to the `CallbackPath` are checked for sign-ins. `CallbackPath` defaults to `/signin-wsfed` but can be changed via the inherited [RemoteAuthenticationOptions.CallbackPath](#) property of the [WsFederationOptions](#) class. This path can be shared with other authentication providers by enabling the [SkipUnrecognizedRequests](#) option.

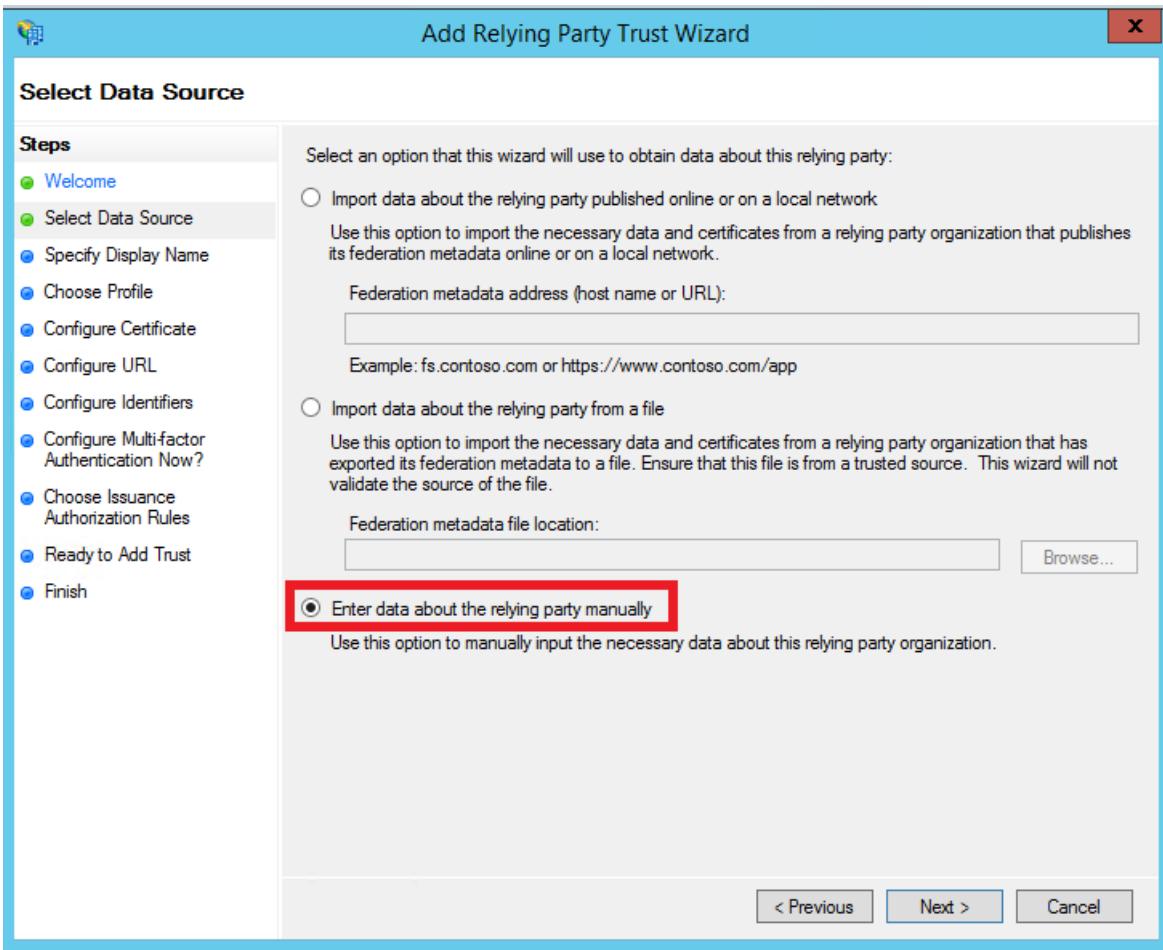
## Register the app with Active Directory

### Active Directory Federation Services

- Open the server's **Add Relying Party Trust Wizard** from the ADFS Management console:



- Choose to enter data manually:

 Add Relying Party Trust Wizard

### Select Data Source

**Steps**

- Welcome
- Select Data Source
- Specify Display Name
- Choose Profile
- Configure Certificate
- Configure URL
- Configure Identifiers
- Configure Multi-factor Authentication Now?
- Choose Issuance Authorization Rules
- Ready to Add Trust
- Finish

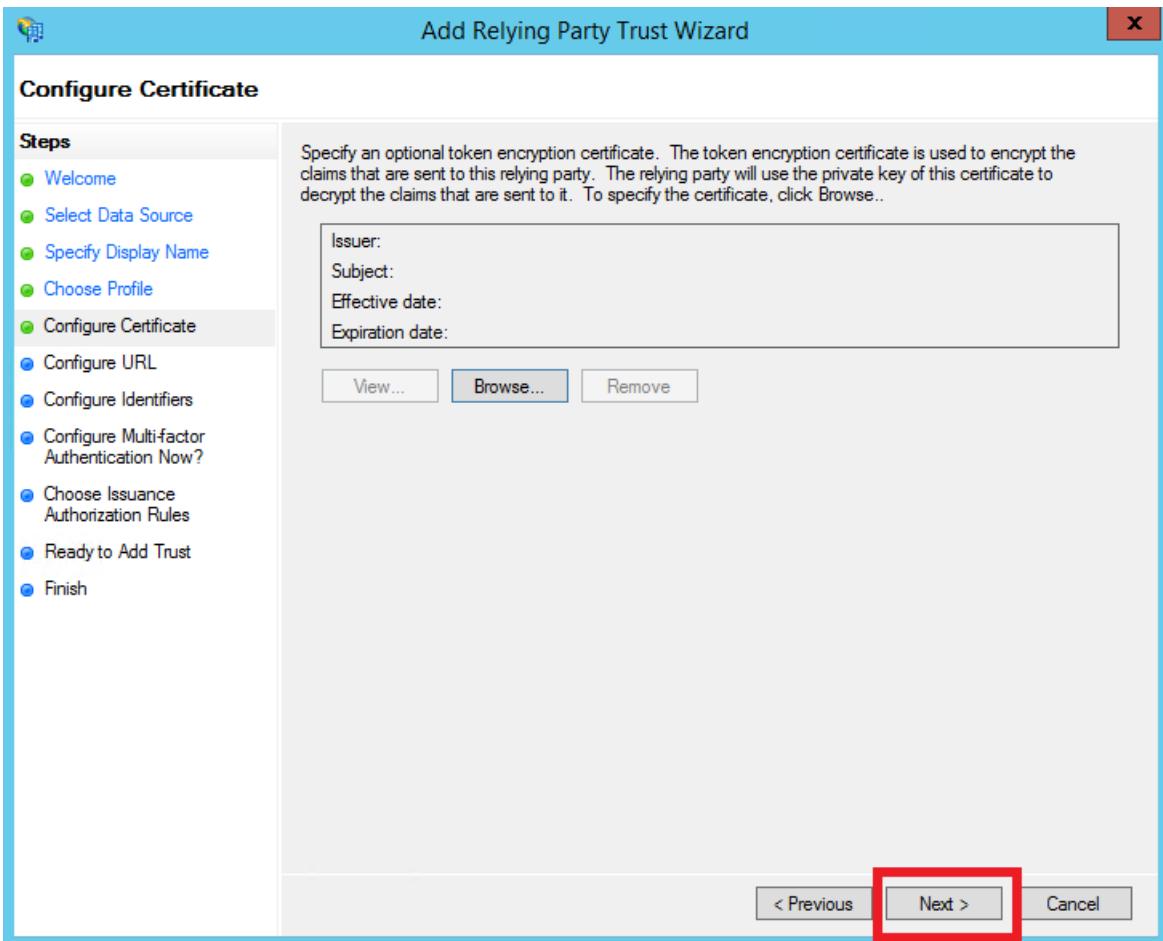
Select an option that this wizard will use to obtain data about this relying party:

Import data about the relying party published online or on a local network  
Use this option to import the necessary data and certificates from a relying party organization that publishes its federation metadata online or on a local network.  
Federation metadata address (host name or URL):  
  
Example: fs.contoso.com or https://www.contoso.com/app

Import data about the relying party from a file  
Use this option to import the necessary data and certificates from a relying party organization that has exported its federation metadata to a file. Ensure that this file is from a trusted source. This wizard will not validate the source of the file.  
Federation metadata file location:

Enter data about the relying party manually  
Use this option to manually input the necessary data about this relying party organization.

- Enter a display name for the relying party. The name isn't important to the ASP.NET Core app.
- [Microsoft.AspNetCore.Authentication.WsFederation](#) lacks support for token encryption, so don't configure a token encryption certificate:

 Add Relying Party Trust Wizard

### Configure Certificate

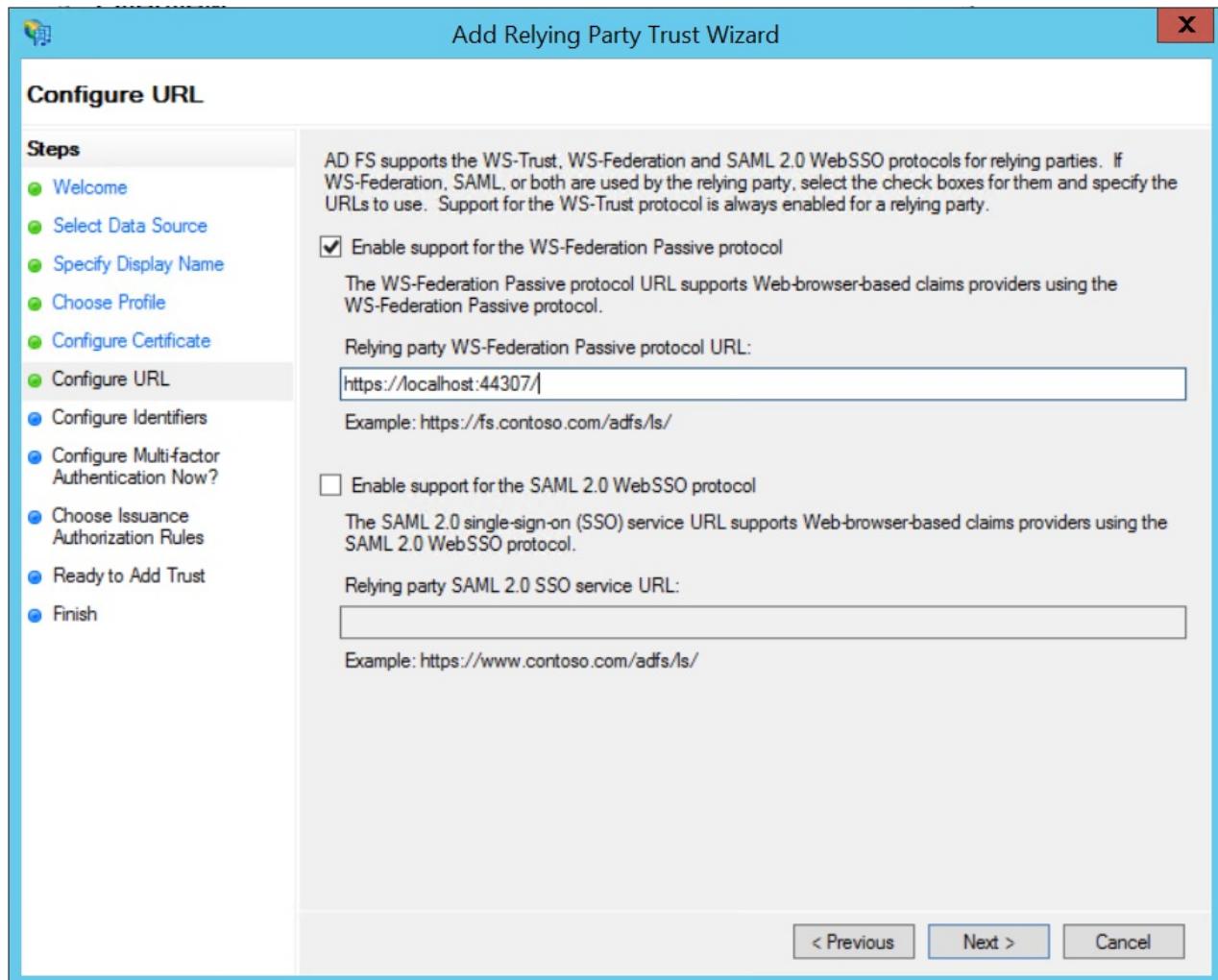
**Steps**

- Welcome
- Select Data Source
- Specify Display Name
- Choose Profile
- Configure Certificate
- Configure URL
- Configure Identifiers
- Configure Multi-factor Authentication Now?
- Choose Issuance Authorization Rules
- Ready to Add Trust
- Finish

Specify an optional token encryption certificate. The token encryption certificate is used to encrypt the claims that are sent to this relying party. The relying party will use the private key of this certificate to decrypt the claims that are sent to it. To specify the certificate, click Browse..

Issuer:  
  
Subject:  
  
Effective date:  
  
Expiration date:

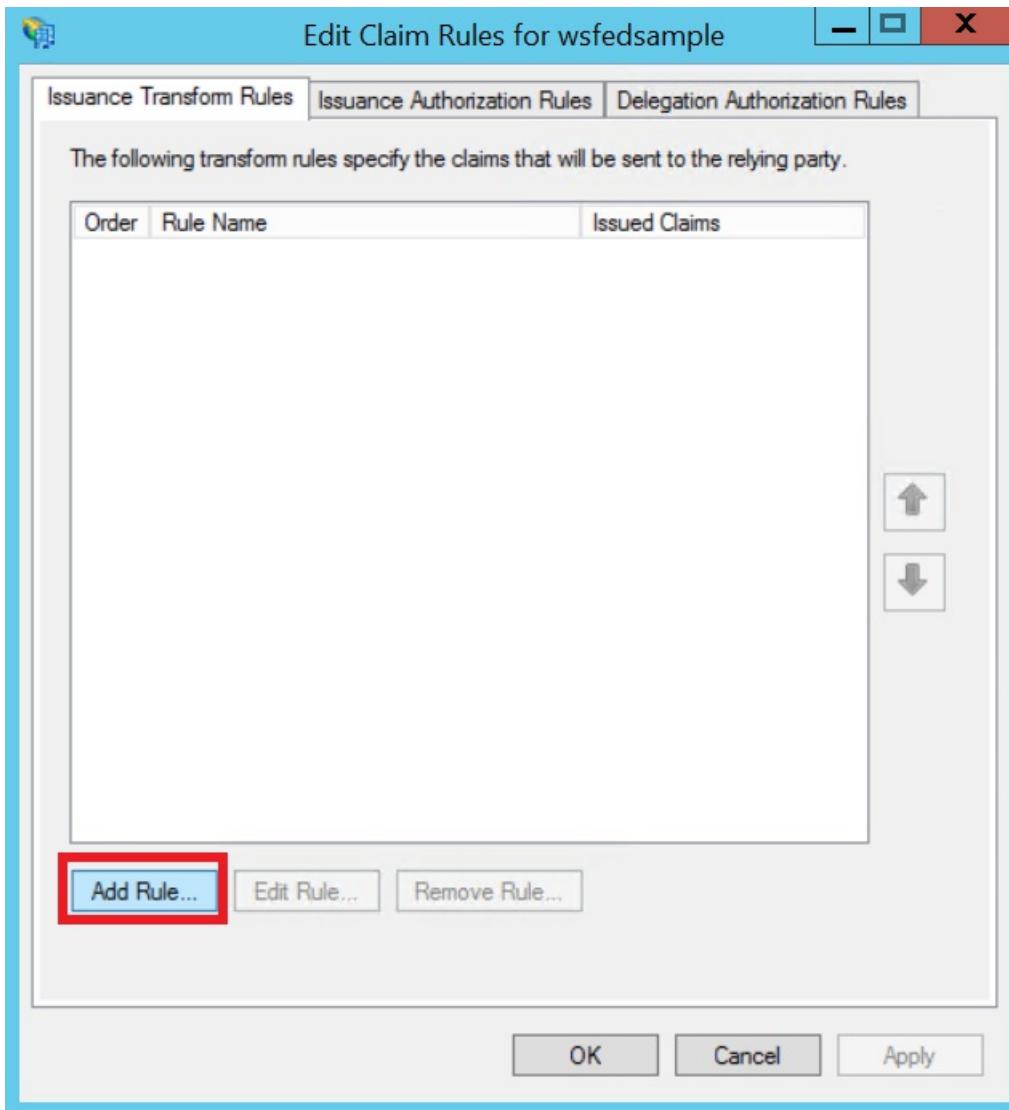
- Enable support for WS-Federation Passive protocol, using the app's URL. Verify the port is correct for the app:



#### NOTE

This must be an HTTPS URL. IIS Express can provide a self-signed certificate when hosting the app during development. Kestrel requires manual certificate configuration. See the [Kestrel documentation](#) for more details.

- Click **Next** through the rest of the wizard and **Close** at the end.
- ASP.NET Core Identity requires a **Name ID** claim. Add one from the **Edit Claim Rules** dialog:



- In the **Add Transform Claim Rule Wizard**, leave the default **Send LDAP Attributes as Claims** template selected, and click **Next**. Add a rule mapping the **SAM-Account-Name** LDAP attribute to the **Name ID** outgoing claim:

Add Transform Claim Rule Wizard

### Configure Rule

**Steps**

- Choose Rule Type
- Configure Claim Rule

You can configure this rule to send the values of LDAP attributes as claims. Select an attribute store from which to extract LDAP attributes. Specify how the attributes will map to the outgoing claim types that will be issued from the rule.

Claim rule name:

Rule template: Send LDAP Attributes as Claims

Attribute store:

Mapping of LDAP attributes to outgoing claim types:

LDAP Attribute (Select or type to add more)	Outgoing Claim Type (Select or type to add more)
SAM-Account-Name	Name ID
*	*

< Previous            Cancel

- Click **Finish** > **OK** in the **Edit Claim Rules** window.

### Azure Active Directory

- Navigate to the AAD tenant's app registrations blade. Click **New application registration**:

Home > wsfedsample - App registrations

wsfedsample - App registrations

Overview    Endpoints    Troubleshoot

+ New application registration

To view and manage your registrations for converged applications, please visit the [Microsoft Application Console](#).

Search by name or AppID    My apps

DISPLAY NAME	APPLICATION TYPE	APPLICATION ID
No results.		

Quick start    Users    Groups    Enterprise applications    Devices    App registrations    Application proxy

- Enter a name for the app registration. This isn't important to the ASP.NET Core app.
- Enter the URL the app listens on as the **Sign-on URL**:



\* Name ⓘ

wsfedsample



Application type ⓘ

Web app / API



\* Sign-on URL ⓘ

https://localhost:44307



Create

- Click **Endpoints** and note the **Federation Metadata Document** URL. This is the WS-Federation middleware's `MetadataAddress`:

New application registration   **Endpoints**   Troubleshoot

To view and manage your registrations for converged applications, please visit the Microsoft [Application Console](#).

Search by name or AppId   All apps

DISPLAY NAME	APPLICATION TYPE	APPLICATION ID
WS wsfedsample	Web app / API	adc50fba-9ac5-43cd-9d40-bb7...

**FEDERATION METADATA DOCUMENT**  
https://login.microsoftonline.com/39afe...

**WS-FEDERATION SIGN-ON ENDPOINT**  
https://login.microsoftonline.com/39af...

**SAML-P SIGN-ON ENDPOINT**

- Navigate to the new app registration. Click **Settings > Properties** and make note of the **App ID URI**. This is the WS-Federation middleware's `Wtrealm`:

## Add WS-Federation as an external login provider for ASP.NET Core Identity

- Add a dependency on [Microsoft.AspNetCore.Authentication.WsFederation](#) to the project.
- Add WS-Federation to the `Configure` method in *Startup.cs*:

```

services.AddIdentity<ApplicationUser, IdentityRole>()
    .AddEntityFrameworkStores<ApplicationContext>()
    .AddDefaultTokenProviders();

services.AddAuthentication()
    .AddWsFederation(options =>
{
    // MetadataAddress represents the Active Directory instance used to authenticate users.
    options.MetadataAddress = "https://<ADFS FQDN or AAD tenant>/FederationMetadata/2007-
    06/FederationMetadata.xml";

    // Wtrealm is the app's identifier in the Active Directory instance.
    // For ADFS, use the relying party's identifier, its WS-Federation Passive protocol URL:
    options.Wtrealm = "https://localhost:44307/";

    // For AAD, use the App ID URI from the app registration's Properties blade:
    options.Wtrealm = "https://wsfedsample.onmicrosoft.com/bf0e7e6d-056e-4e37-b9a6-2c36797b9f01";
});

services.AddMvc()
// ...

```

The call to `AddIdentity` configures the default scheme settings. The `AddAuthentication(String)` overload sets the `DefaultScheme` property. The `AddAuthentication(Action<AuthenticationOptions>)` overload allows configuring authentication options, which can be used to set up default authentication schemes for different purposes. Subsequent calls to `AddAuthentication` override previously configured `AuthenticationOptions` properties.

`AuthenticationBuilder` extension methods that register an authentication handler may only be called once per authentication scheme. Overloads exist that allow configuring the scheme properties, scheme name, and display name.

### Log in with WS-Federation

Browse to the app and click the **Log in** link in the nav header. There's an option to log in with WsFederation:

## Log in

Use a local account to log in.

Email

WsFederation

[Log in using your WsFederation account](#)

Password

Remember me?

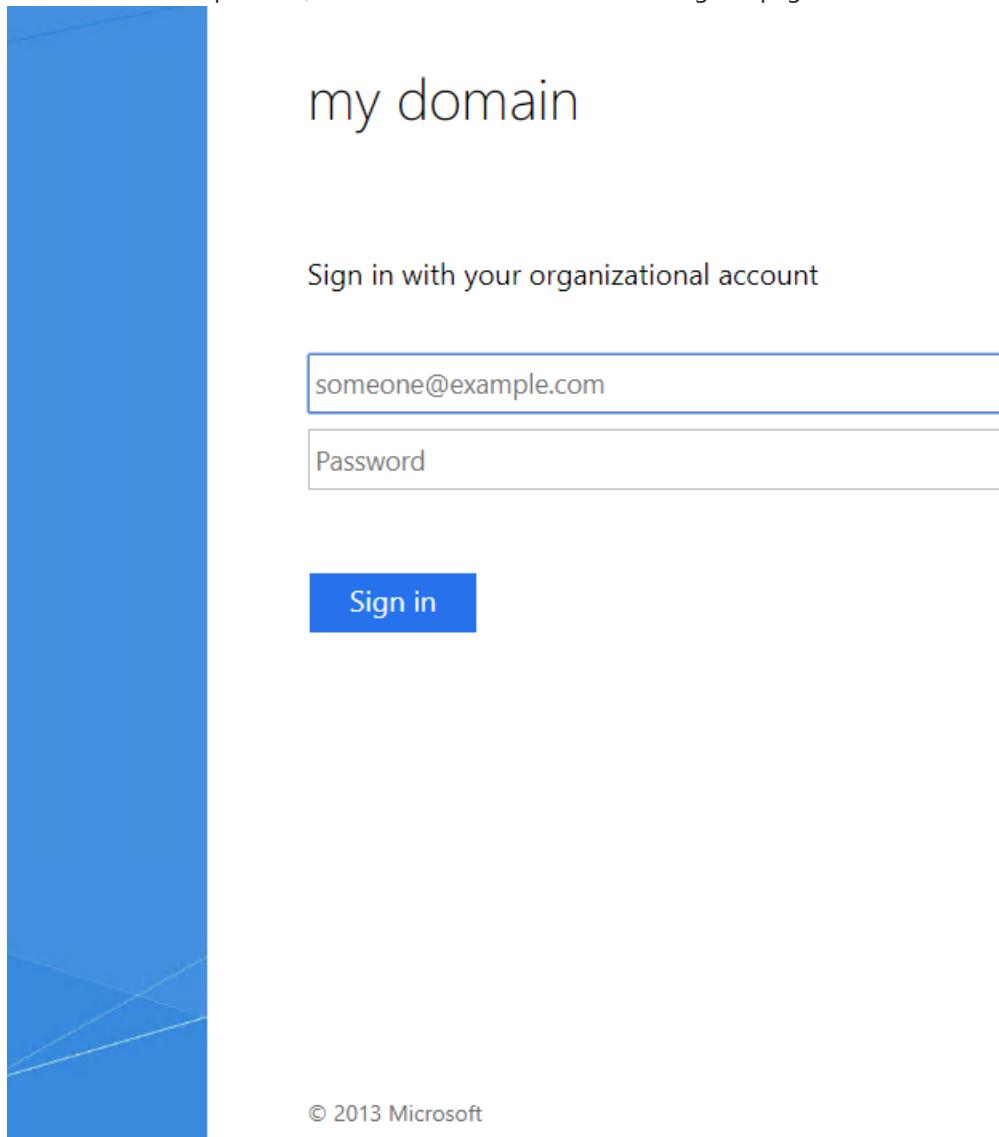
[Log in](#)

[Forgot your password?](#)

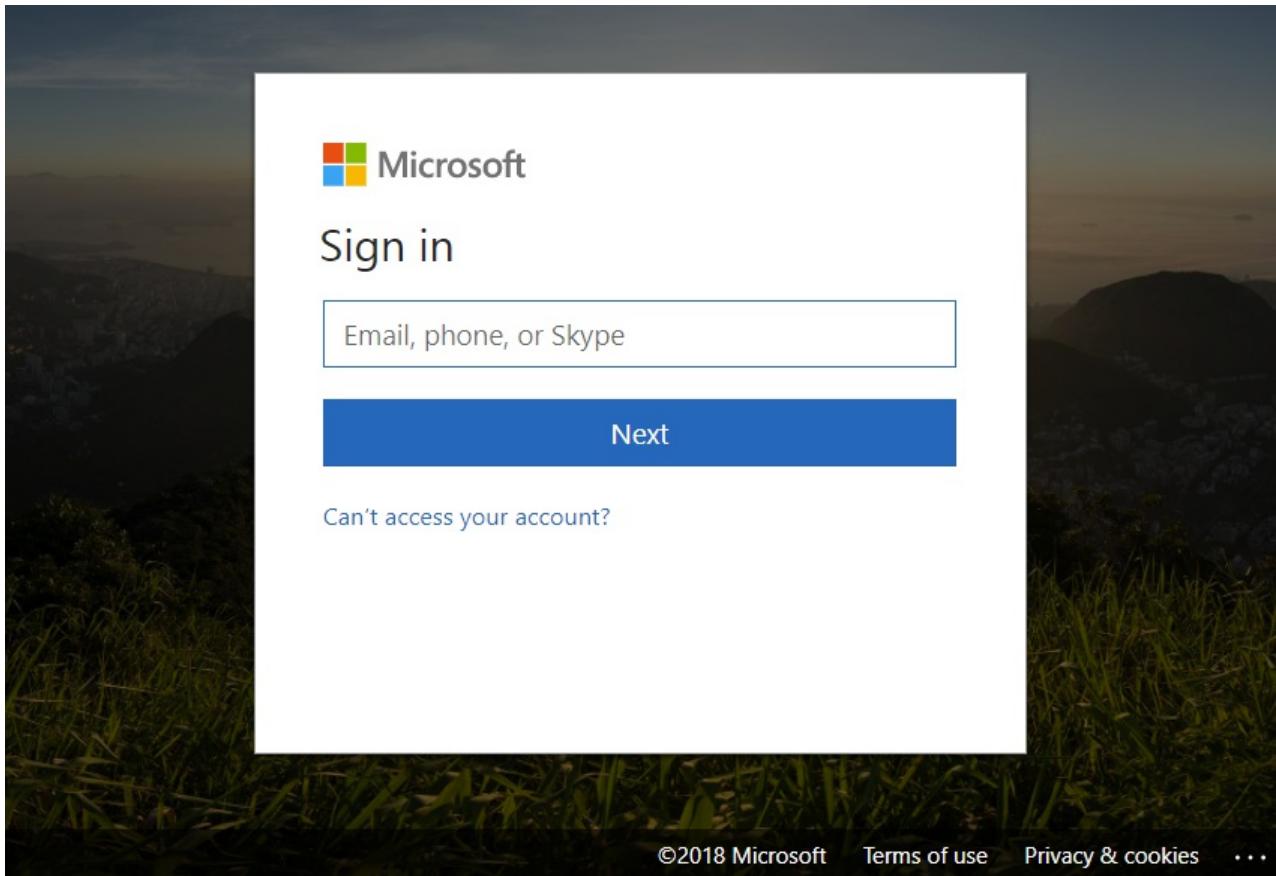
[Register as a new user](#)

Use another service to log in.

With ADFS as the provider, the button redirects to an ADFS sign-in page:



With Azure Active Directory as the provider, the button redirects to an AAD sign-in page:



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A successful sign-in for a new user redirects to the app's user registration page:



## Register

Associate your WsFederation account.

You've successfully authenticated with **WsFederation**. Please enter an email address for this site below and click the Register button to finish logging in.

Email

[Register](#)

## Use WS-Federation without ASP.NET Core Identity

The WS-Federation middleware can be used without Identity. For example:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddAuthentication(sharedOptions =>
    {
        sharedOptions.DefaultScheme = CookieAuthenticationDefaults.AuthenticationScheme;
        sharedOptions.DefaultSignInScheme = CookieAuthenticationDefaults.AuthenticationScheme;
        sharedOptions.DefaultChallengeScheme = WsFederationDefaults.AuthenticationScheme;
    })
    .AddWsFederation(options =>
    {
        options.Wtrealm = Configuration["wsfed:realm"];
        options.MetadataAddress = Configuration["wsfed:metadata"];
    })
    .AddCookie();
}

public void Configure(IApplicationBuilder app)
{
    app.UseAuthentication();
    // ...
}
```

See [this PDF file](#) for the ASP.NET Core 1.1 and 2.1 version.

# Account confirmation and password recovery in ASP.NET Core

By [Rick Anderson](#) and [Joe Audette](#)

This tutorial shows how to build an ASP.NET Core app with email confirmation and password reset. This tutorial is **not** a beginning topic. You should be familiar with:

- [ASP.NET Core](#)
- [Authentication](#)
- [Entity Framework Core](#)

## Prerequisites

[.NET Core 2.1 SDK or later](#)

## Create a web app and scaffold Identity

- [Visual Studio](#)
- [.NET Core CLI](#)
- In Visual Studio, create a new **Web Application** project.
- Select **ASP.NET Core 2.1**.
- Keep the default **Authentication** set to **No Authentication**. Authentication is added in the next step.

In the next step:

- Set the layout page to `~/Pages/Shared/_Layout.cshtml`
- Select `Account/Register`
- Create a new **Data context class**

Follow the instructions in [Enable authentication](#):

- Add `app.UseAuthentication();` to `Startup.Configure`
- Add `<partial name="_LoginPartial" />` to the layout file.

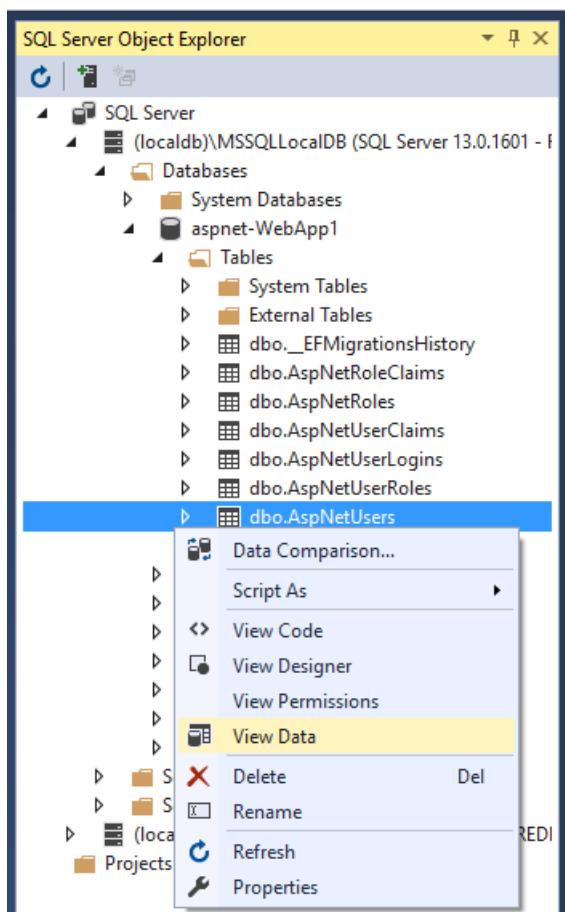
## Test new user registration

Run the app, select the **Register** link, and register a user. At this point, the only validation on the email is with the [\[EmailAddress\]](#) attribute. After submitting the registration, you are logged into the app. Later in the tutorial, the code is updated so new users can't log in until their email is validated.

## View the Identity database

- [Visual Studio](#)
- [.NET Core CLI](#)

- From the **View** menu, select **SQL Server Object Explorer** (SSOX).
- Navigate to **(localdb)\MSSQLLocalDB(SQL Server 13)**. Right-click on **dbo.AspNetUsers** > **View Data**:



Note the table's `EmailConfirmed` field is `False`.

You might want to use this email again in the next step when the app sends a confirmation email. Right-click on the row and select **Delete**. Deleting the email alias makes it easier in the following steps.

## Require email confirmation

It's a best practice to confirm the email of a new user registration. Email confirmation helps to verify they're not impersonating someone else (that is, they haven't registered with someone else's email). Suppose you had a discussion forum, and you wanted to prevent "yli@example.com" from registering as "nolivetto@contoso.com". Without email confirmation, "nolivetto@contoso.com" could receive unwanted email from your app. Suppose the user accidentally registered as "ylo@example.com" and hadn't noticed the misspelling of "yli". They wouldn't be able to use password recovery because the app doesn't have their correct email. Email confirmation provides limited protection from bots. Email confirmation doesn't provide protection from malicious users with many email accounts.

You generally want to prevent new users from posting any data to your web site before they have a confirmed email.

Update `Areas/Identity/IdentityHostingStartup.cs` to require a confirmed email:

```

public class IdentityHostingStartup : IHostingStartup
{
    public void Configure(IWebHostBuilder builder)
    {
        builder.ConfigureServices((context, services) => {
            services.AddDbContext<WebPWrecoverContext>(options =>
                options.UseSqlServer(
                    context.Configuration.GetConnectionString("WebPWrecoverContextConnection")));
            services.AddDefaultIdentity<IdentityUser>(config =>
            {
                config.SignIn.RequireConfirmedEmail = true;
            })
            .AddEntityFrameworkStores<WebPWrecoverContext>();
        });
    }
}

```

`config.SignIn.RequireConfirmedEmail = true;` prevents registered users from logging in until their email is confirmed.

## Configure email provider

In this tutorial, [SendGrid](#) is used to send email. You need a SendGrid account and key to send email. You can use other email providers. ASP.NET Core 2.x includes `System.Net.Mail`, which allows you to send email from your app. We recommend you use SendGrid or another email service to send email. SMTP is difficult to secure and set up correctly.

The [Options pattern](#) is used to access the user account and key settings. For more information, see [configuration](#).

Create a class to fetch the secure email key. For this sample, create `Services/AuthMessageSenderOptions.cs`:

```

public class AuthMessageSenderOptions
{
    public string SendGridUser { get; set; }
    public string SendGridKey { get; set; }
}

```

## Configure SendGrid user secrets

Add a unique `<UserSecretsId>` value to the `<PropertyGroup>` element of the project file:

```

<Project Sdk="Microsoft.NET.Sdk.Web">

    <PropertyGroup>
        <TargetFramework>netcoreapp2.1</TargetFramework>
        <UserSecretsId>aspnet-WebPWrecover-1234</UserSecretsId>
    </PropertyGroup>

    <ItemGroup>
        <PackageReference Include="Microsoft.AspNetCore.App" Version="2.1.1" />
        <PackageReference Include="Microsoft.VisualStudio.Web.CodeGeneration.Design" Version="2.1.1" />
        <PackageReference Include="SendGrid" Version="9.9.0" />
    </ItemGroup>

</Project>

```

Set the `SendGridUser` and `SendGridKey` with the [secret-manager tool](#). For example:

```

C:/WebApp>dotnet user-secrets set SendGridUser RickAndMSFT
info: Successfully saved SendGridUser = RickAndMSFT to the secret store.

```

On Windows, Secret Manager stores keys/value pairs in a `secrets.json` file in the `%APPDATA%/Microsoft/UserSecrets/<WebAppName-userSecretsId>` directory.

The contents of the `secrets.json` file aren't encrypted. The `secrets.json` file is shown below (the `SendGridKey` value has been removed.)

```
{  
  "SendGridUser": "RickAndMSFT",  
  "SendGridKey": "<key removed>"  
}
```

## Install SendGrid

This tutorial shows how to add email notifications through [SendGrid](#), but you can send email using SMTP and other mechanisms.

Install the `SendGrid` NuGet package:

- [Visual Studio](#)
- [.NET Core CLI](#)

From the Package Manager Console, enter the following command:

```
Install-Package SendGrid
```

See [Get Started with SendGrid for Free](#) to register for a free SendGrid account.

## Implement `IEmailSender`

To Implement `IEmailSender`, create `Services/EmailSender.cs` with code similar to the following:

```

using Microsoft.AspNetCore.Identity.UI.Services;
using Microsoft.Extensions.Options;
using SendGrid;
using SendGrid.Helpers.Mail;
using System.Threading.Tasks;

namespace WebPWrecover.Services
{
    public class EmailSender : IEmailSender
    {
        public EmailSender(IOptions<AuthMessageSenderOptions> optionsAccessor)
        {
            Options = optionsAccessor.Value;
        }

        public AuthMessageSenderOptions Options { get; } //set only via Secret Manager

        public Task SendEmailAsync(string email, string subject, string message)
        {
            return Execute(Options.SendGridKey, subject, message, email);
        }

        public Task Execute(string apiKey, string subject, string message, string email)
        {
            var client = new SendGridClient(apiKey);
            var msg = new SendGridMessage()
            {
                From = new EmailAddress("Joe@contoso.com", "Joe Smith"),
                Subject = subject,
                PlainTextContent = message,
                HtmlContent = message
            };
            msg.AddTo(new EmailAddress(email));

            // Disable click tracking.
            // See https://sendgrid.com/docs/User_Guide/Settings/tracking.html
            msg.TrackingSettings = new TrackingSettings
            {
                ClickTracking = new ClickTracking { Enable = false }
            };

            return client.SendEmailAsync(msg);
        }
    }
}

```

## Configure startup to support email

Add the following code to the `ConfigureServices` method in the `Startup.cs` file:

- Add `EmailSender` as a singleton service.
- Register the `AuthMessageSenderOptions` configuration instance.

```
public void ConfigureServices(IServiceCollection services)
{
    services.Configure<CookiePolicyOptions>(options =>
    {
        options.CheckConsentNeeded = context => true;
        options.MinimumSameSitePolicy = SameSiteMode.None;
    });

    services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1);

    // requires
    // using Microsoft.AspNetCore.Identity.UI.Services;
    // using WebPWrecover.Services;
    services.AddSingleton<IEmailSender, EmailSender>();
    services.Configure<AuthMessageSenderOptions>(Configuration);
}
```

## Enable account confirmation and password recovery

The template has the code for account confirmation and password recovery. Find the `OnPostAsync` method in `Areas/Identity/Pages/Account/Register.cshtml.cs`.

Prevent newly registered users from being automatically logged on by commenting out the following line:

```
await _signInManager.SignInAsync(user, isPersistent: false);
```

The complete method is shown with the changed line highlighted:

```

public async Task<IActionResult> OnPostAsync(string returnUrl = null)
{
    returnUrl = returnUrl ?? Url.Content("~/");
    if (ModelState.IsValid)
    {
        var user = new IdentityUser { UserName = Input.Email, Email = Input.Email };
        var result = await _userManager.CreateAsync(user, Input.Password);
        if (result.Succeeded)
        {
            _logger.LogInformation("User created a new account with password.");
            var code = await _userManager.GenerateEmailConfirmationTokenAsync(user);
            var callbackUrl = Url.Page(
                "/Account/ConfirmEmail",
                pageHandler: null,
                values: new { userId = user.Id, code = code },
                protocol: Request.Scheme);

            await _emailSender.SendEmailAsync(Input.Email, "Confirm your email",
                $"Please confirm your account by <a href='{HtmlEncoder.Default.Encode(callbackUrl)}'>clicking here</a>.");
            // await _signInManager.SignInAsync(user, isPersistent: false);
            return LocalRedirect(returnUrl);
        }
        foreach (var error in result.Errors)
        {
            ModelState.AddModelError(string.Empty, error.Description);
        }
    }

    // If we got this far, something failed, redisplay form
    return Page();
}

```

## Register, confirm email, and reset password

Run the web app, and test the account confirmation and password recovery flow.

- Run the app and register a new user

Register - WebApplication1 X +

localhost:10801/Account/Register

WebApplication1 Home About Contact Register Log in

# Register.

Create a new account.

---

Email

Password

Confirm password

---

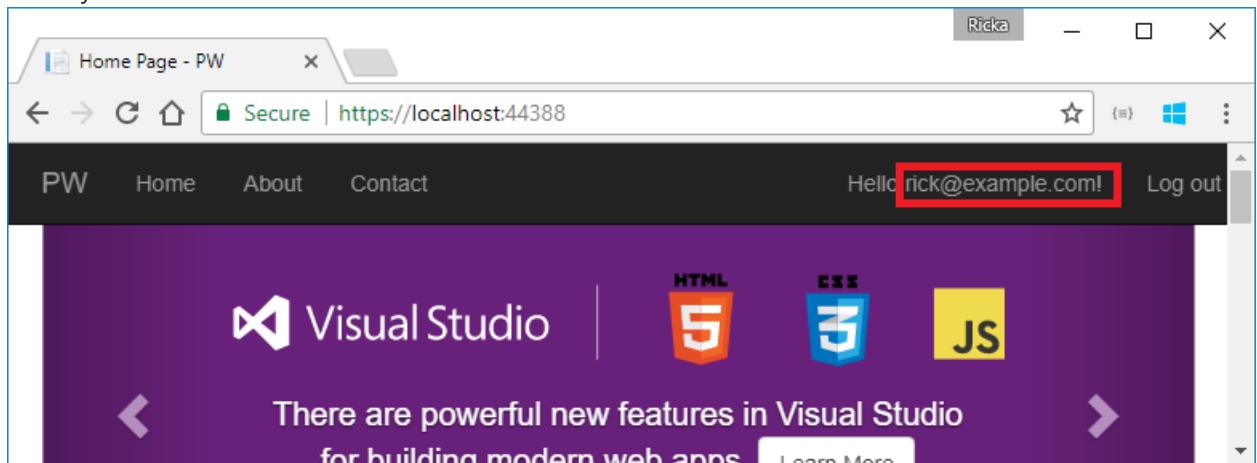
© 2015 - WebApplication1

The 'Register' button is highlighted with a yellow box.

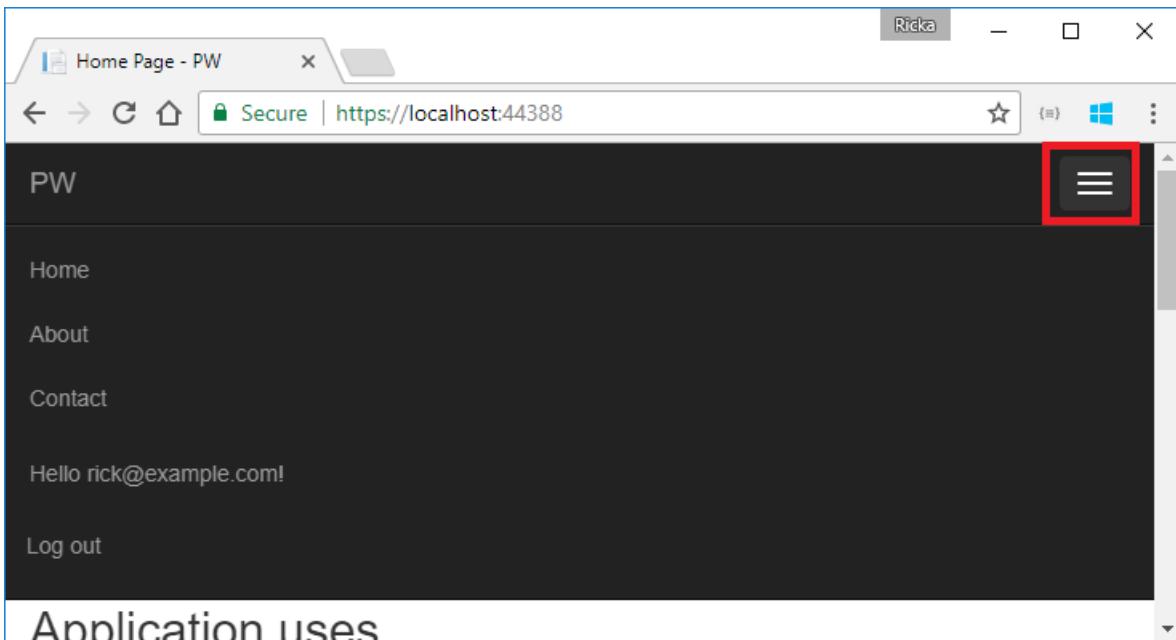
- Check your email for the account confirmation link. See [Debug email](#) if you don't get the email.
- Click the link to confirm your email.
- Log in with your email and password.
- Log off.

### View the manage page

Select your user name in the browser:



You might need to expand the navbar to see user name.



The manage page is displayed with the **Profile** tab selected. The **Email** shows a check box indicating the email has been confirmed.

### Test password reset

- If you're logged in, select **Logout**.
- Select the **Log in** link and select the **Forgot your password?** link.
- Enter the email you used to register the account.
- An email with a link to reset your password is sent. Check your email and click the link to reset your password. After your password has been successfully reset, you can log in with your email and new password.

### Debug email

If you can't get email working:

- Set a breakpoint in `EmailSender.Execute` to verify `SendGridClient.SendEmailAsync` is called.
- Create a [console app to send email](#) using similar code to `EmailSender.Execute`.
- Review the [Email Activity](#) page.
- Check your spam folder.
- Try another email alias on a different email provider (Microsoft, Yahoo, Gmail, etc.)
- Try sending to different email accounts.

A **security best practice** is to **not** use production secrets in test and development. If you publish the app to Azure, you can set the SendGrid secrets as application settings in the Azure Web App portal. The configuration system is set up to read keys from environment variables.

## Combine social and local login accounts

To complete this section, you must first enable an external authentication provider. See [Facebook, Google, and external provider authentication](#).

You can combine local and social accounts by clicking on your email link. In the following sequence, "RickAndMSFT@gmail.com" is first created as a local login; however, you can create the account as a social login first, then add a local login.

The screenshot shows a web browser window with the title bar "Home Page - Web1". The address bar displays "localhost:1234". The navigation bar includes links for "Web1", "Home", "About", and "Contact". On the right side of the navigation bar, there is a "Hello rickandmsft@gmail.com!" message and a "Log off" link, both highlighted with a yellow box. The main content area features the text "ASP.NET 5" and "Windows Linux OSX" followed by a call-to-action: "Learn how to build ASP.NET apps that can run anywhere." A "Learn More" button is present. Below this, there is a small circular progress indicator.

**Application uses**

- Sample pages using ASP.NET 5 (MVC 6)
- [Gulp](#) and [Bower](#) for managing client-side resources
- Theming using [Bootstrap](#)

**New concepts**

- [Conceptual overview of ASP.NET 5](#)

Click on the **Manage** link. Note the 0 external (social logins) associated with this account.

The screenshot shows a web browser window with the title bar "Manage your account - Web1". The address bar displays "localhost:1234/Manage". The navigation bar includes links for "Web1", "Home", "About", and "Contact". On the right side of the navigation bar, there is a "Hello rickandmsft@gmail.com!" message and a "Log off" link. The main content area has a heading "Manage your account." and a sub-section "Change your account settings". It lists several account management options:

- Password: [ [Change](#) ]
- External Logins: 0 [[Manage](#)] (This link is highlighted with a red box.)
- Phone Number: Phone Numbers can be used as a second factor of verification in two-factor authentication. See [this article](#) for details on setting up this ASP.NET application to support two-factor authentication using SMS.
- Two-Factor Authentic...: There are no two-factor authentication providers configured. See [this article](#) for setting up this application to support two-factor authentication.

Click the link to another login service and accept the app requests. In the following image, Facebook is the external authentication provider:

The screenshot shows a web browser window with the title bar "Web1". The navigation bar includes links for "Home", "About", and "Contact". On the right side of the navigation bar, there is a user name "rickandmsft@gmail.com!" and a "Log out" link. The main content area has a heading "Manage your external logins." and a sub-section "Registered Logins". It lists the registered login provider "Facebook".

The two accounts have been combined. You are able to log on with either account. You might want your users to add local accounts in case their social login authentication service is down, or more likely they've lost access to their social account.

## Enable account confirmation after a site has users

Enabling account confirmation on a site with users locks out all the existing users. Existing users are locked out because their accounts aren't confirmed. To work around existing user lockout, use one of the following approaches:

- Update the database to mark all existing users as being confirmed.
- Confirm exiting users. For example, batch-send emails with confirmation links.

# Enable QR Code generation for TOTP authenticator apps in ASP.NET Core

6/28/2018 • 2 minutes to read • [Edit Online](#)

ASP.NET Core ships with support for authenticator applications for individual authentication. Two factor authentication (2FA) authenticator apps, using a Time-based One-time Password Algorithm (TOTP), are the industry recommended approach for 2FA. 2FA using TOTP is preferred to SMS 2FA. An authenticator app provides a 6 to 8 digit code which users must enter after confirming their username and password. Typically an authenticator app is installed on a smart phone.

The ASP.NET Core web app templates support authenticators, but don't provide support for QRCode generation. QRCode generators ease the setup of 2FA. This document will guide you through adding [QR Code](#) generation to the 2FA configuration page.

## Adding QR Codes to the 2FA configuration page

These instructions use `qrcode.js` from the <https://davidshimjs.github.io/qrcodejs/> repo.

- Download the [qrcode.js javascript library](#) to the `wwwroot\lib` folder in your project.
- In `Pages\Account\Manage\EnableAuthenticator.cshtml` (Razor Pages) or `Views\Manage\EnableAuthenticator.cshtml` (MVC), locate the `Scripts` section at the end of the file:

```
@section Scripts {
    @await Html.PartialAsync("_ValidationScriptsPartial")
}
```

- Update the `Scripts` section to add a reference to the `qrcodejs` library you added and a call to generate the QR Code. It should look as follows:

```
@section Scripts {
    @await Html.PartialAsync("_ValidationScriptsPartial")

    <script type="text/javascript" src="~/lib/qrcode.js"></script>
    <script type="text/javascript">
        new QRCode(document.getElementById("qrCode"),
        {
            text: "@Html.Raw(Model.AuthenticatorUri)",
            width: 150,
            height: 150
        });
    </script>
}
```

- Delete the paragraph which links you to these instructions.

Run your app and ensure that you can scan the QR code and validate the code the authenticator proves.

## Change the site name in the QR Code

The site name in the QR Code is taken from the project name you choose when initially creating your project. You can change it by looking for the `GenerateQrCodeUri(string email, string unformattedKey)` method in the

*Pages\Account\Manage\EnableAuthenticator.cshtml.cs* (Razor Pages) file or the *Controllers\ManageController.cs* (MVC) file.

The default code from the template looks as follows:

```
private string GenerateQrCodeUri(string email, string unformattedKey)
{
    return string.Format(
        AuthenticatorUriFormat,
        _urlEncoder.Encode("Razor Pages"),
        _urlEncoder.Encode(email),
        unformattedKey);
}
```

The second parameter in the call to `string.Format` is your site name, taken from your solution name. It can be changed to any value, but it must always be URL encoded.

## Using a different QR Code library

You can replace the QR Code library with your preferred library. The HTML contains a `qrCode` element into which you can place a QR Code by whatever mechanism your library provides.

The correctly formatted URL for the QR Code is available in the:

- `AuthenticatorUri` property of the model.
- `data-url` property in the `qrCodeData` element.

## TOTP client and server time skew

TOTP (Time-based One-Time Password) authentication depends on both the server and authenticator device having an accurate time. Tokens only last for 30 seconds. If TOTP 2FA logins are failing, check that the server time is accurate, and preferably synchronized to an accurate NTP service.

# Two-factor authentication with SMS in ASP.NET Core

6/28/2018 • 5 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Swiss-Devs](#)

Two factor authentication (2FA) authenticator apps, using a Time-based One-time Password Algorithm (TOTP), are the industry recommended approach for 2FA. 2FA using TOTP is preferred to SMS 2FA. For more information, see [Enable QR Code generation for TOTP authenticator apps in ASP.NET Core](#) for ASP.NET Core 2.0 and later.

This tutorial shows how to set up two-factor authentication (2FA) using SMS. Instructions are given for [twilio](#) and [ASPSMS](#), but you can use any other SMS provider. We recommend you complete [Account Confirmation and Password Recovery](#) before starting this tutorial.

View the [completed sample](#). [How to download](#).

## Create a new ASP.NET Core project

Create a new ASP.NET Core web app named `Web2FA` with individual user accounts. Follow the instructions in [Enforce SSL in an ASP.NET Core app](#) to set up and require SSL.

### Create an SMS account

Create an SMS account, for example, from [twilio](#) or [ASPSMS](#). Record the authentication credentials (for twilio: accountSid and authToken, for ASPSMS: Userkey and Password).

#### Figuring out SMS Provider credentials

**Twilio:** From the Dashboard tab of your Twilio account, copy the **Account SID** and **Auth token**.

**ASPSMS:** From your account settings, navigate to **Userkey** and copy it together with your **Password**.

We will later store these values in with the secret-manager tool within the keys `SMSAccountIdentification` and `SMSAccountPassword`.

#### Specifying SenderID / Originator

**Twilio:** From the Numbers tab, copy your Twilio **phone number**.

**ASPSMS:** Within the Unlock Originators Menu, unlock one or more Originators or choose an alphanumeric Originator (Not supported by all networks).

We will later store this value with the secret-manager tool within the key `SMSAccountFrom`.

### Provide credentials for the SMS service

We'll use the [Options pattern](#) to access the user account and key settings.

- Create a class to fetch the secure SMS key. For this sample, the `SMSOptions` class is created in the `Services/SMSOptions.cs` file.

```
namespace Web2FA.Services
{
    public class SMSOptions
    {
        public string SMSAccountIdentification { get; set; }
        public string SMSAccountPassword { get; set; }
        public string SMSAccountFrom { get; set; }
    }
}
```

Set the `SMSAccountIdentification`, `SMSAccountPassword` and `SMSAccountFrom` with the [secret-manager tool](#). For example:

```
C:/Web2FA/src/WebApp1>dotnet user-secrets set SMSAccountIdentification 12345
info: Successfully saved SMSAccountIdentification = 12345 to the secret store.
```

- Add the NuGet package for the SMS provider. From the Package Manager Console (PMC) run:

**Twilio:** `Install-Package Twilio`

**ASPSMS:** `Install-Package ASPSMS`

- Add code in the `Services/MessageServices.cs` file to enable SMS. Use either the Twilio or the ASPSMS section:

**Twilio:**

```

using Microsoft.Extensions.Options;
using System.Threading.Tasks;
using Twilio;
using Twilio.Rest.Api.V2010.Account;
using Twilio.Types;

namespace Web2FA.Services
{
    // This class is used by the application to send Email and SMS
    // when you turn on two-factor authentication in ASP.NET Identity.
    // For more details see this link https://go.microsoft.com/fwlink/?LinkID=532713
    public class AuthMessageSender : IEmailSender, ISmsSender
    {
        public AuthMessageSender(IOptions<SMSOptions> optionsAccessor)
        {
            Options = optionsAccessor.Value;
        }

        public SMSOptions Options { get; } // set only via Secret Manager

        public Task SendEmailAsync(string email, string subject, string message)
        {
            // Plug in your email service here to send an email.
            return Task.FromResult(0);
        }

        public Task SendSmsAsync(string number, string message)
        {
            // Plug in your SMS service here to send a text message.
            // Your Account SID from twilio.com/console
            var accountSid = Options.SMSAccountIdentification;
            // Your Auth Token from twilio.com/console
            var authToken = Options.SMSAccountPassword;

            TwilioClient.Init(accountSid, authToken);

            return MessageResource.CreateAsync(
                to: new PhoneNumber(number),
                from: new PhoneNumber(Options.SMSAccountFrom),
                body: message);
        }
    }
}

```

## ASPSMS:

```

using Microsoft.Extensions.Options;
using System.Threading.Tasks;

namespace Web2FA.Services
{
    // This class is used by the application to send Email and SMS
    // when you turn on two-factor authentication in ASP.NET Identity.
    // For more details see this link https://go.microsoft.com/fwlink/?LinkID=532713
    public class AuthMessageSender : IEmailSender, ISmsSender
    {
        public AuthMessageSender(IOptions<SMSOptions> optionsAccessor)
        {
            Options = optionsAccessor.Value;
        }

        public SMSOptions Options { get; } // set only via Secret Manager

        public Task SendEmailAsync(string email, string subject, string message)
        {
            // Plug in your email service here to send an email.
            return Task.FromResult(0);
        }

        public Task SendSmsAsync(string number, string message)
        {
            ASPSMS.SMS SMSSender = new ASPSMS.SMS();

            SMSSender.Userkey = Options.SMSAccountIdentification;
            SMSSender.Password = Options.SMSAccountPassword;
            SMSSender.Originator = Options.SMSAccountFrom;

            SMSSender.AddRecipient(number);
            SMSSender.MessageData = message;

            SMSSender.SendTextSMS();

            return Task.FromResult(0);
        }
    }
}

```

### Configure startup to use `SMSOptions`

Add `SMSOptions` to the service container in the `ConfigureServices` method in the `Startup.cs`:

```

// Add application services.
services.AddTransient<IEmailSender, AuthMessageSender>();
services.AddTransient<ISmsSender, AuthMessageSender>();
services.Configure<SMSOptions>(Configuration);
}

```

### Enable two-factor authentication

Open the `Views/Manage/Index.cshtml` Razor view file and remove the comment characters (so no markup is commented out).

## Log in with two-factor authentication

- Run the app and register a new user

Register - WebApplication1

localhost:44300

WebApplication1

# Register.

Create a new account.

Email  
joe@contoso.com

Password  
\*\*\*\*\*

Confirm password  
\*\*\*\*\*

Register

© 2015 - WebApplication1

- Tap on your user name, which activates the `Index` action method in Manage controller. Then tap the phone number **Add** link.

Manage your account -

localhost:44300/Manage

Hello joe@contoso.com! Log off

# Manage your account.

Change your account settings

Password: [\[ Change \]](#)

External Logins: 0 [\[ Manage \]](#)

Phone Number: Phone Numbers can be used as a second factor of verification in two-factor authentication. See [this article](#) for details on setting up this ASP.NET application to support two-factor authentication using SMS.

Two-Factor Authentic... None [\[ Add \]](#)

Disabled [Enable](#)

© 2015 - WebApplication1

- Add a phone number that will receive the verification code, and tap **Send verification code**.

The screenshot shows a web browser window with the title bar "Add Phone Number - W X". The address bar displays "localhost:44300/Manage". The page content is titled "Add Phone Number." and contains the instruction "Add a phone number." Below this is a form field labeled "Phone number" containing the value "206-555-1234". A button labeled "Send verification code" is visible. At the bottom of the page is a copyright notice: "© 2015 - WebApplication1".

- You will get a text message with the verification code. Enter it and tap **Submit**

The screenshot shows a web browser window with the title bar "Verify Phone Number - We... X". The address bar displays "https://localhost:44300/Manage/VerifyPhoneNumber?PhoneNumber=206-555-1234". The page content is titled "Verify Phone Number." and contains the instruction "Add a phone number." Below this is a form field labeled "Code" containing the value "5879". A button labeled "Submit" is visible. At the bottom of the page is a copyright notice: "© 2015 - WebApplication1".

If you don't get a text message, see twilio log page.

- The Manage view shows your phone number was added successfully.

Your phone number was added.

Change your account settings

**Password:** [ [Change](#) ]  
**External Logins:** 0 [ [Manage](#) ]  
**Phone Number:** Phone Numbers can be used as a second factor of verification in two-factor authentication. See [this article](#) for details on setting up this ASP.NET application to support two-factor authentication using SMS.  
206-555-1234 [ [Change](#) | [Remove](#) ]

**Two-Factor Authentication:** Disabled [Enable](#)

© 2015 - WebApplication1

- Tap **Enable** to enable two-factor authentication.

Your phone number was added.

Change your account settings

**Password:** [ [Change](#) ]  
**External Logins:** 0 [ [Manage](#) ]  
**Phone Number:** Phone Numbers can be used as a second factor of verification in two-factor authentication. See [this article](#) for details on setting up this ASP.NET application to support two-factor authentication using SMS.  
206-555-1234 [ [Change](#) | [Remove](#) ]

**Two-Factor Authentication:** Enabled

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#### Test two-factor authentication

- Log off.
- Log in.
- The user account has enabled two-factor authentication, so you have to provide the second factor of authentication. In this tutorial you have enabled phone verification. The built-in templates also allow you to set up email as the second factor. You can set up additional second factors for authentication such as QR

codes. Tap **Submit**.

The screenshot shows a web browser window with the URL <https://localhost:44300/Account/SendCode?RememberMe=True>. The page title is "Send Verification Code - W...". The header includes navigation icons, a search bar, and links for "Home", "About", "Contact", "Register", and "Log in". The main content area has a heading "Send Verification Code." and a form with the placeholder "Select Two-Factor Authentication Provider: Phone" and a "Submit" button. At the bottom, there is a copyright notice: "© 2015 - WebApplication1".

- Enter the code you get in the SMS message.
- Clicking on the **Remember this browser** check box will exempt you from needing to use 2FA to log on when using the same device and browser. Enabling 2FA and clicking on **Remember this browser** will provide you with strong 2FA protection from malicious users trying to access your account, as long as they don't have access to your device. You can do this on any private device you regularly use. By setting **Remember this browser**, you get the added security of 2FA from devices you don't regularly use, and you get the convenience on not having to go through 2FA on your own devices.

The screenshot shows a web browser window with the URL <https://localhost:44300/Account/VerifyCode?Provider=Phone&RememberMe=True>. The page title is "Verify - WebApplication1". The header includes navigation icons, a search bar, and links for "Home", "About", "Contact", "Register", and "Log in". The main content area has a heading "Verify." and a form with a "Code" input field containing "198740", a checked "Remember this browser?" checkbox (which is highlighted with a red border), and a "Submit" button. At the bottom, there is a copyright notice: "© 2015 - WebApplication1".

## Account lockout for protecting against brute force attacks

Account lockout is recommended with 2FA. Once a user signs in through a local account or social account, each failed attempt at 2FA is stored. If the maximum failed access attempts is reached, the user is locked out (default: 5 minute lockout after 5 failed access attempts). A successful authentication resets the failed access attempts count and resets the clock. The maximum failed access attempts and lockout time can be set with [MaxFailedAccessAttempts](#) and [DefaultLockoutTimeSpan](#). The following configures account lockout for 10 minutes after 10 failed access attempts:

```
public void ConfigureServices(IServiceCollection services)
{
    // Add framework services.
    services.AddDbContext<ApplicationDbContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("DefaultConnection")));

    services.AddIdentity< ApplicationUser, IdentityRole>()
        .AddEntityFrameworkStores<ApplicationDbContext>()
        .AddDefaultTokenProviders();

    services.AddMvc();

    services.Configure<IdentityOptions>(options =>
    {
        options.Lockout.MaxFailedAccessAttempts = 10;
        options.Lockout.DefaultLockoutTimeSpan = TimeSpan.FromMinutes(10);
    });

    // Add application services.
    services.AddTransient< IEmailSender, AuthMessageSender>();
    services.AddTransient< ISmsSender, AuthMessageSender>();
    services.Configure< SMSOptions>(Configuration);
}
```

Confirm that [PasswordSignInAsync](#) sets `lockoutOnFailure` to `true`:

```
var result = await _signInManager.PasswordSignInAsync(
    Input.Email, Input.Password, Input.RememberMe, lockoutOnFailure: true);
```

# Use cookie authentication without ASP.NET Core Identity

6/21/2018 • 15 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Luke Latham](#)

As you've seen in the earlier authentication topics, [ASP.NET Core Identity](#) is a complete, full-featured authentication provider for creating and maintaining logins. However, you may want to use your own custom authentication logic with cookie-based authentication at times. You can use cookie-based authentication as a standalone authentication provider without ASP.NET Core Identity.

[View or download sample code \(how to download\)](#)

For demonstration purposes in the sample app, the user account for the hypothetical user, Maria Rodriguez, is hardcoded into the app. Use the Email username "maria.rodriguez@contoso.com" and any password to sign in the user. The user is authenticated in the `AuthenticateUser` method in the `Pages/Account/Login.cshtml.cs` file. In a real-world example, the user would be authenticated against a database.

For information on migrating cookie-based authentication from ASP.NET Core 1.x to 2.0, see [Migrate Authentication and Identity to ASP.NET Core 2.0 topic \(Cookie-based Authentication\)](#).

To use ASP.NET Core Identity, see the [Introduction to Identity](#) topic.

## Configuration

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

If the app doesn't use the [Microsoft.AspNetCore.App metapackage](#), create a package reference in the project file for the [Microsoft.AspNetCore.Authentication.Cookies](#) package (version 2.1.0 or later).

In the `ConfigureServices` method, create the Authentication Middleware service with the `AddAuthentication` and `AddCookie` methods:

```
services.AddAuthentication(CookieAuthenticationDefaults.AuthenticationScheme)
    .AddCookie();
```

`AuthenticationScheme` passed to `AddAuthentication` sets the default authentication scheme for the app. `AuthenticationScheme` is useful when there are multiple instances of cookie authentication and you want to [authorize with a specific scheme](#). Setting the `AuthenticationScheme` to `CookieAuthenticationDefaults.AuthenticationScheme` provides a value of "Cookies" for the scheme. You can supply any string value that distinguishes the scheme.

In the `Configure` method, use the `UseAuthentication` method to invoke the Authentication Middleware that sets the `HttpContext.User` property. Call the `UseAuthentication` method before calling `UseMvcWithDefaultRoute` or `UseMvc`:

```
app.UseAuthentication();
```

## AddCookie Options

The [CookieAuthenticationOptions](#) class is used to configure the authentication provider options.

OPTION	DESCRIPTION
<a href="#">AccessDeniedPath</a>	Provides the path to supply with a 302 Found (URL redirect) when triggered by <code>HttpContext.ForbidAsync</code> . The default value is <code>/Account/AccessDenied</code> .
<a href="#">ClaimsIssuer</a>	The issuer to use for the <a href="#">Issuer</a> property on any claims created by the cookie authentication service.
<a href="#">Cookie.Domain</a>	The domain name where the cookie is served. By default, this is the host name of the request. The browser only sends the cookie in requests to a matching host name. You may wish to adjust this to have cookies available to any host in your domain. For example, setting the cookie domain to <code>.contoso.com</code> makes it available to <code>contoso.com</code> , <code>www.contoso.com</code> , and <code>staging.www.contoso.com</code> .
<a href="#">Cookie.Expiration</a>	Gets or sets the lifespan of a cookie. Currently, this option no-ops and will become obsolete in ASP.NET Core 2.1+. Use the <code>ExpireTimeSpan</code> option to set cookie expiration. For more information, see <a href="#">Clarify behavior of CookieAuthenticationOptions.Cookie.Expiration</a> .
<a href="#">Cookie.HttpOnly</a>	A flag indicating if the cookie should be accessible only to servers. Changing this value to <code>false</code> permits client-side scripts to access the cookie and may open your app to cookie theft should your app have a <a href="#">Cross-site scripting (XSS)</a> vulnerability. The default value is <code>true</code> .
<a href="#">Cookie.Name</a>	Sets the name of the cookie.
<a href="#">Cookie.Path</a>	Used to isolate apps running on the same host name. If you have an app running at <code>/app1</code> and want to restrict cookies to that app, set the <code>CookiePath</code> property to <code>/app1</code> . By doing so, the cookie is only available on requests to <code>/app1</code> and any app underneath it.
<a href="#">Cookie.SameSite</a>	Indicates whether the browser should allow the cookie to be attached to same-site requests only ( <code>SameSiteMode.Strict</code> ) or cross-site requests using safe HTTP methods and same-site requests ( <code>SameSiteMode.Lax</code> ). When set to <code>SameSiteMode.None</code> , the cookie header value isn't set. Note that <a href="#">Cookie Policy Middleware</a> might overwrite the value that you provide. To support OAuth authentication, the default value is <code>SameSiteMode.Lax</code> . For more information, see <a href="#">OAuth authentication broken due to SameSite cookie policy</a> .
<a href="#">Cookie.SecurePolicy</a>	A flag indicating if the cookie created should be limited to HTTPS ( <code>CookieSecurePolicy.Always</code> ), HTTP or HTTPS ( <code>CookieSecurePolicy.None</code> ), or the same protocol as the request ( <code>CookieSecurePolicy.SameAsRequest</code> ). The default value is <code>CookieSecurePolicy.SameAsRequest</code> .

OPTION	DESCRIPTION
DataProtectionProvider	Sets the <code>DataProtectionProvider</code> that's used to create the default <code>TicketDataFormat</code> . If the <code>TicketDataFormat</code> property is set, the <code>DataProtectionProvider</code> option isn't used. If not provided, the app's default data protection provider is used.
Events	The handler calls methods on the provider that give the app control at certain processing points. If <code>Events</code> aren't provided, a default instance is supplied that does nothing when the methods are called.
EventsType	Used as the service type to get the <code>Events</code> instance instead of the property.
ExpireTimeSpan	The <code>TimeSpan</code> after which the authentication ticket stored inside the cookie expires. <code>ExpireTimeSpan</code> is added to the current time to create the expiration time for the ticket. The <code>ExpiredTimeSpan</code> value always goes into the encrypted <code>AuthTicket</code> verified by the server. It may also go into the <code>Set-Cookie</code> header, but only if <code>IsPersistent</code> is set. To set <code>IsPersistent</code> to <code>true</code> , configure the <code>AuthenticationProperties</code> passed to <code>SignInAsync</code> . The default value of <code>ExpireTimeSpan</code> is 14 days.
LoginPath	Provides the path to supply with a 302 Found (URL redirect) when triggered by <code>HttpContext.ChallengeAsync</code> . The current URL that generated the 401 is added to the <code>LoginPath</code> as a query string parameter named by the <code>ReturnUrlParameter</code> . Once a request to the <code>LoginPath</code> grants a new sign-in identity, the <code>ReturnUrlParameter</code> value is used to redirect the browser back to the URL that caused the original unauthorized status code. The default value is <code>/Account/Login</code> .
LogoutPath	If the <code>LogoutPath</code> is provided to the handler, then a request to that path redirects based on the value of the <code>ReturnUrlParameter</code> . The default value is <code>/Account/Logout</code> .
ReturnUrlParameter	Determines the name of the query string parameter that's appended by the handler for a 302 Found (URL redirect) response. <code>ReturnUrlParameter</code> is used when a request arrives on the <code>LoginPath</code> or <code>LogoutPath</code> to return the browser to the original URL after the login or logout action is performed. The default value is <code>ReturnUrl</code> .
SessionStore	An optional container used to store identity across requests. When used, only a session identifier is sent to the client. <code>SessionStore</code> can be used to mitigate potential problems with large identities.

OPTION	DESCRIPTION
SlidingExpiration	A flag indicating if a new cookie with an updated expiration time should be issued dynamically. This can happen on any request where the current cookie expiration period is more than 50% expired. The new expiration date is moved forward to be the current date plus the <code>ExpireTimespan</code> . An <a href="#">absolute cookie expiration time</a> can be set by using the <code>AuthenticationProperties</code> class when calling <code>SignInAsync</code> . An absolute expiration time can improve the security of your app by limiting the amount of time that the authentication cookie is valid. The default value is <code>true</code> .
TicketDataFormat	The <code>TicketDataFormat</code> is used to protect and unprotect the identity and other properties that are stored in the cookie value. If not provided, a <code>TicketDataFormat</code> is created using the <a href="#">DataProtectionProvider</a> .
Validate	Method that checks that the options are valid.

Set `CookieAuthenticationOptions` in the service configuration for authentication in the `ConfigureServices` method:

```
services.AddAuthentication(CookieAuthenticationDefaults.AuthenticationScheme)
    .AddCookie(options =>
{
    ...
});
```

## Cookie Policy Middleware

[Cookie Policy Middleware](#) enables cookie policy capabilities in an app. Adding the middleware to the app processing pipeline is order sensitive; it only affects components registered after it in the pipeline.

```
app.UseCookiePolicy(cookiePolicyOptions);
```

The `CookiePolicyOptions` provided to the Cookie Policy Middleware allow you to control global characteristics of cookie processing and hook into cookie processing handlers when cookies are appended or deleted.

PROPERTY	DESCRIPTION
HttpOnly	Affects whether cookies must be HttpOnly, which is a flag indicating if the cookie should be accessible only to servers. The default value is <code>HttpOnlyPolicy.None</code> .
MinimumSameSitePolicy	Affects the cookie's same-site attribute (see below). The default value is <code>SameSiteMode.Lax</code> . This option is available for ASP.NET Core 2.0+.
OnAppendCookie	Called when a cookie is appended.
OnDeleteCookie	Called when a cookie is deleted.
Secure	Affects whether cookies must be Secure. The default value is <code>CookieSecurePolicy.None</code> .

## MinimumSameSitePolicy (ASP.NET Core 2.0+ only)

The default `MinimumSameSitePolicy` value is `SameSiteMode.Lax` to permit OAuth2 authentication. To strictly enforce a same-site policy of `SameSiteMode.Strict`, set the `MinimumSameSitePolicy`. Although this setting breaks OAuth2 and other cross-origin authentication schemes, it elevates the level of cookie security for other types of apps that don't rely on cross-origin request processing.

```
var cookiePolicyOptions = new CookiePolicyOptions
{
    MinimumSameSitePolicy = SameSiteMode.Strict,
};
```

The Cookie Policy Middleware setting for `MinimumSameSitePolicy` can affect your setting of `Cookie.SameSite` in `CookieAuthenticationOptions` settings according to the matrix below.

MINIMUMSAMESITEPOLICY	COOKIE.SAMESITE	RESULTANT COOKIE.SAMESITE SETTING
SameSiteMode.None	SameSiteMode.None SameSiteMode.Lax SameSiteMode.Strict	SameSiteMode.None SameSiteMode.Lax SameSiteMode.Strict
SameSiteMode.Lax	SameSiteMode.None SameSiteMode.Lax SameSiteMode.Strict	SameSiteMode.Lax SameSiteMode.Lax SameSiteMode.Strict
SameSiteMode.Strict	SameSiteMode.None SameSiteMode.Lax SameSiteMode.Strict	SameSiteMode.Strict SameSiteMode.Strict SameSiteMode.Strict

## Create an authentication cookie

To create a cookie holding user information, you must construct a [ClaimsPrincipal](#). The user information is serialized and stored in the cookie.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

Create a [ClaimsIdentity](#) with any required [Claims](#) and call [SignInAsync](#) to sign in the user:

```

var claims = new List<Claim>
{
    new Claim(ClaimTypes.Name, user.Email),
    new Claim("FullName", user.FullName),
    new Claim(ClaimTypes.Role, "Administrator"),
};

var claimsIdentity = new ClaimsIdentity(
    claims, CookieAuthenticationDefaults.AuthenticationScheme);

var authProperties = new AuthenticationProperties
{
    //AllowRefresh = <bool>,
    // Refreshing the authentication session should be allowed.

    //ExpiresUtc = DateTimeOffset.UtcNow.AddMinutes(10),
    // The time at which the authentication ticket expires. A
    // value set here overrides the ExpireTimeSpan option of
    // CookieAuthenticationOptions set with AddCookie.

    //IsPersistent = true,
    // Whether the authentication session is persisted across
    // multiple requests. Required when setting the
    // ExpireTimeSpan option of CookieAuthenticationOptions
    // set with AddCookie. Also required when setting
    // ExpiresUtc.

    //IssuedUtc = <DateTimeOffset>,
    // The time at which the authentication ticket was issued.

    //RedirectUri = <string>
    // The full path or absolute URI to be used as an http
    // redirect response value.
};

await HttpContext.SignInAsync(
    CookieAuthenticationDefaults.AuthenticationScheme,
    new ClaimsPrincipal(claimsIdentity),
    authProperties);

```

`SignInAsync` creates an encrypted cookie and adds it to the current response. If you don't specify an `AuthenticationScheme`, the default scheme is used.

Under the covers, the encryption used is ASP.NET Core's [Data Protection](#) system. If you're hosting app on multiple machines, load balancing across apps, or using a web farm, then you must [configure data protection](#) to use the same key ring and app identifier.

## Sign out

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

To sign out the current user and delete their cookie, call `SignOutAsync`:

```

await HttpContext.SignOutAsync(
    CookieAuthenticationDefaults.AuthenticationScheme);

```

If you aren't using `CookieAuthenticationDefaults.AuthenticationScheme` (or "Cookies") as the scheme (for example, "ContosoCookie"), supply the scheme you used when configuring the authentication provider. Otherwise, the default scheme is used.

## React to back-end changes

Once a cookie is created, it becomes the single source of identity. Even if you disable a user in your back-end systems, the cookie authentication system has no knowledge of this, and a user stays logged in as long as their cookie is valid.

The [ValidatePrincipal](#) event in ASP.NET Core 2.x or the [ValidateAsync](#) method in ASP.NET Core 1.x can be used to intercept and override validation of the cookie identity. This approach mitigates the risk of revoked users accessing the app.

One approach to cookie validation is based on keeping track of when the user database has been changed. If the database hasn't been changed since the user's cookie was issued, there's no need to re-authenticate the user if their cookie is still valid. To implement this scenario, the database, which is implemented in [IUserRepository](#) for this example, stores a [LastChanged](#) value. When any user is updated in the database, the [LastChanged](#) value is set to the current time.

In order to invalidate a cookie when the database changes based on the [LastChanged](#) value, create the cookie with a [LastChanged](#) claim containing the current [LastChanged](#) value from the database:

```
var claims = new List<Claim>
{
    new Claim(ClaimTypes.Name, user.Email),
    new Claim("LastChanged", {Database Value})
};

var claimsIdentity = new ClaimsIdentity(
    claims,
    CookieAuthenticationDefaults.AuthenticationScheme);

await HttpContext.SignInAsync(
    CookieAuthenticationDefaults.AuthenticationScheme,
    new ClaimsPrincipal(claimsIdentity));
```

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

To implement an override for the [ValidatePrincipal](#) event, write a method with the following signature in a class that you derive from [CookieAuthenticationEvents](#):

```
ValidatePrincipal(CookieValidatePrincipalContext)
```

An example looks like the following:

```

using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Authentication;
using Microsoft.AspNetCore.Authentication.Cookies;

public class CustomCookieAuthenticationEvents : CookieAuthenticationEvents
{
    private readonly IUserRepository _userRepository;

    public CustomCookieAuthenticationEvents(IUserRepository userRepository)
    {
        // Get the database from registered DI services.
        _userRepository = userRepository;
    }

    public override async Task ValidatePrincipal(CookieValidatePrincipalContext context)
    {
        var userPrincipal = context.Principal;

        // Look for the LastChanged claim.
        var lastChanged = (from c in userPrincipal.Claims
                           where c.Type == "LastChanged"
                           select c.Value).FirstOrDefault();

        if (string.IsNullOrEmpty(lastChanged) ||
            !_userRepository.ValidateLastChanged(lastChanged))
        {
            context.RejectPrincipal();

            await context.HttpContext.SignOutAsync(
                CookieAuthenticationDefaults.AuthenticationScheme);
        }
    }
}

```

Register the events instance during cookie service registration in the `ConfigureServices` method. Provide a scoped service registration for your `CustomCookieAuthenticationEvents` class:

```

services.AddAuthentication(CookieAuthenticationDefaults.AuthenticationScheme)
    .AddCookie(options =>
{
    options.EventsType = typeof(CustomCookieAuthenticationEvents);
});

services.AddScoped<CustomCookieAuthenticationEvents>();

```

Consider a situation in which the user's name is updated — a decision that doesn't affect security in any way. If you want to non-destructively update the user principal, call `context.ReplacePrincipal` and set the `context.ShouldRenew` property to `true`.

#### **WARNING**

The approach described here is triggered on every request. This can result in a large performance penalty for the app.

## Persistent cookies

You may want the cookie to persist across browser sessions. This persistence should only be enabled with explicit user consent with a "Remember Me" checkbox on login or a similar mechanism.

The following code snippet creates an identity and corresponding cookie that survives through browser closures.

Any sliding expiration settings previously configured are honored. If the cookie expires while the browser is closed, the browser clears the cookie once it's restarted.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
await HttpContext.SignInAsync(
    CookieAuthenticationDefaults.AuthenticationScheme,
    new ClaimsPrincipal(claimsIdentity),
    new AuthenticationProperties
    {
        IsPersistent = true
    });
}
```

The [AuthenticationProperties](#) class resides in the `Microsoft.AspNetCore.Authentication` namespace.

## Absolute cookie expiration

You can set an absolute expiration time with `ExpiresUtc`. You must also set `IsPersistent`; otherwise, `ExpiresUtc` is ignored and a single-session cookie is created. When `ExpiresUtc` is set on `SignInAsync`, it overrides the value of the `ExpireTimeSpan` option of `CookieAuthenticationOptions`, if set.

The following code snippet creates an identity and corresponding cookie that lasts for 20 minutes. This ignores any sliding expiration settings previously configured.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
await HttpContext.SignInAsync(
    CookieAuthenticationDefaults.AuthenticationScheme,
    new ClaimsPrincipal(claimsIdentity),
    new AuthenticationProperties
    {
        IsPersistent = true,
        ExpiresUtc = DateTime.UtcNow.AddMinutes(20)
    });
}
```

## Additional resources

- [Auth 2.0 Changes / Migration Announcement](#)
- [Limit identity by scheme](#)
- [Claims-Based Authorization](#)
- [Policy-based role checks](#)

# Azure Active Directory with ASP.NET Core

6/28/2018 • 2 minutes to read • [Edit Online](#)

## Azure AD V1 samples

The following samples show how to integrate Azure AD V1, enabling users to sign-in with a work and school account:

- [Integrating Azure AD Into an ASP.NET Core Web App](#)
- [Calling a ASP.NET Core Web API From a WPF Application Using Azure AD](#)
- [Calling a Web API in an ASP.NET Core Web Application Using Azure AD](#)

## Azure AD V2 samples

The following samples show how to integrate Azure AD V2, enabling users to sign-in with a work and school account or a Microsoft personal account (formely Live account):

- [Integrating Azure AD V2 into an ASP.NET Core 2.0 web app:](#)
  - See [this associated video](#)
- [Calling a ASP.NET Core 2.0 Web API from a WPF application using Azure AD V2:](#)
  - See [this associated video](#)

## Azure AD B2C sample

This sample shows how to integrate Azure AD B2C, enabling users to sign-in with social identities (like Facebook, Google, ...)

- [An ASP.NET Core web API with Azure AD B2C](#)

# Cloud authentication with Azure Active Directory B2C in ASP.NET Core

6/21/2018 • 4 minutes to read • [Edit Online](#)

By [Cam Soper](#)

Azure Active Directory B2C (Azure AD B2C) is a cloud identity management solution for web and mobile apps. The service provides authentication for apps hosted in the cloud and on-premises. Authentication types include individual accounts, social network accounts, and federated enterprise accounts. Additionally, Azure AD B2C can provide multi-factor authentication with minimal configuration.

## TIP

Azure Active Directory (Azure AD) and Azure AD B2C are separate product offerings. An Azure AD tenant represents an organization, while an Azure AD B2C tenant represents a collection of identities to be used with relying party applications. To learn more, see [Azure AD B2C: Frequently asked questions \(FAQ\)](#).

In this tutorial, learn how to:

- Create an Azure Active Directory B2C tenant
- Register an app in Azure AD B2C
- Use Visual Studio to create an ASP.NET Core web app configured to use the Azure AD B2C tenant for authentication
- Configure policies controlling the behavior of the Azure AD B2C tenant

## Prerequisites

The following are required for this walkthrough:

- [Microsoft Azure subscription](#)
- [Visual Studio 2017](#) (any edition)

## Create the Azure Active Directory B2C tenant

Create an Azure Active Directory B2C tenant [as described in the documentation](#). When prompted, associating the tenant with an Azure subscription is optional for this tutorial.

## Register the app in Azure AD B2C

In the newly created Azure AD B2C tenant, register your app using [the steps in the documentation](#) under the **Register a web app** section. Stop at the **Create a web app client secret** section. A client secret isn't required for this tutorial.

Use the following values:

SETTING	VALUE	NOTES
Name	<app name>	Enter a <b>Name</b> for the app that describes your app to consumers.

SETTING	VALUE	NOTES
<b>Include web app / web API</b>	Yes	
<b>Allow implicit flow</b>	Yes	
<b>Reply URL</b>	<code>https://localhost:44300</code>	Reply URLs are endpoints where Azure AD B2C returns any tokens that your app requests. Visual Studio provides the Reply URL to use. For now, enter <code>https://localhost:44300</code> to complete the form.
<b>App ID URI</b>	Leave blank	Not required for this tutorial.
<b>Include native client</b>	No	

#### WARNING

If setting up a non-localhost Reply URL, be aware of the [constraints on what is allowed in the Reply URL list](#).

After the app is registered, the list of apps in the tenant is displayed. Select the app that was just registered. Select the **Copy** icon to the right of the **Application ID** field to copy it to the clipboard.

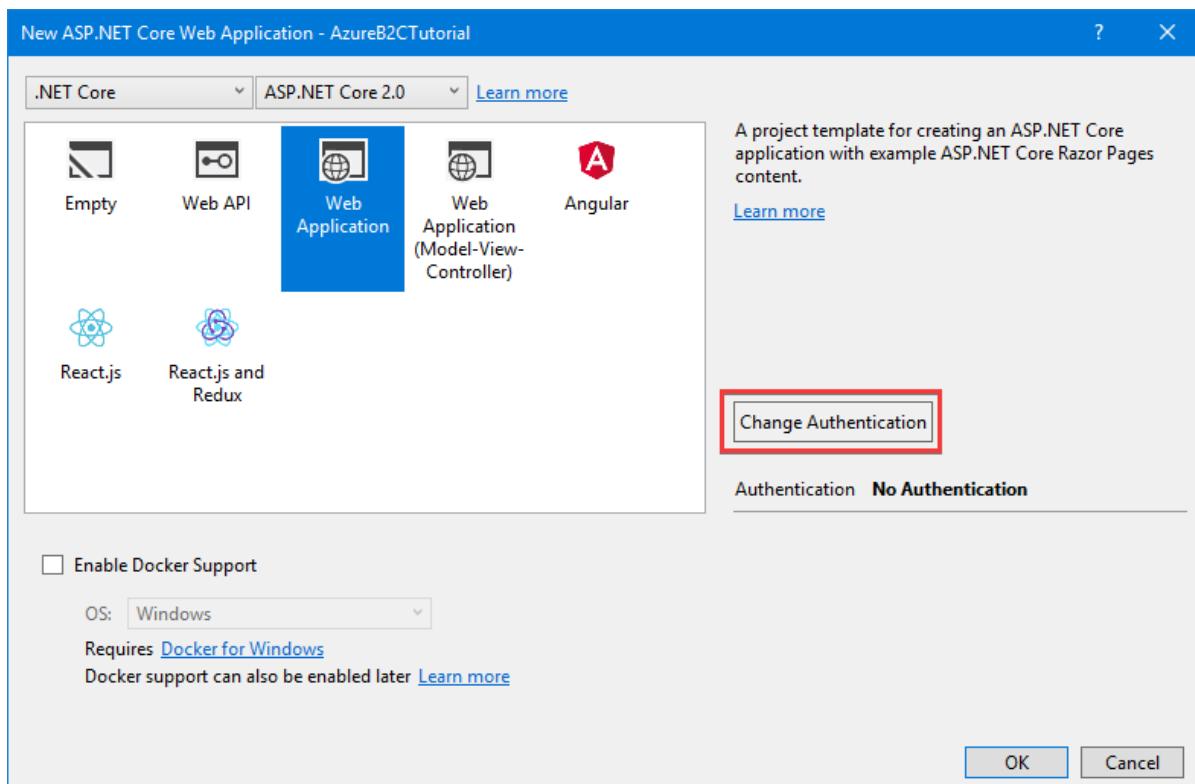
Nothing more can be configured in the Azure AD B2C tenant at this time, but leave the browser window open. There is more configuration after the ASP.NET Core app is created.

## Create an ASP.NET Core app in Visual Studio 2017

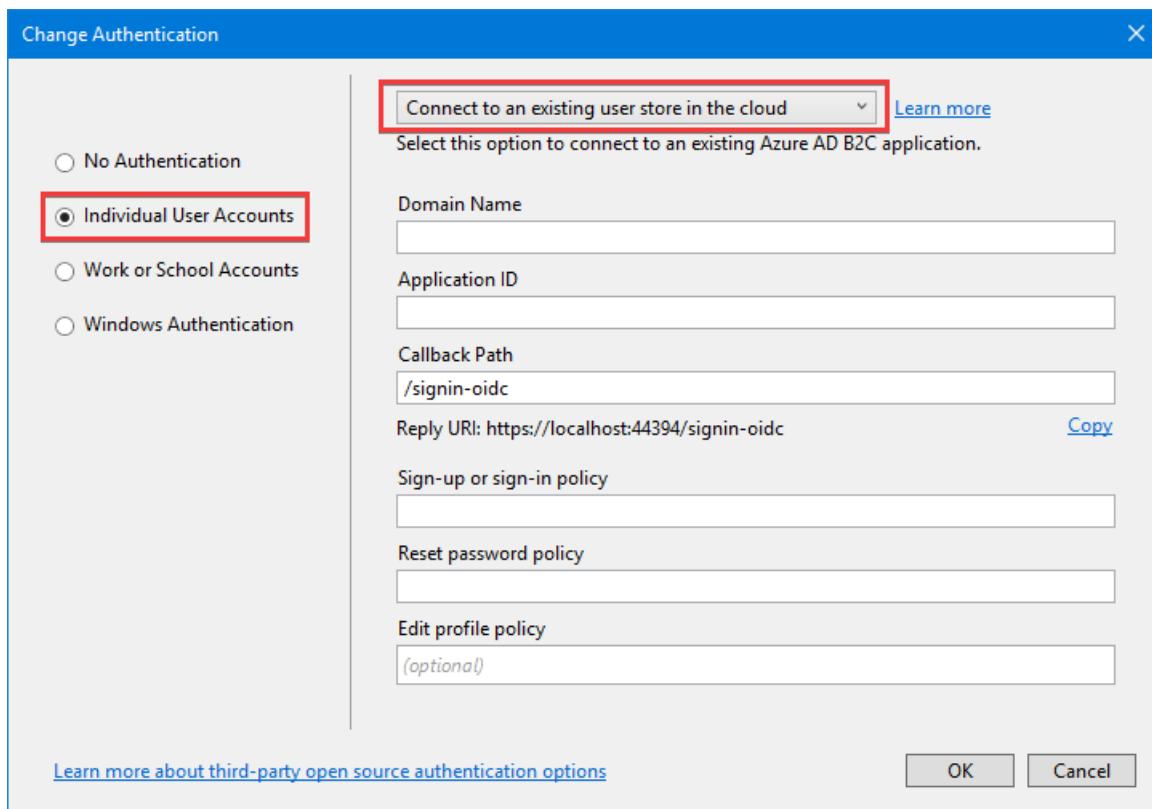
The Visual Studio Web Application template can be configured to use the Azure AD B2C tenant for authentication.

In Visual Studio:

1. Create a new ASP.NET Core Web Application.
2. Select **Web Application** from the list of templates.
3. Select the **Change Authentication** button.



4. In the **Change Authentication** dialog, select **Individual User Accounts**, and then select **Connect to an existing user store in the cloud** in the dropdown.



5. Complete the form with the following values:

SETTING	VALUE
<b>Domain Name</b>	<the domain name of your B2C tenant>
<b>Application ID</b>	<paste the Application ID from the clipboard>

SETTING	VALUE
<b>Callback Path</b>	<use the default value>
<b>Sign-up or sign-in policy</b>	B2C_1_SiUpIn
<b>Reset password policy</b>	B2C_1_SSPr
<b>Edit profile policy</b>	<leave blank>

Select the **Copy** link next to **Reply URI** to copy the Reply URI to the clipboard. Select **OK** to close the **Change Authentication** dialog. Select **OK** to create the web app.

## Finish the B2C app registration

Return to the browser window with the B2C app properties still open. Change the temporary **Reply URL** specified earlier to the value copied from Visual Studio. Select **Save** at the top of the window.

### TIP

If you didn't copy the Reply URL, use the SSL address from the Debug tab in the web project properties, and append the **CallbackPath** value from *appsettings.json*.

## Configure policies

Use the steps in the Azure AD B2C documentation to [create a sign-up or sign-in policy](#), and then [create a password reset policy](#). Use the example values provided in the documentation for **Identity providers**, **Sign-up attributes**, and **Application claims**. Using the **Run now** button to test the policies as described in the documentation is optional.

### WARNING

Ensure the policy names are exactly as described in the documentation, as those policies were used in the **Change Authentication** dialog in Visual Studio. The policy names can be verified in *appsettings.json*.

## Run the app

In Visual Studio, press **F5** to build and run the app. After the web app launches, select **Sign in**.

A screenshot of a web browser showing the 'Home page - AzureB2C' at <https://localhost:44394/>. The page has a dark header with 'AzureB2CTutorial' and navigation links for 'Home', 'About', and 'Contact'. A red box highlights the 'Sign in' button. Below the header is a green banner with the word 'Packages' and links for 'NuGet', 'npm', 'Bower', and 'Gulp'. A central text area says 'Bring in libraries from NuGet and npm, and automate tasks using Grunt or Gulp.' with a 'Learn More' button. At the bottom left, there's a section titled 'Application uses' with a list of items.

## Application uses

- Sample pages using ASP.NET Core Razor Pages
- Theming using [Bootstrap](#)

## How to

- Working with Razor Pages.
- Manage User Secrets using [Secret Manager](#).
- Use logging to log a message.
- Add packages using NuGet.

The browser redirects to the Azure AD B2C tenant. Sign in with an existing account (if one was created testing the policies) or select **Sign up now** to create a new account. The **Forgot your password?** link is used to reset a forgotten password.

A screenshot of a web browser showing the 'Sign up or sign in' page at <https://login.microsoftonline.com/te/camthegeekb2c.onmicrosoft.com>. The page features a blue background with a lightbulb icon and a city skyline illustration. It includes a 'Sign in with your existing account' section with fields for 'Email Address' and 'Password', and a 'Sign in' button. Below this is a link for users who don't have an account: 'Don't have an account? [Sign up now](#)'.

After successfully signing in, the browser redirects to the web app.

The screenshot shows a web browser window with the title "Home page - AzureB2C". The address bar shows the URL "https://localhost:44394/". The page content includes a navigation bar with links for "AzureB2CTutorial", "Home", "About", "Contact", "Hello Tutorial User!" (which is highlighted with a red box), and "Sign out". Below the navigation bar is a purple banner for Visual Studio, featuring icons for HTML, CSS, and JS, and text about new features for building modern web apps. The main content area has sections for "Application uses" and "How to", each with a list of items.

## Application uses

- Sample pages using ASP.NET Core Razor Pages
- Theming using Bootstrap

## How to

- Working with Razor Pages.
- Manage User Secrets using Secret Manager.
- Use logging to log a message.
- Add packages using NuGet.

## Next steps

In this tutorial, you learned how to:

- Create an Azure Active Directory B2C tenant
- Register an app in Azure AD B2C
- Use Visual Studio to create an ASP.NET Core Web Application configured to use the Azure AD B2C tenant for authentication
- Configure policies controlling the behavior of the Azure AD B2C tenant

Now that the ASP.NET Core app is configured to use Azure AD B2C for authentication, the [Authorize attribute](#) can be used to secure your app. Continue developing your app by learning to:

- [Customize the Azure AD B2C user interface.](#)
- [Configure password complexity requirements.](#)
- [Enable multi-factor authentication.](#)
- Configure additional identity providers, such as [Microsoft](#), [Facebook](#), [Google](#), [Amazon](#), [Twitter](#), and others.
- [Use the Azure AD Graph API](#) to retrieve additional user information, such as group membership, from the Azure AD B2C tenant.
- [Secure an ASP.NET Core web API using Azure AD B2C.](#)
- [Call a .NET web API from a .NET web app using Azure AD B2C.](#)

# Cloud authentication in web APIs with Azure Active Directory B2C in ASP.NET Core

6/22/2018 • 7 minutes to read • [Edit Online](#)

By [Cam Soper](#)

Azure Active Directory B2C (Azure AD B2C) is a cloud identity management solution for web and mobile apps. The service provides authentication for apps hosted in the cloud and on-premises. Authentication types include individual accounts, social network accounts, and federated enterprise accounts. Additionally, Azure AD B2C can provide multi-factor authentication with minimal configuration.

## TIP

Azure Active Directory (Azure AD) and Azure AD B2C are separate product offerings. An Azure AD tenant represents an organization, while an Azure AD B2C tenant represents a collection of identities to be used with relying party applications. To learn more, see [Azure AD B2C: Frequently asked questions \(FAQ\)](#).

Since web APIs have no user interface, they're unable to redirect the user to a secure token service like Azure AD B2C. Instead, the API is passed a bearer token from the calling app, which has already authenticated the user with Azure AD B2C. The API then validates the token without direct user interaction.

In this tutorial, learn how to:

- Create an Azure Active Directory B2C tenant.
- Register a Web API in Azure AD B2C.
- Use Visual Studio to create a Web API configured to use the Azure AD B2C tenant for authentication.
- Configure policies controlling the behavior of the Azure AD B2C tenant.
- Use Postman to simulate a web app which presents a login dialog, retrieves a token, and uses it to make a request against the web API.

## Prerequisites

The following are required for this walkthrough:

- [Microsoft Azure subscription](#)
- [Visual Studio 2017](#) (any edition)
- [Postman](#)

## Create the Azure Active Directory B2C tenant

Create an Azure AD B2C tenant [as described in the documentation](#). When prompted, associating the tenant with an Azure subscription is optional for this tutorial.

## Configure a sign-up or sign-in policy

Use the steps in the Azure AD B2C documentation to [create a sign-up or sign-in policy](#). Name the policy **SiUpIn**. Use the example values provided in the documentation for **Identity providers**, **Sign-up attributes**, and **Application claims**. Using the **Run now** button to test the policy as described in the documentation is optional.

## Register the API in Azure AD B2C

In the newly created Azure AD B2C tenant, register your API using [the steps in the documentation](#) under the **Register a web API** section.

Use the following values:

SETTING	VALUE	NOTES
<b>Name</b>	<API name>	Enter a <b>Name</b> for the app that describes your app to consumers.
<b>Include web app / web API</b>	Yes	
<b>Allow implicit flow</b>	Yes	
<b>Reply URL</b>	<code>https://localhost</code>	Reply URLs are endpoints where Azure AD B2C returns any tokens that your app requests.
<b>App ID URI</b>	<code>api</code>	The URI doesn't need to resolve to a physical address. It only needs to be unique.
<b>Include native client</b>	No	

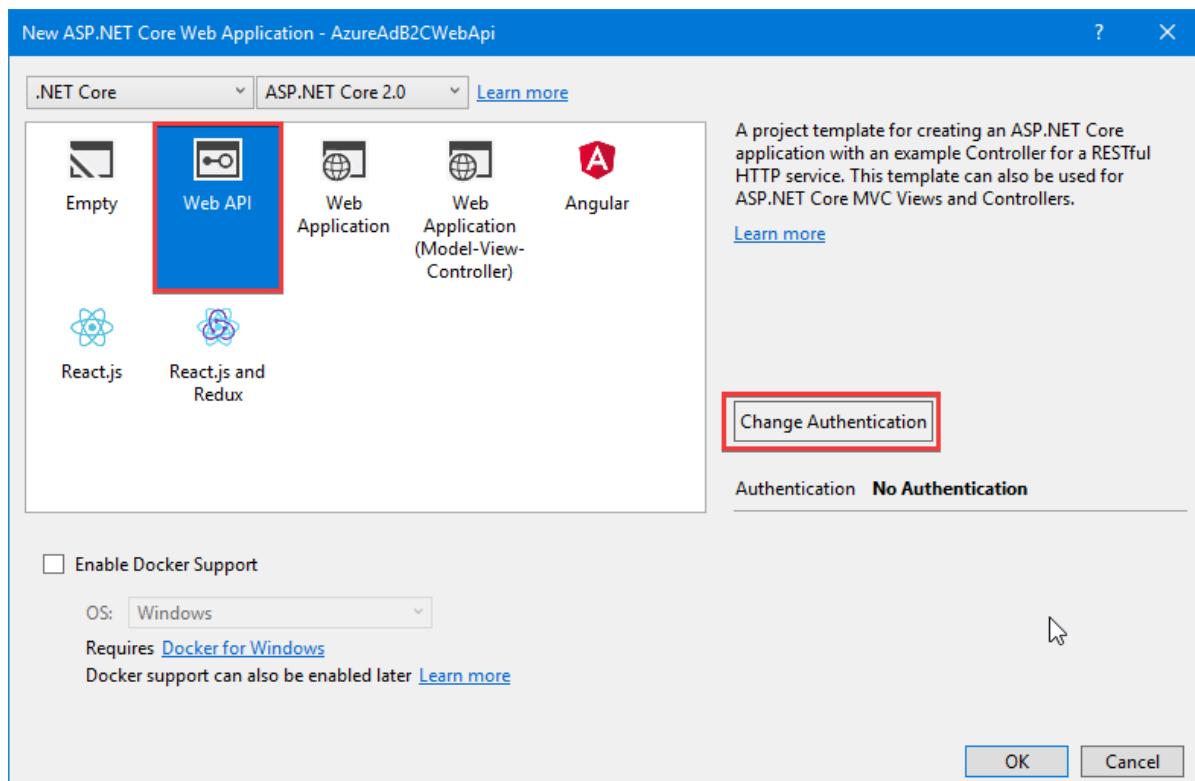
After the API is registered, the list of apps and APIs in the tenant is displayed. Select the API that was just registered. Select the **Copy** icon to the right of the **Application ID** field to copy it to the clipboard. Select **Published scopes** and verify the default `user_impersonation` scope is present.

## Create an ASP.NET Core app in Visual Studio 2017

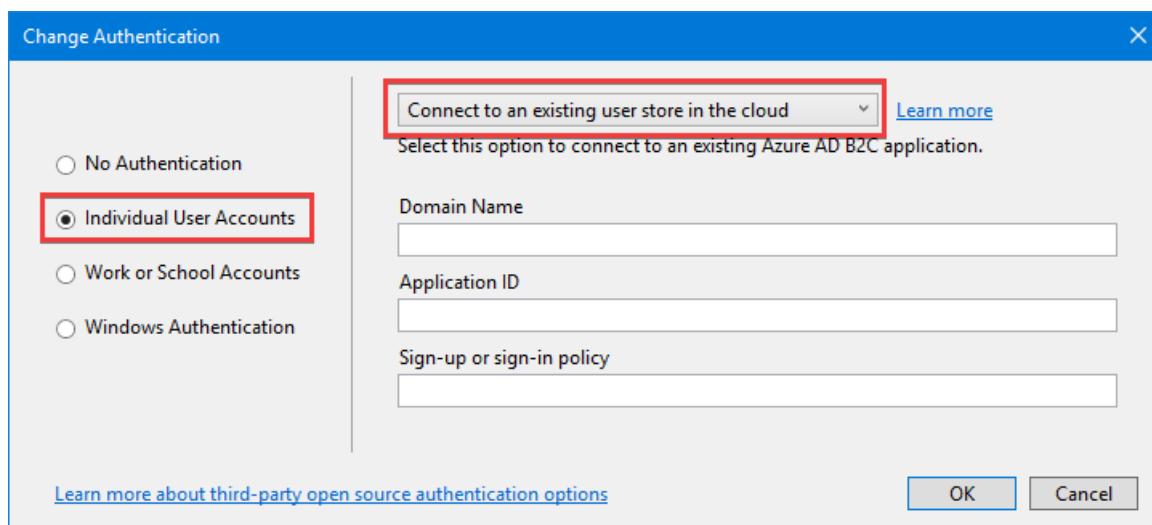
The Visual Studio Web Application template can be configured to use the Azure AD B2C tenant for authentication.

In Visual Studio:

1. Create a new ASP.NET Core Web Application.
2. Select **Web API** from the list of templates.
3. Select the **Change Authentication** button.



4. In the **Change Authentication** dialog, select **Individual User Accounts**, and then select **Connect to an existing user store in the cloud** in the dropdown.



5. Complete the form with the following values:

SETTING	VALUE
<b>Domain Name</b>	<the domain name of your B2C tenant>
<b>Application ID</b>	<paste the Application ID from the clipboard>
<b>Sign-up or sign-in policy</b>	B2C_1_SiUpIn

Select **OK** to close the **Change Authentication** dialog. Select **OK** to create the web app.

Visual Studio creates the web API with a controller named `ValuesController.cs` that returns hard-coded values for GET requests. The class is decorated with the [Authorize attribute](#), so all requests require authentication.

# Run the web API

In Visual Studio, run the API. Visual Studio launches a browser pointed at the API's root URL. Note the URL in the address bar, and leave the API running in the background.

## NOTE

Since there is no controller defined for the root URL, the browser displays a 404 (page not found) error. This is expected behavior.

# Use Postman to get a token and test the API

[Postman](#) is a tool for testing web APIs. For this tutorial, Postman simulates a web app that accesses the web API on the user's behalf.

## Register Postman as a web app

Since Postman simulates a web app that can obtain tokens from the Azure AD B2C tenant, it must be registered in the tenant as a web app. Register Postman using [the steps in the documentation](#) under the **Register a web app** section. Stop at the **Create a web app client secret** section. A client secret isn't required for this tutorial.

Use the following values:

SETTING	VALUE	NOTES
Name	Postman	
Include web app / web API	Yes	
Allow implicit flow	Yes	
Reply URL	<code>https://getpostman.com/postman</code>	
App ID URI	<leave blank>	Not required for this tutorial.
Include native client	No	

The newly registered web app needs permission to access the web API on the user's behalf.

1. Select **Postman** in the list of apps and then select **API access** from the menu on the left.
2. Select **+ Add**.
3. In the **Select API** dropdown, select the name of the web API.
4. In the **Select Scopes** dropdown, ensure all scopes are selected.
5. Select **Ok**.

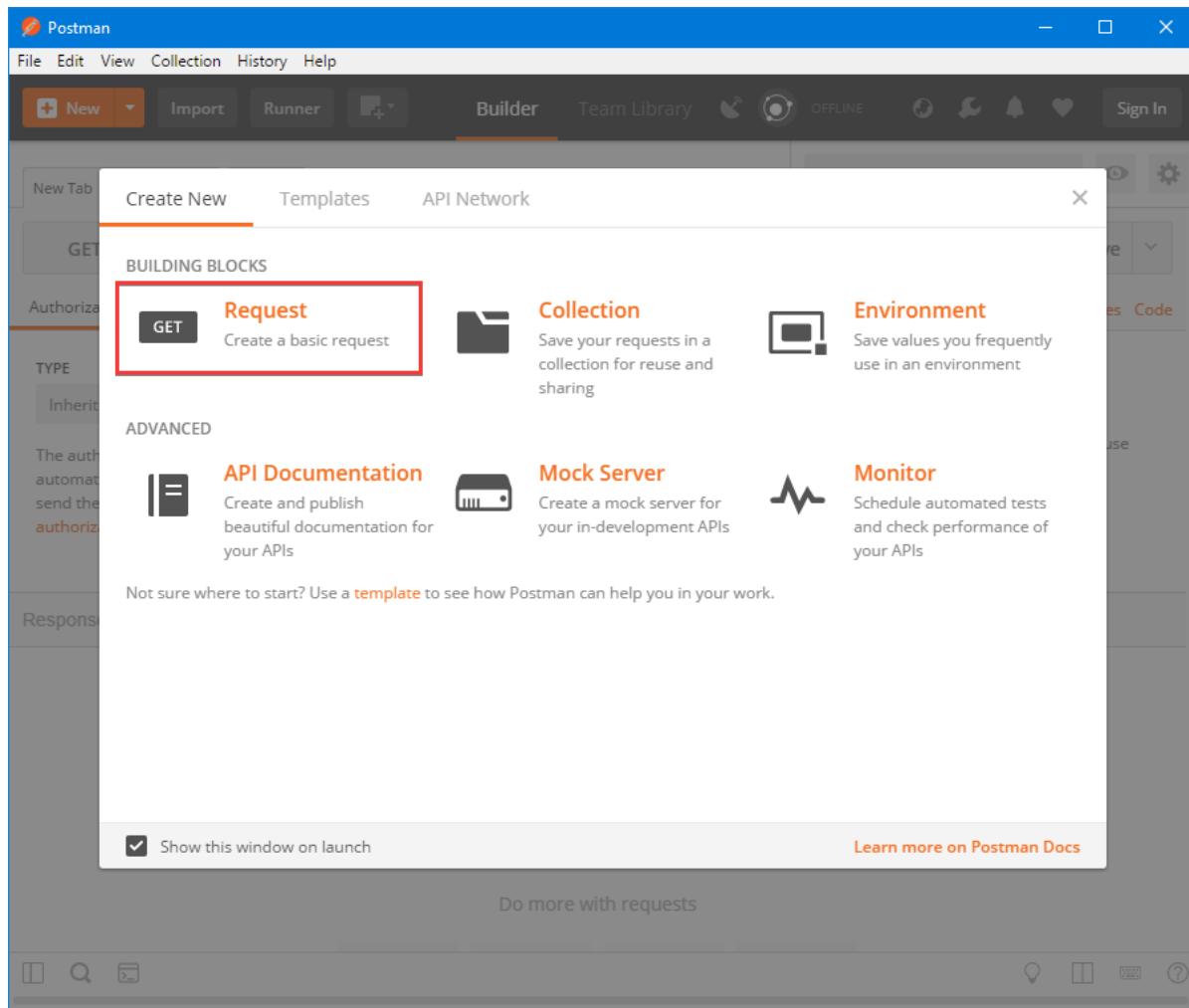
Note the Postman app's Application ID, as it's required to obtain a bearer token.

## Create a Postman request

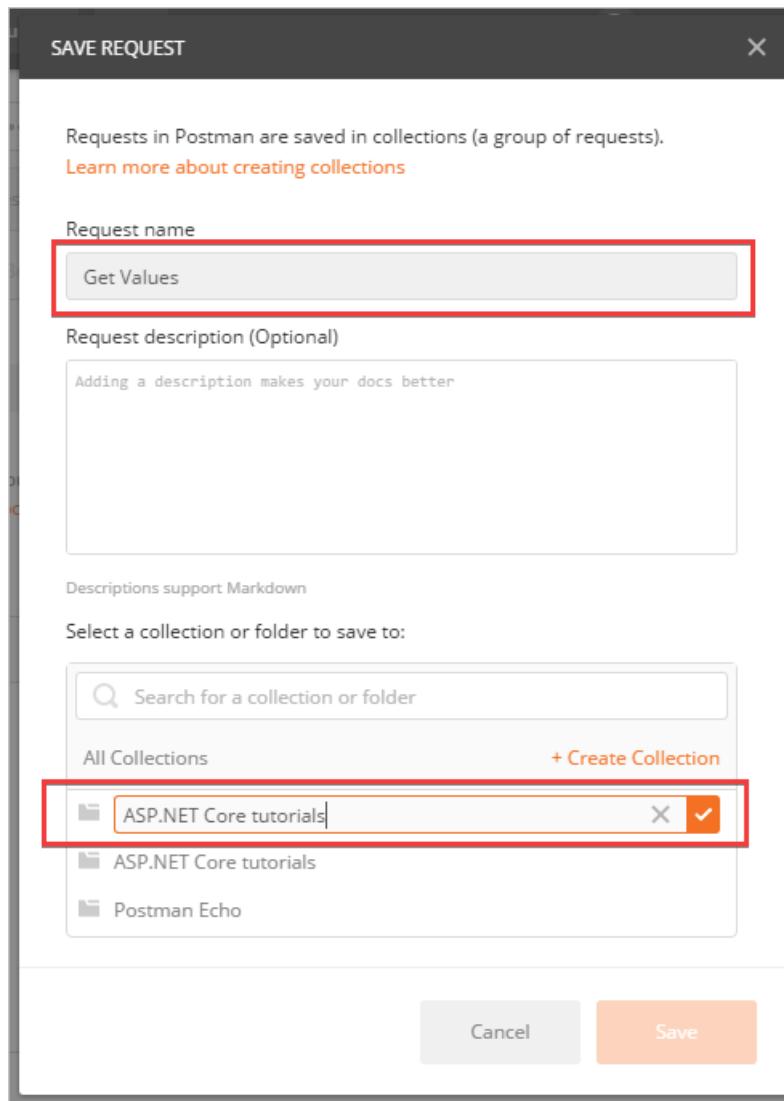
Launch Postman. By default, Postman displays the **Create New** dialog upon launching. If the dialog isn't displayed, select the **+ New** button in the upper left.

From the **Create New** dialog:

1. Select **Request**.



2. Enter **Get Values** in the **Request name** box.
3. Select **+ Create Collection** to create a new collection for storing the request. Name the collection **ASP.NET Core tutorials** and then select the checkmark.

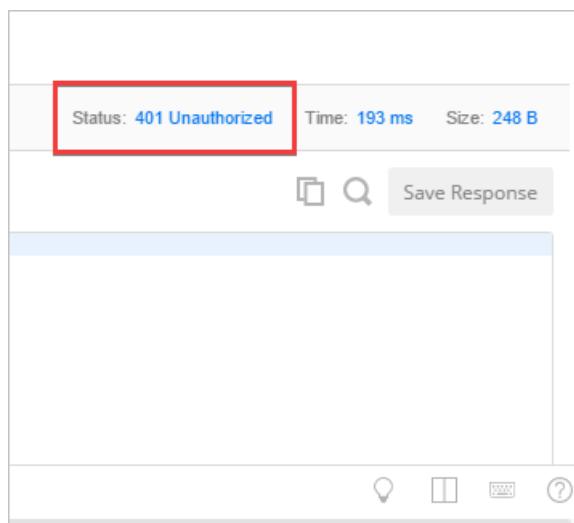


4. Select the **Save to ASP.NET Core tutorials** button.

#### Test the web API without authentication

To verify that the web API requires authentication, first make a request without authentication.

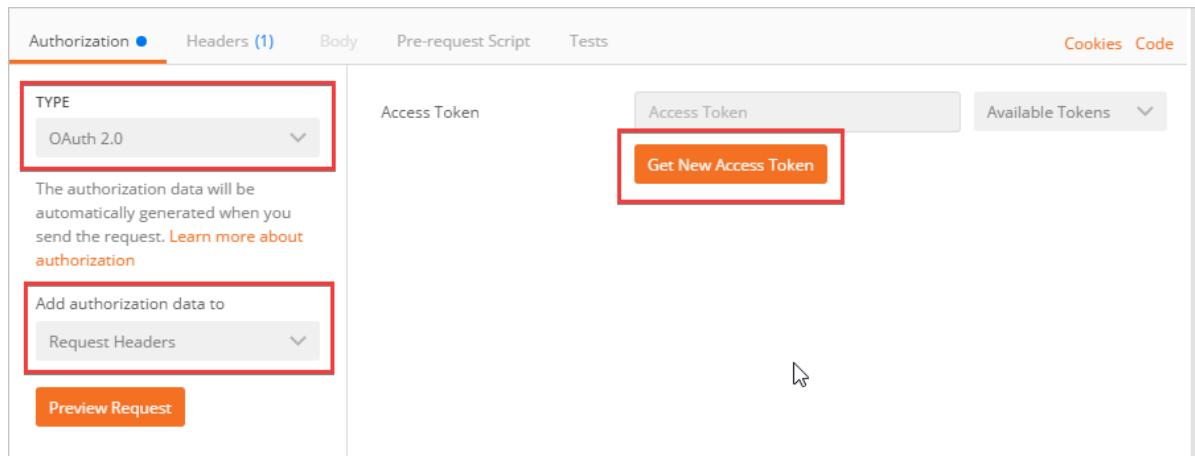
1. In the **Enter request URL** box, enter the URL for `valuesController`. The URL is the same as displayed in the browser with `api/values` appended. An example would be `https://localhost:44375/api/values`.
2. Select the **Send** button.
3. Note the status of the response is *401 Unauthorized*.



## Obtain a bearer token

To make an authenticated request to the web API, a bearer token is required. Postman makes it easy to sign in to the Azure AD B2C tenant and obtain a token.

1. On the **Authorization** tab, in the **TYPE** dropdown, select **OAuth 2.0**. In the **Add authorization data to** dropdown, select **Request Headers**. Select **Get New Access Token**.



2. Complete the **GET NEW ACCESS TOKEN** dialog as follows:

SETTING	VALUE	NOTES
<b>Token Name</b>	<token name>	Enter a descriptive name for the token.
<b>Grant Type</b>	Implicit	
<b>Callback URL</b>	<code>https://getpostman.com/postman</code>	
<b>Auth URL</b>	<code>https://login.microsoftonline.com/tfp/&lt;tenant domain name&gt;/domain name&gt;/B2C_1_SiUpIn/oauth2/v2.0/authorize</code>	Replace <tenant domain name> with the tenant's domain name.
<b>Client ID</b>	<enter the Postman app's <b>Application ID</b> >	
<b>Client Secret</b>	<leave blank>	
<b>Scope</b>	<code>https://&lt;tenant domain name&gt;/&lt;api&gt;/user_impersonation openid offline_access</code>	Replace <tenant domain name> with the tenant's domain name. Replace <api> with the Web API project name. You can also use Application ID. The pattern for the URL is: <code>https://&lt;tenant&gt;.onmicrosoft.com/&lt;app_name_or_id&gt;/&lt;scope name&gt;</code> .
<b>Client Authentication</b>	Send client credentials in body	

3. Select the **Request Token** button.
4. Postman opens a new window containing the Azure AD B2C tenant's sign in dialog. Sign in with an existing account (if one was created testing the policies) or select **Sign up now** to create a new account. The **Forgot your password?** link is used to reset a forgotten password.

5. After successfully signing in, the window closes and the **MANAGE ACCESS TOKENS** dialog appears. Scroll down to the bottom and select the **Use Token** button.

The screenshot shows the Postman interface with a 'MANAGE ACCESS TOKENS' dialog open. The token details are as follows:

	token_type	expires_in
ALL TOKENS	Bearer	3600
Azure AD B2C Tutorial Te...		

The 'Use Token' button at the bottom right of the dialog is highlighted with a red box.

## Test the web API with authentication

Select the **Send** button to send the request again. This time, the response status is *200 OK* and the JSON payload is visible on the response **Body** tab.

The screenshot shows the Postman response body tab with the following JSON content:

```

1 [ "value1",
2   "value2"
3 ]
4 ]

```

The status bar at the top right indicates **Status: 200 OK**.

## Next steps

In this tutorial, you learned how to:

- Create an Azure Active Directory B2C tenant.
- Register a Web API in Azure AD B2C.
- Use Visual Studio to create a Web API configured to use the Azure AD B2C tenant for authentication.
- Configure policies controlling the behavior of the Azure AD B2C tenant.
- Use Postman to simulate a web app which presents a login dialog, retrieves a token, and uses it to make a request against the web API.

Continue developing your API by learning to:

- [Secure an ASP.NET Core web app using Azure AD B2C](#).
- [Call a .NET web API from a .NET web app using Azure AD B2C](#).
- [Customize the Azure AD B2C user interface](#).
- [Configure password complexity requirements](#).
- [Enable multi-factor authentication](#).
- Configure additional identity providers, such as [Microsoft](#), [Facebook](#), [Google](#), [Amazon](#), [Twitter](#), and others.
- [Use the Azure AD Graph API](#) to retrieve additional user information, such as group membership, from the Azure AD B2C tenant.

# Articles based on ASP.NET Core projects created with individual user accounts

6/21/2018 • 2 minutes to read • [Edit Online](#)

ASP.NET Core Identity is included in project templates in Visual Studio with the "Individual User Accounts" option.

The authentication templates are available in .NET Core CLI with `-au Individual`:

```
dotnet new mvc -au Individual  
dotnet new webapi -au Individual  
dotnet new webapp -au Individual
```

## NOTE

In ASP.NET Core 2.1 or later, `webapp` is an alias of the `razor` argument. If the `dotnet new webapp <OPTIONS>` command loads the `dotnet new` command help instead of creating a new Razor Pages app, install the [.NET Core 2.1 SDK](#).

```
dotnet new mvc -au Individual  
dotnet new webapi -au Individual  
dotnet new razor -au Individual
```

The following articles show how to use the code generated in ASP.NET Core templates that use individual user accounts:

- [Two-factor authentication with SMS](#)
- [Account confirmation and password recovery in ASP.NET Core](#)
- [Create an ASP.NET Core app with user data protected by authorization](#)

# Authorization in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

- [Introduction](#)
- [Create an app with user data protected by authorization](#)
- [Razor Pages authorization](#)
- [Simple authorization](#)
- [Role-based authorization](#)
- [Claims-based authorization](#)
- [Policy-based authorization](#)
- [Authorization policy providers](#)
- [Dependency injection in requirement handlers](#)
- [Resource-based authorization](#)
- [View-based authorization](#)
- [Authorize with a specific scheme](#)

# Introduction to authorization in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

Authorization refers to the process that determines what a user is able to do. For example, an administrative user is allowed to create a document library, add documents, edit documents, and delete them. A non-administrative user working with the library is only authorized to read the documents.

Authorization is orthogonal and independent from authentication. However, authorization requires an authentication mechanism. Authentication is the process of ascertaining who a user is. Authentication may create one or more identities for the current user.

## Authorization types

ASP.NET Core authorization provides a simple, declarative [role](#) and a rich [policy-based](#) model. Authorization is expressed in requirements, and handlers evaluate a user's claims against requirements. Imperative checks can be based on simple policies or policies which evaluate both the user identity and properties of the resource that the user is attempting to access.

## Namespaces

Authorization components, including the `AuthorizeAttribute` and `AllowAnonymousAttribute` attributes, are found in the `Microsoft.AspNetCore.Authorization` namespace.

Consult the documentation on [simple authorization](#).

# Create an ASP.NET Core app with user data protected by authorization

6/21/2018 • 19 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Joe Audette](#)

This tutorial shows how to create an ASP.NET Core web app with user data protected by authorization. It displays a list of contacts that authenticated (registered) users have created. There are three security groups:

- **Registered users** can view all the approved data and can edit/delete their own data.
- **Managers** can approve or reject contact data. Only approved contacts are visible to users.
- **Administrators** can approve/reject and edit/delete any data.

In the following image, user Rick (`rick@example.com`) is signed in. Rick can only view approved contacts and **Edit/Delete/Create New** links for his contacts. Only the last record, created by Rick, displays **Edit** and **Delete** links. Other users won't see the last record until a manager or administrator changes the status to "Approved".

Address	City	Email	Name	State	Zip	Status	
5678 1st Ave W	Redmond	<a href="#">thorsten@example.com</a>	Thorsten Weinrich	WA	10999	Approved	<a href="#">Details</a>
9012 State st	Redmond	<a href="#">yuhong@example.com</a>	Yuhong Li	WA	10999	Approved	<a href="#">Details</a>
3456 Maple St	Redmond	<a href="#">jon@example.com</a>	Jon Orton	WA	10999	Approved	<a href="#">Details</a>
123 N 456 E	GF	<a href="#">rick@example.com</a>	Rick Anderson	MT	59405	Submitted	<a href="#">Edit   Details   Delete</a>

In the following image, `manager@contoso.com` is signed in and in the managers role:

The screenshot shows the ContactManager application's index page. At the top, there is a navigation bar with links for Home, About, and Contact. On the right side of the header, there is a yellow box highlighting the user information: "Hello manager@contoso.com!" and a Log off link. Below the header, a section titled "Create New" is visible. The main content is a table listing six contacts. The columns are labeled: Address, City, Email, Name, State, Zip, and Status. The "Status" column contains values like "Rejected" (highlighted with a red box) and "Approved". The last contact listed has a status of "Submitted" (highlighted with a red box). At the bottom of the page, there is a copyright notice: "© 2016 - ContactManager".

Address	City	Email	Name	State	Zip	Status	
1234 Main St	Redmond	debra@example.com	Debra Garcia	WA	10999	Rejected	<a href="#">Details</a>
5678 1st Ave W	Redmond	thorsten@example.com	Thorsten Weinrich	WA	10999	Approved	<a href="#">Details</a>
9012 State st	Redmond	yuhong@example.com	Yuhong Li	WA	10999	Approved	<a href="#">Details</a>
3456 Maple St	Redmond	jon@example.com	Jon Orton	WA	10999	Approved	<a href="#">Details</a>
7890 2nd Ave E	Redmond	diliana@example.com	Diliana Alexieva-Bosseva	WA	10999	Submitted	<a href="#">Details</a>
123 N 456 E	GF	rick@example.com	Rick Anderson	MT	59405	Approved	<a href="#">Details</a>

The following image shows the managers details view of a contact:

The screenshot shows the ContactManager application's details page for a contact. At the top, there is a navigation bar with links for Home, About, and Contact. On the right side of the header, there is a yellow box highlighting the user information: "Hello manager@contoso.com!" and a Log off link. Below the header, the page title is "Contact". The main content displays the contact's details in a table format. The columns are labeled: Name, Email, Address, City, State, Zip, and Status. The contact's name is Rick Anderson, email is rick@example.com, address is 123 N 456 E, city is GF, state is MT, zip is 59405, and status is Submitted. At the bottom of the page, there are two buttons: "Approve" (green) and "Reject" (red). There are also links for "Edit" and "Back to List". At the very bottom, there is a copyright notice: "© 2016 - ContactManager".

Name	Rick Anderson
Email	rick@example.com
Address	123 N 456 E
City	GF
State	MT
Zip	59405
Status	Submitted

The **Approve** and **Reject** buttons are only displayed for managers and administrators.

In the following image, `admin@contoso.com` is signed in and in the administrators role:

Address	City	Email	Name	State	Zip	Status	
1234 Main St	Redmond	<a href="#">debra@example.com</a>	Debra Garcia	WA	10999	Rejected	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
5678 1st Ave W	Redmond	<a href="#">thorsten@example.com</a>	Thorsten Weinrich	WA	10999	Approved	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
9012 State st	Redmond	<a href="#">yuhong@example.com</a>	Yuhong Li	WA	10999	Approved	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>
3456 Maple St	Redmond	<a href="#">jon@example.com</a>	Jon Orton	WA	10999	Approved	<a href="#">Edit</a>   <a href="#">Details</a>   <a href="#">Delete</a>

The administrator has all privileges. She can read/edit/delete any contact and change the status of contacts.

The app was created by [scaffolding](#) the following `Contact` model:

```
public class Contact
{
    public int ContactId { get; set; }
    public string Name { get; set; }
    public string Address { get; set; }
    public string City { get; set; }
    public string State { get; set; }
    public string Zip { get; set; }
    [DataType(DataType.EmailAddress)]
    public string Email { get; set; }
}
```

The sample contains the following authorization handlers:

- `ContactIsOwnerAuthorizationHandler` : Ensures that a user can only edit their data.
- `ContactManagerAuthorizationHandler` : Allows managers to approve or reject contacts.
- `ContactAdministratorsAuthorizationHandler` : Allows administrators to approve or reject contacts and to edit/delete contacts.

## Prerequisites

This tutorial is advanced. You should be familiar with:

- [ASP.NET Core](#)
- [Authentication](#)

- [Account Confirmation and Password Recovery](#)
- [Authorization](#)
- [Entity Framework Core](#)

See [this PDF file](#) for the ASP.NET Core MVC version. The ASP.NET Core 1.1 version of this tutorial is in [this folder](#). The 1.1 ASP.NET Core sample is in the [samples](#).

## The starter and completed app

[Download](#) the [completed](#) app. Test the completed app so you become familiar with its security features.

### The starter app

[Download](#) the [starter](#) app.

Run the app, tap the **ContactManager** link, and verify you can create, edit, and delete a contact.

## Secure user data

The following sections have all the major steps to create the secure user data app. You may find it helpful to refer to the completed project.

### Tie the contact data to the user

Use the ASP.NET [Identity](#) user ID to ensure users can edit their data, but not other users data. Add `OwnerID` and `ContactStatus` to the `Contact` model:

```
public class Contact
{
    public int ContactId { get; set; }

    // user ID from AspNetUser table.
    public string OwnerID { get; set; }

    public string Name { get; set; }
    public string Address { get; set; }
    public string City { get; set; }
    public string State { get; set; }
    public string Zip { get; set; }
    [DataType(DataType.EmailAddress)]
    public string Email { get; set; }

    public ContactStatus Status { get; set; }
}

public enum ContactStatus
{
    Submitted,
    Approved,
    Rejected
}
```

`OwnerID` is the user's ID from the `AspNetUser` table in the [Identity](#) database. The `Status` field determines if a contact is viewable by general users.

Create a new migration and update the database:

```
dotnet ef migrations add userID_Status
dotnet ef database update
```

### Require HTTPS and authenticated users

Add `IHostingEnvironment` to `Startup`:

```
public class Startup
{
    public Startup(IConfiguration configuration, IHostingEnvironment env)
    {
        Configuration = configuration;
        Environment = env;
    }

    public IConfiguration Configuration { get; }
    private IHostingEnvironment Environment { get; }
```

In the `ConfigureServices` method of the `Startup.cs` file, add the `RequireHttpsAttribute` authorization filter:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<ApplicationDbContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("DefaultConnection")));

    services.AddIdentity< ApplicationUser, IdentityRole >()
        .AddEntityFrameworkStores< ApplicationDbContext >()
        .AddDefaultTokenProviders();

    var skipHTTPS = Configuration.GetValue< bool >("LocalTest:skipHTTPS");
    // requires using Microsoft.AspNetCore.Mvc;
    services.Configure< MvcOptions >(options =>
    {
        // Set LocalTest:skipHTTPS to true to skip SSL requirement in
        // debug mode. This is useful when not using Visual Studio.
        if (Environment.IsDevelopment() && !skipHTTPS)
        {
            options.Filters.Add(new RequireHttpsAttribute());
        }
    });
}
```

If you're using Visual Studio, enable HTTPS.

To redirect HTTP requests to HTTPS, see [URL Rewriting Middleware](#). If you're using Visual Studio Code or testing on a local platform that doesn't include a test certificate for HTTPS:

Set `"LocalTest:skipHTTPS": true` in the `appsettings.Development.json` file.

### Require authenticated users

Set the default authentication policy to require users to be authenticated. You can opt out of authentication at the Razor Page, controller, or action method level with the `[AllowAnonymous]` attribute. Setting the default authentication policy to require users to be authenticated protects newly added Razor Pages and controllers. Having authentication required by default is safer than relying on new controllers and Razor Pages to include the `[Authorize]` attribute.

With the requirement of all users authenticated, the `AuthorizeFolder` and `AuthorizePage` calls are not required.

Update `ConfigureServices` with the following changes:

- Comment out `AuthorizeFolder` and `AuthorizePage`.
- Set the default authentication policy to require users to be authenticated.

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<ApplicationContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("DefaultConnection")));

    services.AddIdentity<ApplicationUser, IdentityRole>()
        .AddEntityFrameworkStores<ApplicationContext>()
        .AddDefaultTokenProviders();

    var skipHTTPS = Configuration.GetValue<bool>("LocalTest:skipHTTPS");
    // requires using Microsoft.AspNetCore.Mvc;
    services.Configure<MvcOptions>(options =>
    {
        // Set LocalTest:skipHTTPS to true to skip SSL requirement in
        // debug mode. This is useful when not using Visual Studio.
        if (Environment.IsDevelopment() && !skipHTTPS)
        {
            options.Filters.Add(new RequireHttpsAttribute());
        }
    });
}

// services.AddMvc();
//.AddRazorPagesOptions(options =>
//{
//    options.Conventions.AuthorizeFolder("/Account/Manage");
//    options.Conventions.AuthorizePage("/Account/Logout");
//});

services.AddSingleton<IEmailSender, EmailSender>();

// requires: using Microsoft.AspNetCore.Authorization;
//           using Microsoft.AspNetCore.Mvc.Authorization;
services.AddMvc(config =>
{
    var policy = new AuthorizationPolicyBuilder()
        .RequireAuthenticatedUser()
        .Build();
    config.Filters.Add(new AuthorizeFilter(policy));
});

```

Add [AllowAnonymous](#) to the Index, About, and Contact pages so anonymous users can get information about the site before they register.

```

// requires using Microsoft.AspNetCore.Mvc.RazorPages;
[AllowAnonymous]
public class IndexModel : PageModel
{
    public void OnGet()
    {
    }
}

```

Add [\[AllowAnonymous\]](#) to the [LoginModel](#) and [RegisterModel](#).

## Configure the test account

The [SeedData](#) class creates two accounts: administrator and manager. Use the [Secret Manager tool](#) to set a password for these accounts. Set the password from the project directory (the directory containing *Program.cs*):

```
dotnet user-secrets set SeedUserPW <PW>
```

If you don't use a strong password, an exception is thrown when `SeedData.Initialize` is called.

Update `Main` to use the test password:

```
public class Program
{
    public static void Main(string[] args)
    {
        var host = BuildWebHost(args);

        using (var scope = host.Services.CreateScope())
        {
            var services = scope.ServiceProvider;
            var context = services.GetRequiredService<ApplicationDbContext>();
            context.Database.Migrate();

            // requires using Microsoft.Extensions.Configuration;
            var config = host.Services.GetRequiredService< IConfiguration>();
            // Set password with the Secret Manager tool.
            // dotnet user-secrets set SeedUserPW <pw>

            var testUserPw = config["SeedUserPW"];

            try
            {
                SeedData.Initialize(services, testUserPw).Wait();
            }
            catch (Exception ex)
            {
                var logger = services.GetRequiredService< ILogger<Program>>();
                logger.LogError(ex, "An error occurred while seeding the database.");
                throw ex;
            }
        }

        host.Run();
    }

    public static IWebHost BuildWebHost(string[] args) =>
        WebHost.CreateDefaultBuilder(args)
            .UseStartup<Startup>()
            .Build();
}
```

### Create the test accounts and update the contacts

Update the `Initialize` method in the `SeedData` class to create the test accounts:

```

public static async Task Initialize(IServiceProvider serviceProvider, string testUserPw)
{
    using (var context = new ApplicationDbContext(
        serviceProvider.GetRequiredService<DbContextOptions<ApplicationDbContext>>()))
    {
        // For sample purposes we are seeding 2 users both with the same password.
        // The password is set with the following command:
        // dotnet user-secrets set SeedUserPW <pw>
        // The admin user can do anything

        var adminID = await EnsureUser(serviceProvider, testUserPw, "admin@contoso.com");
        await EnsureRole(serviceProvider, adminID, Constants.ContactAdministratorsRole);

        // allowed user can create and edit contacts that they create
        var uid = await EnsureUser(serviceProvider, testUserPw, "manager@contoso.com");
        await EnsureRole(serviceProvider, uid, Constants.ContactManagersRole);

        SeedDB(context, adminID);
    }
}

private static async Task<string> EnsureUser(IServiceProvider serviceProvider,
                                              string testUserPw, string UserName)
{
    var userManager = serviceProvider.GetService<UserManager< ApplicationUser >>();

    var user = await userManager.FindByNameAsync(UserName);
    if (user == null)
    {
        user = new ApplicationUser { UserName = UserName };
        await userManager.CreateAsync(user, testUserPw);
    }

    return user.Id;
}

private static async Task<IdentityResult> EnsureRole(IServiceProvider serviceProvider,
                                                       string uid, string role)
{
    IdentityResult IR = null;
    var roleManager = serviceProvider.GetService<RoleManager< IdentityRole >>();

    if (!await roleManager.RoleExistsAsync(role))
    {
        IR = await roleManager.CreateAsync(new IdentityRole(role));
    }

    var userManager = serviceProvider.GetService<UserManager< ApplicationUser >>();

    var user = await userManager.FindByIdAsync(uid);

    IR = await userManager.AddToRoleAsync(user, role);

    return IR;
}

```

Add the administrator user ID and `contactStatus` to the contacts. Make one of the contacts "Submitted" and one "Rejected". Add the user ID and status to all the contacts. Only one contact is shown:

```
public static void SeedDB(ApplicationDbContext context, string adminID)
{
    if (context.Contact.Any())
    {
        return; // DB has been seeded
    }

    context.Contact.AddRange(
        new Contact
        {
            Name = "Debra Garcia",
            Address = "1234 Main St",
            City = "Redmond",
            State = "WA",
            Zip = "10999",
            Email = "debra@example.com",
            Status = ContactStatus.Approved,
            OwnerID = adminID
        },
    );
}
```

## Create owner, manager, and administrator authorization handlers

Create a `ContactIsOwnerAuthorizationHandler` class in the *Authorization* folder. The `ContactIsOwnerAuthorizationHandler` verifies that the user acting on a resource owns the resource.

```

using System.Threading.Tasks;
using ContactManager.Data;
using ContactManager.Models;
using Microsoft.AspNetCore.Authorization;
using Microsoft.AspNetCore.Authorization.Infrastructure;
using Microsoft.AspNetCore.Identity;

namespace ContactManager.Authorization
{
    public class ContactIsOwnerAuthorizationHandler
        : AuthorizationHandler<OperationAuthorizationRequirement, Contact>
    {
        UserManager< ApplicationUser > _userManager;

        public ContactIsOwnerAuthorizationHandler(UserManager< ApplicationUser > userManager)
        {
            _userManager = userManager;
        }

        protected override Task
            HandleRequirementAsync(AuthorizationHandlerContext context,
                OperationAuthorizationRequirement requirement,
                Contact resource)
        {
            if (context.User == null || resource == null)
            {
                // Return Task.FromResult(0) if targeting a version of
                // .NET Framework older than 4.6:
                return Task.CompletedTask;
            }

            // If we're not asking for CRUD permission, return.

            if (requirement.Name != Constants.CreateOperationName &&
                requirement.Name != Constants.ReadOperationName &&
                requirement.Name != Constants.UpdateOperationName &&
                requirement.Name != Constants.DeleteOperationName )
            {
                return Task.CompletedTask;
            }

            if (resource.OwnerID == _userManager.GetUserId(context.User))
            {
                context.Succeed(requirement);
            }

            return Task.CompletedTask;
        }
    }
}

```

The `ContactIsOwnerAuthorizationHandler` calls `context.Succeed` if the current authenticated user is the contact owner. Authorization handlers generally:

- Return `context.Succeed` when the requirements are met.
- Return `Task.CompletedTask` when requirements aren't met. `Task.CompletedTask` is neither success or failure—it allows other authorization handlers to run.

If you need to explicitly fail, return `context.Fail`.

The app allows contact owners to edit/delete/create their own data. `ContactIsOwnerAuthorizationHandler` doesn't need to check the operation passed in the requirement parameter.

## Create a manager authorization handler

Create a `ContactManagerAuthorizationHandler` class in the *Authorization* folder. The `ContactManagerAuthorizationHandler` verifies the user acting on the resource is a manager. Only managers can approve or reject content changes (new or changed).

```
using System.Threading.Tasks;
using ContactManager.Models;
using Microsoft.AspNetCore.Authorization;
using Microsoft.AspNetCore.Authorization.Infrastructure;
using Microsoft.AspNetCore.Identity;

namespace ContactManager.Authorization
{
    public class ContactManagerAuthorizationHandler :
        AuthorizationHandler<OperationAuthorizationRequirement, Contact>
    {
        protected override Task
            HandleRequirementAsync(AuthorizationHandlerContext context,
                OperationAuthorizationRequirement requirement,
                Contact resource)
        {
            if (context.User == null || resource == null)
            {
                return Task.CompletedTask;
            }

            // If not asking for approval/reject, return.
            if (requirement.Name != Constants.ApproveOperationName &&
                requirement.Name != Constants.RejectOperationName)
            {
                return Task.CompletedTask;
            }

            // Managers can approve or reject.
            if (context.User.IsInRole(Constants.ContactManagersRole))
            {
                context.Succeed(requirement);
            }

            return Task.CompletedTask;
        }
    }
}
```

## Create an administrator authorization handler

Create a `ContactAdministratorsAuthorizationHandler` class in the *Authorization* folder. The `ContactAdministratorsAuthorizationHandler` verifies the user acting on the resource is an administrator. Administrator can do all operations.

```

using System.Threading.Tasks;
using ContactManager.Models;
using Microsoft.AspNetCore.Authorization;
using Microsoft.AspNetCore.Authorization.Infrastructure;

namespace ContactManager.Authorization
{
    public class ContactAdministratorsAuthorizationHandler
        : AuthorizationHandler<OperationAuthorizationRequirement, Contact>
    {
        protected override Task HandleRequirementAsync(
            AuthorizationHandlerContext context,
            OperationAuthorizationRequirement requirement,
            Contact resource)
        {
            if (context.User == null)
            {
                return Task.CompletedTask;
            }

            // Administrators can do anything.
            if (context.User.IsInRole(Constants.ContactAdministratorsRole))
            {
                context.Succeed(requirement);
            }

            return Task.CompletedTask;
        }
    }
}

```

## Register the authorization handlers

Services using Entity Framework Core must be registered for [dependency injection](#) using [AddScoped](#). The

`ContactIsOwnerAuthorizationHandler` uses ASP.NET Core [Identity](#), which is built on Entity Framework Core.

Register the handlers with the service collection so they're available to the `ContactsController` through

[dependency injection](#). Add the following code to the end of `ConfigureServices` :

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<ApplicationContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("DefaultConnection")));

    services.AddIdentity<ApplicationUser, IdentityRole>()
        .AddEntityFrameworkStores<ApplicationContext>()
        .AddDefaultTokenProviders();

    var skipHTTPS = Configuration.GetValue<bool>("LocalTest:skipHTTPS");
    // requires using Microsoft.AspNetCore.Mvc;
    services.Configure<MvcOptions>(options =>
    {
        // Set LocalTest:skipHTTPS to true to skip SSL requirement in
        // debug mode. This is useful when not using Visual Studio.
        if (Environment.IsDevelopment() && !skipHTTPS)
        {
            options.Filters.Add(new RequireHttpsAttribute());
        }
    });
}

// services.AddMvc();
// .AddRazorPagesOptions(options =>
//{
//     options.Conventions.AuthorizeFolder("/Account/Manage");
//     options.Conventions.AuthorizePage("/Account/Logout");
//});

services.AddSingleton<IEmailSender, EmailSender>();

// requires: using Microsoft.AspNetCore.Authorization;
//           using Microsoft.AspNetCore.Mvc.Authorization;
services.AddMvc(config =>
{
    var policy = new AuthorizationPolicyBuilder()
        .RequireAuthenticatedUser()
        .Build();
    config.Filters.Add(new AuthorizeFilter(policy));
});

// Authorization handlers.
services.AddScoped<IAuthorizationHandler,
    ContactIsOwnerAuthorizationHandler>();

services.AddSingleton<IAuthorizationHandler,
    ContactAdministratorsAuthorizationHandler>();

services.AddSingleton<IAuthorizationHandler,
    ContactManagerAuthorizationHandler>();
}

```

`ContactAdministratorsAuthorizationHandler` and `ContactManagerAuthorizationHandler` are added as singletons. They're singletons because they don't use EF and all the information needed is in the `context` parameter of the `HandleRequirementAsync` method.

## Support authorization

In this section, you update the Razor Pages and add an operations requirements class.

### Review the contact operations requirements class

Review the `ContactOperations` class. This class contains the requirements the app supports:

```

using Microsoft.AspNetCore.Authorization.Infrastructure;

namespace ContactManager.Authorization
{
    public static class ContactOperations
    {
        public static OperationAuthorizationRequirement Create =
            new OperationAuthorizationRequirement {Name=Constants.CreateOperationName};
        public static OperationAuthorizationRequirement Read =
            new OperationAuthorizationRequirement {Name=Constants.ReadOperationName};
        public static OperationAuthorizationRequirement Update =
            new OperationAuthorizationRequirement {Name=Constants.UpdateOperationName};
        public static OperationAuthorizationRequirement Delete =
            new OperationAuthorizationRequirement {Name=Constants.DeleteOperationName};
        public static OperationAuthorizationRequirement Approve =
            new OperationAuthorizationRequirement {Name=Constants.ApproveOperationName};
        public static OperationAuthorizationRequirement Reject =
            new OperationAuthorizationRequirement {Name=Constants.RejectOperationName};
    }

    public class Constants
    {
        public static readonly string CreateOperationName = "Create";
        public static readonly string ReadOperationName = "Read";
        public static readonly string UpdateOperationName = "Update";
        public static readonly string DeleteOperationName = "Delete";
        public static readonly string ApproveOperationName = "Approve";
        public static readonly string RejectOperationName = "Reject";

        public static readonly string ContactAdministratorsRole =
            "ContactAdministrators";
        public static readonly string ContactManagersRole = "ContactManagers";
    }
}

```

## Create a base class for the Razor Pages

Create a base class that contains the services used in the contacts Razor Pages. The base class puts that initialization code in one location:

```

using ContactManager.Data;
using Microsoft.AspNetCore.Authorization;
using Microsoft.AspNetCore.Identity;
using Microsoft.AspNetCore.Mvc.RazorPages;

namespace ContactManager.Pages.Contacts
{
    public class DI_BasePageModel : PageModel
    {
        protected ApplicationDbContext Context { get; }
        protected IAuthorizationService AuthorizationService { get; }
        protected UserManager<ApplicationUser> UserManager { get; }

        public DI_BasePageModel(
            ApplicationDbContext context,
            IAuthorizationService authorizationService,
            UserManager<ApplicationUser> userManager) : base()
        {
            Context = context;
            UserManager = userManager;
            AuthorizationService = authorizationService;
        }
    }
}

```

The preceding code:

- Adds the `IAuthorizationService` service to access to the authorization handlers.
- Adds the Identity `UserManager` service.
- Add the `ApplicationDbContext`.

## Update the CreateModel

Update the create page model constructor to use the `DI_BasePageModel` base class:

```
public class CreateModel : DI_BasePageModel
{
    public CreateModel(
        ApplicationDbContext context,
        IAuthorizationService authorizationService,
        UserManager< ApplicationUser > userManager)
        : base(context, authorizationService, userManager)
    {
    }
}
```

Update the `CreateModel.OnPostAsync` method to:

- Add the user ID to the `Contact` model.
- Call the authorization handler to verify the user has permission to create contacts.

```
public async Task< IActionResult > OnPostAsync()
{
    if (!ModelState.IsValid)
    {
        return Page();
    }

    Contact.OwnerID = UserManager.GetUserId(User);

    // requires using ContactManager.Authorization;
    var isAuthorized = await AuthorizationService.AuthorizeAsync(
        User, Contact,
        ContactOperations.Create);

    if (!isAuthorized.Succeeded)
    {
        return new ChallengeResult();
    }

    Context.Contact.Add(Contact);
    await Context.SaveChangesAsync();

    return RedirectToPage("./Index");
}
```

## Update the IndexModel

Update the `OnGetAsync` method so only approved contacts are shown to general users:

```

public class IndexModel : DI_BasePageModel
{
    public IndexModel(
        ApplicationDbContext context,
        IAuthorizationService authorizationService,
        UserManager<ApplicationUser> userManager)
        : base(context, authorizationService, userManager)
    {
    }

    public IList<Contact> Contact { get; set; }

    public async Task OnGetAsync()
    {
        var contacts = from c in Context.Contact
                      select c;

        var isAuthorized = User.IsInRole(Constants.ContactManagersRole) ||
                           User.IsInRole(Constants.ContactAdministratorsRole);

        var currentUserID = UserManager.GetUserId(User);

        // Only approved contacts are shown UNLESS you're authorized to see them
        // or you are the owner.
        if (!isAuthorized)
        {
            contacts = contacts.Where(c => c.Status == ContactStatus.Approved
                                      || c.OwnerID == currentUserID);
        }

        Contact = await contacts.ToListAsync();
    }
}

```

## Update the EditModel

Add an authorization handler to verify the user owns the contact. Because resource authorization is being validated, the `[Authorize]` attribute is not enough. The app doesn't have access to the resource when attributes are evaluated. Resource-based authorization must be imperative. Checks must be performed once the app has access to the resource, either by loading it in the page model or by loading it within the handler itself. You frequently access the resource by passing in the resource key.

```

public class EditModel : DI_BasePageModel
{
    public EditModel(
        ApplicationDbContext context,
        IAuthorizationService authorizationService,
        UserManager<ApplicationUser> userManager)
        : base(context, authorizationService, userManager)
    {
    }

    [BindProperty]
    public Contact Contact { get; set; }

    public async Task<IActionResult> OnGetAsync(int id)
    {
        Contact = await Context.Contact.FirstOrDefaultAsync(
            m => m.ContactId == id);

        if (Contact == null)
        {
            return NotFound();
        }
    }
}

```

```

        var isAuthorized = await AuthorizationService.AuthorizeAsync(
            User, Contact,
            ContactOperations.Update);

        if (!isAuthorized.Succeeded)
        {
            return new ChallengeResult();
        }

        return Page();
    }

    public async Task<IActionResult> OnPostAsync(int id)
    {
        if (!ModelState.IsValid)
        {
            return Page();
        }

        // Fetch Contact from DB to get OwnerID.
        var contact = await Context
            .Contact.AsNoTracking()
            .FirstOrDefaultAsync(m => m.ContactId == id);

        if (contact == null)
        {
            return NotFound();
        }

        var isAuthorized = await AuthorizationService.AuthorizeAsync(
            User, contact,
            ContactOperations.Update);

        if (!isAuthorized.Succeeded)
        {
            return new ChallengeResult();
        }

        Contact.OwnerID = contact.OwnerID;

        Context.Attach(Contact).State = EntityState.Modified;

        if (contact.Status == ContactStatus.Approved)
        {
            // If the contact is updated after approval,
            // and the user cannot approve,
            // set the status back to submitted so the update can be
            // checked and approved.
            var canApprove = await AuthorizationService.AuthorizeAsync(User,
                contact,
                ContactOperations.Approve);

            if (!canApprove.Succeeded)
            {
                contact.Status = ContactStatus.Submitted;
            }
        }

        await Context.SaveChangesAsync();

        return RedirectToPage("./Index");
    }

    private bool ContactExists(int id)
    {
        return Context.Contact.Any(e => e.ContactId == id);
    }
}

```

## Update the DeleteModel

Update the delete page model to use the authorization handler to verify the user has delete permission on the contact.

```
public class DeleteModel : DI_BasePageModel
{
    public DeleteModel(
        ApplicationDbContext context,
        IAuthorizationService authorizationService,
        UserManager<ApplicationUser> userManager)
        : base(context, authorizationService, userManager)
    {
    }

    [BindProperty]
    public Contact Contact { get; set; }

    public async Task<IActionResult> OnGetAsync(int id)
    {
        Contact = await Context.Contact.FirstOrDefaultAsync(
            m => m.ContactId == id);

        if (Contact == null)
        {
            return NotFound();
        }

        var isAuthorized = await AuthorizationService.AuthorizeAsync(
            User, Contact,
            ContactOperations.Delete);

        if (!isAuthorized.Succeeded)
        {
            return new ChallengeResult();
        }

        return Page();
    }

    public async Task<IActionResult> OnPostAsync(int id)
    {
        Contact = await Context.Contact.FindAsync(id);

        var contact = await Context
            .Contact.AsNoTracking()
            .FirstOrDefaultAsync(m => m.ContactId == id);

        if (contact == null)
        {
            return NotFound();
        }

        var isAuthorized = await AuthorizationService.AuthorizeAsync(
            User, contact,
            ContactOperations.Delete);

        if (!isAuthorized.Succeeded)
        {
            return new ChallengeResult();
        }

        Context.Contact.Remove(Contact);
        await Context.SaveChangesAsync();

        return RedirectToPage("./Index");
    }
}
```

## Inject the authorization service into the views

Currently, the UI shows edit and delete links for data the user can't modify. The UI is fixed by applying the authorization handler to the views.

Inject the authorization service in the `Views/_ViewImports.cshtml` file so it's available to all views:

```
@using Microsoft.AspNetCore.Identity
@using ContactManager
@using ContactManager.Data
@namespace ContactManager.Pages
@addTagHelper *, Microsoft.AspNetCore.Mvc.TagHelpers
@using ContactManager.Authorization;
@using Microsoft.AspNetCore.Authorization
@using ContactManager.Models
@inject IAuthorizationService AuthorizationService
```

The preceding markup adds several `using` statements.

Update the **Edit** and **Delete** links in `Pages/Contacts/Index.cshtml` so they're only rendered for users with the appropriate permissions:

```
@page
@model ContactManager.Pages.Contacts.IndexModel

 @{
    ViewData["Title"] = "Index";
}

<h2>Index</h2>

<p>
    <a asp-page="Create">Create New</a>
</p>
<table class="table">
    <thead>
        <tr>
            <th>
                @Html.DisplayNameFor(model => model.Contact[0].Name)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Contact[0].Address)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Contact[0].City)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Contact[0].State)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Contact[0].Zip)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Contact[0].Email)
            </th>
            <th>
                @Html.DisplayNameFor(model => model.Contact[0].Status)
            </th>
            <th></th>
        </tr>
    </thead>
    <tbody>
        @foreach (var item in Model.Contact)
        {
            <tr>
```

```

<td>
    @Html.DisplayFor(modelItem => item.Name)
</td>
<td>
    @Html.DisplayFor(modelItem => item.Address)
</td>
<td>
    @Html.DisplayFor(modelItem => item.City)
</td>
<td>
    @Html.DisplayFor(modelItem => item.State)
</td>
<td>
    @Html.DisplayFor(modelItem => item.Zip)
</td>

<td>
    @Html.DisplayFor(modelItem => item.Email)
</td>

<td>
    @Html.DisplayFor(modelItem => item.Status)
</td>
<td>
@if ((await AuthorizationService.AuthorizeAsync(
    User, item,
    ContactOperations.Update)).Succeeded)
{
    <a asp-page=".Edit" asp-route-id="@item.ContactId">Edit</a>
    <text> | </text>
}
<a asp-page=".Details" asp-route-id="@item.ContactId">Details</a>

@if ((await AuthorizationService.AuthorizeAsync(
    User, item,
    ContactOperations.Delete)).Succeeded)
{
    <text> | </text>
    <a asp-page=".Delete" asp-route-id="@item.ContactId">Delete</a>
}
</td>
</tr>
}
</tbody>
</table>

```

#### WARNING

Hiding links from users that don't have permission to change data doesn't secure the app. Hiding links makes the app more user-friendly by displaying only valid links. Users can hack the generated URLs to invoke edit and delete operations on data they don't own. The Razor Page or controller must enforce access checks to secure the data.

#### Update Details

Update the details view so managers can approve or reject contacts:

```

/*Preceding markup omitted for brevity.*@

<dd>
    @Html.DisplayFor(model => model.Contact.Email)
</dd>
<dt>
    @Html.DisplayNameFor(model => model.Contact.Status)
</dt>
<dd>
    @Html.DisplayFor(model => model.Contact.Status)
</dd>
</dl>
</div>

@if (Model.Contact.Status != ContactStatus.Approved)
{
    @if ((await AuthorizationService.AuthorizeAsync(
        User, Model.Contact, ContactOperations.Approve)).Succeeded)
    {
        <form style="display:inline;" method="post">
            <input type="hidden" name="id" value="@Model.Contact.ContactId" />
            <input type="hidden" name="status" value="@ContactStatus.Approved" />
            <button type="submit" class="btn btn-xs btn-success">Approve</button>
        </form>
    }
}

@if (Model.Contact.Status != ContactStatus.Rejected)
{
    @if ((await AuthorizationService.AuthorizeAsync(
        User, Model.Contact, ContactOperations.Reject)).Succeeded)
    {
        <form style="display:inline;" method="post">
            <input type="hidden" name="id" value="@Model.Contact.ContactId" />
            <input type="hidden" name="status" value="@ContactStatus.Rejected" />
            <button type="submit" class="btn btn-xs btn-success">Reject</button>
        </form>
    }
}

<div>
    @if ((await AuthorizationService.AuthorizeAsync(
        User, Model.Contact,
        ContactOperations.Update)).Succeeded)
    {
        <a asp-page="./Edit" asp-route-id="@Model.Contact.ContactId">Edit</a>
        <text> | </text>
    }
    <a asp-page="./Index">Back to List</a>
</div>

```

Update the details page model:

```

public class DetailsModel : DI_BasePageModel
{
    public DetailsModel(
        ApplicationDbContext context,
        IAuthorizationService authorizationService,
        UserManager<ApplicationUser> userManager)
        : base(context, authorizationService, userManager)
    {
    }

    public Contact Contact { get; set; }

    public async Task<IActionResult> OnGetAsync(int id)
    {
        Contact = await Context.Contact.FirstOrDefaultAsync(m => m.ContactId == id);

        if (Contact == null)
        {
            return NotFound();
        }
        return Page();
    }

    public async Task<IActionResult> OnPostAsync(int id, ContactStatus status)
    {
        var contact = await Context.Contact.FirstOrDefaultAsync(
            m => m.ContactId == id);

        if (contact == null)
        {
            return NotFound();
        }

        var contactOperation = (status == ContactStatus.Approved)
            ? ContactOperations.Approve
            : ContactOperations.Reject;

        var isAuthorized = await AuthorizationService.AuthorizeAsync(User, contact,
            contactOperation);
        if (!isAuthorized.Succeeded)
        {
            return new ChallengeResult();
        }
        contact.Status = status;
        Context.Contact.Update(contact);
        await Context.SaveChangesAsync();

        return RedirectToPage("./Index");
    }
}

```

## Test the completed app

If you're using Visual Studio Code or testing on a local platform that doesn't include a test certificate for HTTPS:

- Set `"LocalTest:skipHTTPS": true` in the `appsettings.Development.json` file to skip the HTTPS requirement.  
Skip HTTPS only on a development machine.

If the app has contacts:

- Delete all the records in the `Contact` table.
- Restart the app to seed the database.

Register a user for browsing the contacts.

An easy way to test the completed app is to launch three different browsers (or incognito/InPrivate versions). In one browser, register a new user (for example, `test@example.com`). Sign in to each browser with a different user. Verify the following operations:

- Registered users can view all the approved contact data.
- Registered users can edit/delete their own data.
- Managers can approve or reject contact data. The `Details` view shows **Approve** and **Reject** buttons.
- Administrators can approve/reject and edit/delete any data.

USER	OPTIONS
test@example.com	Can edit/delete own data
manager@contoso.com	Can approve/reject and edit/delete own data
admin@contoso.com	Can edit/delete and approve/reject all data

Create a contact in the administrator's browser. Copy the URL for delete and edit from the administrator contact. Paste these links into the test user's browser to verify the test user can't perform these operations.

## Create the starter app

- Create a Razor Pages app named "ContactManager"
  - Create the app with **Individual User Accounts**.
  - Name it "ContactManager" so your namespace matches the namespace used in the sample.

```
dotnet new webapp -o ContactManager -au Individual -uld
```

### NOTE

In ASP.NET Core 2.1 or later, `webapp` is an alias of the `razor` argument. If the `dotnet new webapp <OPTIONS>` command loads the `dotnet new` command help instead of creating a new Razor Pages app, install the [.NET Core 2.1 SDK](#).

```
dotnet new razor -o ContactManager -au Individual -uld
```

- `-uld` specifies LocalDB instead of SQLite
- Add the following `Contact` model:

```
public class Contact
{
    public int ContactId { get; set; }
    public string Name { get; set; }
    public string Address { get; set; }
    public string City { get; set; }
    public string State { get; set; }
    public string Zip { get; set; }
    [DataType(DataType.EmailAddress)]
    public string Email { get; set; }
}
```

- Scaffold the `Contact` model:

```
dotnet aspnet-codegenerator razorpage -m Contact -udl -dc ApplicationContext -outDir Pages\Contacts --referenceScriptLibraries
```

- Update the **ContactManager** anchor in the *Pages/\_Layout.cshtml* file:

```
<a asp-page="/Contacts/Index" class="navbar-brand">ContactManager</a>
```

- Scaffold the initial migration and update the database:

```
dotnet ef migrations add initial  
dotnet ef database update
```

- Test the app by creating, editing, and deleting a contact

## Seed the database

Add the `SeedData` class to the *Data* folder. If you've downloaded the sample, you can copy the *SeedData.cs* file to the *Data* folder of the starter project.

Call `SeedData.Initialize` from `Main`:

```
public class Program  
{  
    public static void Main(string[] args)  
    {  
        var host = BuildWebHost(args);  
  
        using (var scope = host.Services.CreateScope())  
        {  
            var services = scope.ServiceProvider;  
            var context = services.GetRequiredService<ApplicationContext>();  
            context.Database.Migrate();  
  
            try  
            {  
                SeedData.Initialize(services, "").Wait();  
            }  
            catch (Exception ex)  
            {  
                var logger = services.GetRequiredService<ILogger<Program>>();  
                logger.LogError(ex, "An error occurred while seeding the database.");  
                throw ex;  
            }  
        }  
  
        host.Run();  
    }  
  
    public static IWebHost BuildWebHost(string[] args) =>  
        WebHost.CreateDefaultBuilder(args)  
            .UseStartup<Startup>()  
            .Build();  
    }  
}
```

Test that the app seeded the database. If there are any rows in the contact DB, the seed method doesn't run.

## Additional resources

- [ASP.NET Core Authorization Lab](#). This lab goes into more detail on the security features introduced in this tutorial.

- [Authorization in ASP.NET Core: Simple, role, claims-based, and custom](#)
- [Custom policy-based authorization](#)

# Razor Pages authorization conventions in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Luke Latham](#)

One way to control access in your Razor Pages app is to use authorization conventions at startup. These conventions allow you to authorize users and allow anonymous users to access individual pages or folders of pages. The conventions described in this topic automatically apply [authorization filters](#) to control access.

[View or download sample code \(how to download\)](#)

The sample app uses [Cookie authentication without ASP.NET Core Identity](#). The user account for the hypothetical user, Maria Rodriguez, is hardcoded into the app. Use the Email username "maria.rodriguez@contoso.com" and any password to sign in the user. The user is authenticated in the `AuthenticateUser` method in the `Pages/Account/Login.cshtml.cs` file. In a real-world example, the user would be authenticated against a database. To use ASP.NET Core Identity, follow the guidance in the [Introduction to Identity on ASP.NET Core](#) topic. The concepts and examples shown in this topic apply equally to apps that use ASP.NET Core Identity.

## Require authorization to access a page

Use the [AuthorizePage](#) convention via [AddRazorPagesOptions](#) to add an [AuthorizeFilter](#) to the page at the specified path:

```
services.AddMvc()
    .AddRazorPagesOptions(options =>
{
    options.Conventions.AuthorizePage("/Contact");
    options.Conventions.AuthorizeFolder("/Private");
    options.Conventions.AllowAnonymousToPage("/Private/PublicPage");
    options.Conventions.AllowAnonymousToFolder("/Private/PublicPages");
})
.SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
```

The specified path is the View Engine path, which is the Razor Pages root relative path without an extension and containing only forward slashes.

An [AuthorizePage overload](#) is available if you need to specify an authorization policy.

### NOTE

An `AuthorizeFilter` can be applied to a page model class with the `[Authorize]` filter attribute. For more information, see [Authorize filter attribute](#).

## Require authorization to access a folder of pages

Use the [AuthorizeFolder](#) convention via [AddRazorPagesOptions](#) to add an [AuthorizeFilter](#) to all of the pages in a folder at the specified path:

```
services.AddMvc()
    .AddRazorPagesOptions(options =>
{
    options.Conventions.AuthorizePage("/Contact");
    options.Conventions.AuthorizeFolder("/Private");
    options.Conventions.AllowAnonymousToPage("/Private/PublicPage");
    options.Conventions.AllowAnonymousToFolder("/Private/PublicPages");
})
.SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
```

The specified path is the View Engine path, which is the Razor Pages root relative path.

An [AuthorizeFolder overload](#) is available if you need to specify an authorization policy.

## Allow anonymous access to a page

Use the [AllowAnonymousToPage](#) convention via [AddRazorPagesOptions](#) to add an [AllowAnonymousFilter](#) to a page at the specified path:

```
services.AddMvc()
    .AddRazorPagesOptions(options =>
{
    options.Conventions.AuthorizePage("/Contact");
    options.Conventions.AuthorizeFolder("/Private");
    options.Conventions.AllowAnonymousToPage("/Private/PublicPage");
    options.Conventions.AllowAnonymousToFolder("/Private/PublicPages");
})
.SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
```

The specified path is the View Engine path, which is the Razor Pages root relative path without an extension and containing only forward slashes.

## Allow anonymous access to a folder of pages

Use the [AllowAnonymousToFolder](#) convention via [AddRazorPagesOptions](#) to add an [AllowAnonymousFilter](#) to all of the pages in a folder at the specified path:

```
services.AddMvc()
    .AddRazorPagesOptions(options =>
{
    options.Conventions.AuthorizePage("/Contact");
    options.Conventions.AuthorizeFolder("/Private");
    options.Conventions.AllowAnonymousToPage("/Private/PublicPage");
    options.Conventions.AllowAnonymousToFolder("/Private/PublicPages");
})
.SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
```

The specified path is the View Engine path, which is the Razor Pages root relative path.

## Note on combining authorized and anonymous access

It's perfectly valid to specify that a folder of pages require authorization and specify that a page within that folder allows anonymous access:

```
// This works.
.AuthorizeFolder("/Private").AllowAnonymousToPage("/Private/Public")
```

The reverse, however, isn't true. You can't declare a folder of pages for anonymous access and specify a page within for authorization:

```
// This doesn't work!
.AllowAnonymousToFolder("/Public").AuthorizePage("/Public/Private")
```

Requiring authorization on the Private page won't work because when both the `AllowAnonymousFilter` and `AuthorizeFilter` filters are applied to the page, the `AllowAnonymousFilter` wins and controls access.

## Additional resources

- [Razor Pages custom route and page model providers](#)
- [PageConventionCollection class](#)

# Simple authorization in ASP.NET Core

6/26/2018 • 2 minutes to read • [Edit Online](#)

Authorization in MVC is controlled through the `AuthorizeAttribute` attribute and its various parameters. At its simplest, applying the `AuthorizeAttribute` attribute to a controller or action limits access to the controller or action to any authenticated user.

For example, the following code limits access to the `AccountController` to any authenticated user.

```
[Authorize]
public class AccountController : Controller
{
    public ActionResult Login()
    {

    }

    public ActionResult Logout()
    {
    }
}
```

If you want to apply authorization to an action rather than the controller, apply the `AuthorizeAttribute` attribute to the action itself:

```
public class AccountController : Controller
{
    public ActionResult Login()
    {

    }

    [Authorize]
    public ActionResult Logout()
    {
    }
}
```

Now only authenticated users can access the `Logout` function.

You can also use the `AllowAnonymous` attribute to allow access by non-authenticated users to individual actions.

For example:

```
[Authorize]
public class AccountController : Controller
{
    [AllowAnonymous]
    public ActionResult Login()
    {

    }

    public ActionResult Logout()
    {
    }
}
```

This would allow only authenticated users to the `AccountController`, except for the `Login` action, which is

accessible by everyone, regardless of their authenticated or unauthenticated / anonymous status.

### WARNING

`[AllowAnonymous]` bypasses all authorization statements. If you combine `[AllowAnonymous]` and any `[Authorize]` attribute, the `[Authorize]` attributes are ignored. For example if you apply `[AllowAnonymous]` at the controller level, any `[Authorize]` attributes on the same controller (or on any action within it) is ignored.

# Role-based authorization in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

When an identity is created it may belong to one or more roles. For example, Tracy may belong to the Administrator and User roles whilst Scott may only belong to the User role. How these roles are created and managed depends on the backing store of the authorization process. Roles are exposed to the developer through the `IsInRole` method on the `ClaimsPrincipal` class.

## Adding role checks

Role-based authorization checks are declarative—the developer embeds them within their code, against a controller or an action within a controller, specifying roles which the current user must be a member of to access the requested resource.

For example, the following code limits access to any actions on the `AdministrationController` to users who are a member of the `Administrator` role:

```
[Authorize(Roles = "Administrator")]
public class AdministrationController : Controller
{}
```

You can specify multiple roles as a comma separated list:

```
[Authorize(Roles = "HRManager,Finance")]
public class SalaryController : Controller
{}
```

This controller would be only accessible by users who are members of the `HRManager` role or the `Finance` role.

If you apply multiple attributes then an accessing user must be a member of all the roles specified; the following sample requires that a user must be a member of both the `PowerUser` and `ControlPanelUser` role.

```
[Authorize(Roles = "PowerUser")]
[Authorize(Roles = "ControlPanelUser")]
public class ControlPanelController : Controller
{}
```

You can further limit access by applying additional role authorization attributes at the action level:

```
[Authorize(Roles = "Administrator, PowerUser")]
public class ControlPanelController : Controller
{
    public ActionResult SetTime()
    {
    }

    [Authorize(Roles = "Administrator")]
    public ActionResult ShutDown()
    {
    }
}
```

In the previous code snippet members of the `Administrator` role or the `PowerUser` role can access the controller and the `SetTime` action, but only members of the `Administrator` role can access the `ShutDown` action.

You can also lock down a controller but allow anonymous, unauthenticated access to individual actions.

```
[Authorize]
public class ControlPanelController : Controller
{
    public ActionResult SetTime()
    {
    }

    [AllowAnonymous]
    public ActionResult Login()
    {
    }
}
```

## Policy based role checks

Role requirements can also be expressed using the new Policy syntax, where a developer registers a policy at startup as part of the Authorization service configuration. This normally occurs in `ConfigureServices()` in your `Startup.cs` file.

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc();

    services.AddAuthorization(options =>
    {
        options.AddPolicy("RequireAdministratorRole", policy => policy.RequireRole("Administrator"));
    });
}
```

Policies are applied using the `Policy` property on the `AuthorizeAttribute` attribute:

```
[Authorize(Policy = "RequireAdministratorRole")]
public IActionResult Shutdown()
{
    return View();
}
```

If you want to specify multiple allowed roles in a requirement then you can specify them as parameters to the `RequireRole` method:

```
options.AddPolicy("ElevatedRights", policy =>
    policy.RequireRole("Administrator", "PowerUser", "BackupAdministrator"));
```

This example authorizes users who belong to the `Administrator`, `PowerUser` Or `BackupAdministrator` roles.

# Claims-based authorization in ASP.NET Core

6/21/2018 • 3 minutes to read • [Edit Online](#)

When an identity is created it may be assigned one or more claims issued by a trusted party. A claim is a name value pair that represents what the subject is, not what the subject can do. For example, you may have a driver's license, issued by a local driving license authority. Your driver's license has your date of birth on it. In this case the claim name would be `DateOfBirth`, the claim value would be your date of birth, for example `8th June 1970` and the issuer would be the driving license authority. Claims based authorization, at its simplest, checks the value of a claim and allows access to a resource based upon that value. For example if you want access to a night club the authorization process might be:

The door security officer would evaluate the value of your date of birth claim and whether they trust the issuer (the driving license authority) before granting you access.

An identity can contain multiple claims with multiple values and can contain multiple claims of the same type.

## Adding claims checks

Claim based authorization checks are declarative - the developer embeds them within their code, against a controller or an action within a controller, specifying claims which the current user must possess, and optionally the value the claim must hold to access the requested resource. Claims requirements are policy based, the developer must build and register a policy expressing the claims requirements.

The simplest type of claim policy looks for the presence of a claim and doesn't check the value.

First you need to build and register the policy. This takes place as part of the Authorization service configuration, which normally takes part in `ConfigureServices()` in your `Startup.cs` file.

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc();

    services.AddAuthorization(options =>
    {
        options.AddPolicy("EmployeeOnly", policy => policy.RequireClaim("EmployeeNumber"));
    });
}
```

In this case the `EmployeeOnly` policy checks for the presence of an `EmployeeNumber` claim on the current identity.

You then apply the policy using the `Policy` property on the `AuthorizeAttribute` attribute to specify the policy name;

```
[Authorize(Policy = "EmployeeOnly")]
public IActionResult VacationBalance()
{
    return View();
}
```

The `AuthorizeAttribute` attribute can be applied to an entire controller, in this instance only identities matching the policy will be allowed access to any Action on the controller.

```
[Authorize(Policy = "EmployeeOnly")]
public class VacationController : Controller
{
    public ActionResult VacationBalance()
    {
    }
}
```

If you have a controller that's protected by the `AuthorizeAttribute` attribute, but want to allow anonymous access to particular actions you apply the `AllowAnonymousAttribute` attribute.

```
[Authorize(Policy = "EmployeeOnly")]
public class VacationController : Controller
{
    public ActionResult VacationBalance()
    {
    }

    [AllowAnonymous]
    public ActionResult VacationPolicy()
    {
    }
}
```

Most claims come with a value. You can specify a list of allowed values when creating the policy. The following example would only succeed for employees whose employee number was 1, 2, 3, 4 or 5.

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc();

    services.AddAuthorization(options =>
    {
        options.AddPolicy("Founders", policy =>
            policy.RequireClaim("EmployeeNumber", "1", "2", "3", "4", "5"));
    });
}
```

### Add a generic claim check

If the claim value isn't a single value or a transformation is required, use [RequireAssertion](#). For more information, see [Using a func to fulfill a policy](#).

## Multiple Policy Evaluation

If you apply multiple policies to a controller or action, then all policies must pass before access is granted. For example:

```
[Authorize(Policy = "EmployeeOnly")]
public class SalaryController : Controller
{
    public ActionResult Payslip()
    {
    }

    [Authorize(Policy = "HumanResources")]
    public ActionResult UpdateSalary()
    {
    }
}
```

In the above example any identity which fulfills the `EmployeeOnly` policy can access the `Payslip` action as that policy is enforced on the controller. However in order to call the `UpdateSalary` action the identity must fulfill *both* the `EmployeeOnly` policy and the `HumanResources` policy.

If you want more complicated policies, such as taking a date of birth claim, calculating an age from it then checking the age is 21 or older then you need to write [custom policy handlers](#).

# Policy-based authorization in ASP.NET Core

6/21/2018 • 6 minutes to read • [Edit Online](#)

Underneath the covers, [role-based authorization](#) and [claims-based authorization](#) use a requirement, a requirement handler, and a pre-configured policy. These building blocks support the expression of authorization evaluations in code. The result is a richer, reusable, testable authorization structure.

An authorization policy consists of one or more requirements. It's registered as part of the authorization service configuration, in the `Startup.ConfigureServices` method:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc();

    services.AddAuthorization(options =>
    {
        options.AddPolicy("AtLeast21", policy =>
            policy.Requirements.Add(new MinimumAgeRequirement(21)));
    });
}
```

In the preceding example, an "AtLeast21" policy is created. It has a single requirement—that of a minimum age, which is supplied as a parameter to the requirement.

Policies are applied by using the `[Authorize]` attribute with the policy name. For example:

```
using Microsoft.AspNetCore.Authorization;
using Microsoft.AspNetCore.Mvc;

[Authorize(Policy = "AtLeast21")]
public class AlcoholPurchaseController : Controller
{
    public IActionResult Login() => View();

    public IActionResult Logout() => View();
}
```

## Requirements

An authorization requirement is a collection of data parameters that a policy can use to evaluate the current user principal. In our "AtLeast21" policy, the requirement is a single parameter—the minimum age. A requirement implements [IAuthorizationRequirement](#), which is an empty marker interface. A parameterized minimum age requirement could be implemented as follows:

```
using Microsoft.AspNetCore.Authorization;

public class MinimumAgeRequirement : IAuthorizationRequirement
{
    public int MinimumAge { get; private set; }

    public MinimumAgeRequirement(int minimumAge)
    {
        MinimumAge = minimumAge;
    }
}
```

#### NOTE

A requirement doesn't need to have data or properties.

## Authorization handlers

An authorization handler is responsible for the evaluation of a requirement's properties. The authorization handler evaluates the requirements against a provided [AuthorizationHandlerContext](#) to determine if access is allowed.

A requirement can have [multiple handlers](#). A handler may inherit [AuthorizationHandler<TRequirement>](#), where `TRequirement` is the requirement to be handled. Alternatively, a handler may implement [IAuthorizationHandler](#) to handle more than one type of requirement.

### Use a handler for one requirement

The following is an example of a one-to-one relationship in which a minimum age handler utilizes a single requirement:

```

using Microsoft.AspNetCore.Authorization;
using PoliciesAuthApp1.Services.Requirements;
using System;
using System.Security.Claims;
using System.Threading.Tasks;

public class MinimumAgeHandler : AuthorizationHandler<MinimumAgeRequirement>
{
    protected override Task HandleRequirementAsync(AuthorizationHandlerContext context,
                                                MinimumAgeRequirement requirement)
    {
        if (!context.User.HasClaim(c => c.Type == ClaimTypes.DateOfBirth &&
                                   c.Issuer == "http://contoso.com"))
        {
            //TODO: Use the following if targeting a version of
            //NET Framework older than 4.6:
            //      return Task.FromResult(0);
            return Task.CompletedTask;
        }

        var dateOfBirth = Convert.ToDateTime(
            context.User.FindFirst(c => c.Type == ClaimTypes.DateOfBirth &&
                                   c.Issuer == "http://contoso.com").Value);

        int calculatedAge = DateTime.Today.Year - dateOfBirth.Year;
        if (dateOfBirth > DateTime.Today.AddYears(-calculatedAge))
        {
            calculatedAge--;
        }

        if (calculatedAge >= requirement.MinimumAge)
        {
            context.Succeed(requirement);
        }

        //TODO: Use the following if targeting a version of
        //NET Framework older than 4.6:
        //      return Task.FromResult(0);
        return Task.CompletedTask;
    }
}

```

The preceding code determines if the current user principal has a date of birth claim which has been issued by a known and trusted Issuer. Authorization can't occur when the claim is missing, in which case a completed task is returned. When a claim is present, the user's age is calculated. If the user meets the minimum age defined by the requirement, authorization is deemed successful. When authorization is successful, `context.Succeed` is invoked with the satisfied requirement as its sole parameter.

### Use a handler for multiple requirements

The following is an example of a one-to-many relationship in which a permission handler utilizes three requirements:

```

using System.Security.Claims;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Authorization;
using PoliciesAuthApp1.Services.Requirements;

public class PermissionHandler : IAuthorizationHandler
{
    public Task HandleAsync(AuthorizationHandlerContext context)
    {
        var pendingRequirements = context.PendingRequirements.ToList();

        foreach (var requirement in pendingRequirements)
        {
            if (requirement is ReadPermission)
            {
                if (IsOwner(context.User, context.Resource) ||
                    IsSponsor(context.User, context.Resource))
                {
                    context.Succeed(requirement);
                }
            }
            else if (requirement is EditPermission ||
                     requirement is DeletePermission)
            {
                if (IsOwner(context.User, context.Resource))
                {
                    context.Succeed(requirement);
                }
            }
        }

        //TODO: Use the following if targeting a version of
        // .NET Framework older than 4.6:
        // return Task.FromResult(0);
        return Task.CompletedTask;
    }

    private bool IsOwner(ClaimsPrincipal user, object resource)
    {
        // Code omitted for brevity

        return true;
    }

    private bool IsSponsor(ClaimsPrincipal user, object resource)
    {
        // Code omitted for brevity

        return true;
    }
}

```

The preceding code traverses [PendingRequirements](#)—a property containing requirements not marked as successful. If the user has read permission, he or she must be either an owner or a sponsor to access the requested resource. If the user has edit or delete permission, he or she must be an owner to access the requested resource. When authorization is successful, `context.Succeed` is invoked with the satisfied requirement as its sole parameter.

## Handler registration

Handlers are registered in the services collection during configuration. For example:

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc();

    services.AddAuthorization(options =>
    {
        options.AddPolicy("AtLeast21", policy =>
            policy.Requirements.Add(new MinimumAgeRequirement(21)));
    });

    services.AddSingleton<IAuthorizationHandler, MinimumAgeHandler>();
}

```

Each handler is added to the services collection by invoking

```
services.AddSingleton<IAuthorizationHandler, YourHandlerClass>(); .
```

## What should a handler return?

Note that the `Handle` method in the [handler example](#) returns no value. How is a status of either success or failure indicated?

- A handler indicates success by calling `context.Succeed(IAuthorizationRequirement requirement)`, passing the requirement that has been successfully validated.
- A handler doesn't need to handle failures generally, as other handlers for the same requirement may succeed.
- To guarantee failure, even if other requirement handlers succeed, call `context.Fail`.

When set to `false`, the `InvokeHandlersAfterFailure` property (available in ASP.NET Core 1.1 and later) short-circuits the execution of handlers when `context.Fail` is called. `InvokeHandlersAfterFailure` defaults to `true`, in which case all handlers are called. This allows requirements to produce side effects, such as logging, which always take place even if `context.Fail` has been called in another handler.

## Why would I want multiple handlers for a requirement?

In cases where you want evaluation to be on an **OR** basis, implement multiple handlers for a single requirement. For example, Microsoft has doors which only open with key cards. If you leave your key card at home, the receptionist prints a temporary sticker and opens the door for you. In this scenario, you'd have a single requirement, `BuildingEntry`, but multiple handlers, each one examining a single requirement.

*BuildingEntryRequirement.cs*

```

using Microsoft.AspNetCore.Authorization;

public class BuildingEntryRequirement : IAuthorizationRequirement
{
}

```

*BadgeEntryHandler.cs*

```

using Microsoft.AspNetCore.Authorization;
using PoliciesAuthApp1.Services.Requirements;
using System.Security.Claims;
using System.Threading.Tasks;

public class BadgeEntryHandler : AuthorizationHandler<BuildingEntryRequirement>
{
    protected override Task HandleRequirementAsync(AuthorizationHandlerContext context,
                                                BuildingEntryRequirement requirement)
    {
        if (context.User.HasClaim(c => c.Type == ClaimTypes.BadgeId &&
                                  c.Issuer == "http://microsoftsecurity"))
        {
            context.Succeed(requirement);
        }

        //TODO: Use the following if targeting a version of
        //NET Framework older than 4.6:
        //    return Task.FromResult(0);
        return Task.CompletedTask;
    }
}

```

### *TemporaryStickerHandler.cs*

```

using Microsoft.AspNetCore.Authorization;
using PoliciesAuthApp1.Services.Requirements;
using System.Security.Claims;
using System.Threading.Tasks;

public class TemporaryStickerHandler : AuthorizationHandler<BuildingEntryRequirement>
{
    protected override Task HandleRequirementAsync(AuthorizationHandlerContext context,
                                                BuildingEntryRequirement requirement)
    {
        if (context.User.HasClaim(c => c.Type == ClaimTypes.TemporaryBadgeId &&
                                  c.Issuer == "https://microsoftsecurity"))
        {
            // We'd also check the expiration date on the sticker.
            context.Succeed(requirement);
        }

        //TODO: Use the following if targeting a version of
        //NET Framework older than 4.6:
        //    return Task.FromResult(0);
        return Task.CompletedTask;
    }
}

```

Ensure that both handlers are [registered](#). If either handler succeeds when a policy evaluates the `BuildingEntryRequirement`, the policy evaluation succeeds.

## Using a func to fulfill a policy

There may be situations in which fulfilling a policy is simple to express in code. It's possible to supply a `Func<AuthorizationHandlerContext, bool>` when configuring your policy with the `RequireAssertion` policy builder.

For example, the previous `BadgeEntryHandler` could be rewritten as follows:

```
services.AddAuthorization(options =>
{
    options.AddPolicy("BadgeEntry", policy =>
        policy.RequireAssertion(context =>
            context.User.HasClaim(c =>
                (c.Type == ClaimTypes.BadgeId ||
                c.Type == ClaimTypes.TemporaryBadgeId) &&
                c.Issuer == "https://microsoftsecurity")));
});
```

## Accessing MVC request context in handlers

The `HandleRequirementAsync` method you implement in an authorization handler has two parameters: an `AuthorizationHandlerContext` and the `TRequirement` you are handling. Frameworks such as MVC or Jabbr are free to add any object to the `Resource` property on the `AuthorizationHandlerContext` to pass extra information.

For example, MVC passes an instance of `AuthorizationFilterContext` in the `Resource` property. This property provides access to `HttpContext`, `RouteData`, and everything else provided by MVC and Razor Pages.

The use of the `Resource` property is framework specific. Using information in the `Resource` property limits your authorization policies to particular frameworks. You should cast the `Resource` property using the `as` keyword, and then confirm the cast has succeed to ensure your code doesn't crash with an `InvalidOperationException` when run on other frameworks:

```
// Requires the following import:
//     using Microsoft.AspNetCore.Mvc.Filters;
if (context.Resource is AuthorizationFilterContext mvcContext)
{
    // Examine MVC-specific things like routing data.
}
```

# Custom Authorization Policy Providers using IAuthorizationPolicyProvider in ASP.NET Core

7/7/2018 • 4 minutes to read • [Edit Online](#)

By [Mike Rousos](#)

Typically when using [policy-based authorization](#), policies are registered by calling `AuthorizationOptions.AddPolicy` as part of authorization service configuration. In some scenarios, it may not be possible (or desirable) to register all authorization policies in this way. In those cases, you can use a custom `IAuthorizationPolicyProvider` to control how authorization policies are supplied.

Examples of scenarios where a custom `IAuthorizationPolicyProvider` may be useful include:

- Using an external service to provide policy evaluation.
- Using a large range of policies (for different room numbers or ages, for example), so it doesn't make sense to add each individual authorization policy with an `AuthorizationOptions.AddPolicy` call.
- Creating policies at runtime based on information in an external data source (like a database) or determining authorization requirements dynamically through another mechanism.

## Customizing policy retrieval

ASP.NET Core apps use an implementation of the `IAuthorizationPolicyProvider` interface to retrieve authorization policies. By default, `DefaultAuthorizationPolicyProvider` is registered and used.

`DefaultAuthorizationPolicyProvider` returns policies from the `AuthorizationOptions` provided in an `IServiceCollection.AddAuthorization` call.

You can customize this behavior by registering a different `IAuthorizationPolicyProvider` implementation in the app's [dependency injection](#) container.

The `IAuthorizationPolicyProvider` interface contains two APIs:

- `GetPolicyAsync` returns an authorization policy for a given name.
- `GetDefaultPolicyAsync` returns the default authorization policy (the policy used for `[Authorize]` attributes without a policy specified).

By implementing these two APIs, you can customize how authorization policies are provided.

## Parameterized authorize attribute example

One scenario where `IAuthorizationPolicyProvider` is useful is enabling custom `[Authorize]` attributes whose requirements depend on a parameter. For example, in [policy-based authorization](#) documentation, an age-based ("AtLeast21") policy was used as a sample. If different controller actions in an app should be made available to users of *different* ages, it might be useful to have many different age-based policies. Instead of registering all the different age-based policies that the application will need in `AuthorizationOptions`, you can generate the policies dynamically with a custom `IAuthorizationPolicyProvider`. To make using the policies easier, you can annotate actions with custom authorization attribute like `[MinimumAgeAuthorize(20)]`.

## Custom Authorization Attributes

Authorization policies are identified by their names. The custom `MinimumAgeAuthorizeAttribute` described

previously needs to map arguments into a string that can be used to retrieve the corresponding authorization policy. You can do this by deriving from `AuthorizeAttribute` and making the `Age` property wrap the `AuthorizeAttribute.Policy` property.

```
internal class MinimumAgeAuthorizeAttribute : AuthorizeAttribute
{
    const string POLICY_PREFIX = "MinimumAge";

    public MinimumAgeAuthorizeAttribute(int age) => Age = age;

    // Get or set the Age property by manipulating the underlying Policy property
    public int Age
    {
        get
        {
            if (int.TryParse(Policy.Substring(POLICY_PREFIX.Length), out var age))
            {
                return age;
            }
            return default(int);
        }
        set
        {
            Policy = $"{POLICY_PREFIX}{value.ToString()}";
        }
    }
}
```

This attribute type has a `Policy` string based on the hard-coded prefix (`"MinimumAge"`) and an integer passed in via the constructor.

You can apply it to actions in the same way as other `Authorize` attributes except that it takes an integer as a parameter.

```
[MinimumAgeAuthorize(10)]
public IActionResult RequiresMinimumAge10()
```

## Custom IAuthorizationPolicyProvider

The custom `MinimumAgeAuthorizeAttribute` makes it easy to request authorization policies for any minimum age desired. The next problem to solve is making sure that authorization policies are available for all of those different ages. This is where an `IAuthorizationPolicyProvider` is useful.

When using `MinimumAgeAuthorizationAttribute`, the authorization policy names will follow the pattern `"MinimumAge" + Age`, so the custom `IAuthorizationPolicyProvider` should generate authorization policies by:

- Parsing the age from the policy name.
- Using `AuthorizationPolicyBuilder` to create a new `AuthorizationPolicy`
- Adding requirements to the policy based on the age with `AuthorizationPolicyBuilder.AddRequirements`. In other scenarios, you might use `RequireClaim`, `RequireRole`, or `RequireUserName` instead.

```

internal class MinimumAgePolicyProvider : IAuthorizationPolicyProvider
{
    const string POLICY_PREFIX = "MinimumAge";

    // Policies are looked up by string name, so expect 'parameters' (like age)
    // to be embedded in the policy names. This is abstracted away from developers
    // by the more strongly-typed attributes derived from AuthorizeAttribute
    // (like [MinimumAgeAuthorize()] in this sample)
    public Task<AuthorizationPolicy> GetPolicyAsync(string policyName)
    {
        if (policyName.StartsWith(POLICY_PREFIX, StringComparison.OrdinalIgnoreCase) &&
            int.TryParse(policyName.Substring(POLICY_PREFIX.Length), out var age))
        {
            var policy = new AuthorizationPolicyBuilder();
            policy.AddRequirements(new MinimumAgeRequirement(age));
            return Task.FromResult(policy.Build());
        }

        return Task.FromResult<AuthorizationPolicy>(null);
    }
}

```

## Multiple authorization policy providers

When using custom `IAuthorizationPolicyProvider` implementations, keep in mind that ASP.NET Core only uses one instance of `IAuthorizationPolicyProvider`. If a custom provider isn't able to provide authorization policies for all policy names, it should fall back to a backup provider. Policy names might include those that come from a default policy for `[Authorize]` attributes without a name.

For example, consider an application needed both custom age policies and more traditional role-based policy retrieval. Such an app could use a custom authorization policy provider that:

- Attempts to parse policy names.
- Calls into a different policy provider (like `DefaultAuthorizationPolicyProvider`) if the policy name doesn't contain an age.

## Default policy

In addition to providing named authorization policies, a custom `IAuthorizationPolicyProvider` needs to implement `GetDefaultPolicyAsync` to provide an authorization policy for `[Authorize]` attributes without a policy name specified.

In many cases, this authorization attribute only requires an authenticated user, so you can make the necessary policy with a call to `RequireAuthenticatedUser`:

```

public Task<AuthorizationPolicy> GetDefaultPolicyAsync() =>
    Task.FromResult(new AuthorizationPolicyBuilder().RequireAuthenticatedUser().Build());

```

As with all aspects of a custom `IAuthorizationPolicyProvider`, you can customize this, as needed. In some cases:

- Default authorization policies might not be used.
- Retrieving the default policy can be delegated to a fallback `IAuthorizationPolicyProvider`.

## Using a Custom `IAuthorizationPolicyProvider`

To use custom policies from an `IAuthorizationPolicyProvider`, you must:

- Register the appropriate `IAuthorizationHandler` types with dependency injection (described in [policy-based authorization](#)), as with all policy-based authorization scenarios.
- Register the custom `IAuthorizationPolicyProvider` type in the app's dependency injection service collection (in `Startup.ConfigureServices`) to replace the default policy provider.

```
services.AddTransient<IAuthorizationPolicyProvider, MinimumAgePolicyProvider>();
```

A complete custom `IAuthorizationPolicyProvider` sample is available in the [aspnet/AuthSamples GitHub repository](#).

# Dependency injection in requirement handlers in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

Authorization handlers must be registered in the service collection during configuration (using dependency injection).

Suppose you had a repository of rules you wanted to evaluate inside an authorization handler and that repository was registered in the service collection. Authorization will resolve and inject that into your constructor.

For example, if you wanted to use ASP.NET's logging infrastructure you would want to inject `ILoggerFactory` into your handler. Such a handler might look like:

```
public class LoggingAuthorizationHandler : AuthorizationHandler<MyRequirement>
{
    ILogger _logger;

    public LoggingAuthorizationHandler(ILoggerFactory loggerFactory)
    {
        _logger = loggerFactory.CreateLogger(this.GetType().FullName);
    }

    protected override Task HandleRequirementAsync(AuthorizationHandlerContext context, MyRequirement
requirement)
    {
        _logger.LogInformation("Inside my handler");
        // Check if the requirement is fulfilled.
        return Task.CompletedTask;
    }
}
```

You would register the handler with `services.AddSingleton()`:

```
services.AddSingleton<IAuthorizationHandler, LoggingAuthorizationHandler>();
```

An instance of the handler will be created when your application starts, and DI will inject the registered

`ILoggerFactory` into your constructor.

## NOTE

Handlers that use Entity Framework shouldn't be registered as singletons.

# Resource-based authorization in ASP.NET Core

6/21/2018 • 5 minutes to read • [Edit Online](#)

Authorization strategy depends upon the resource being accessed. Consider a document which has an author property. Only the author is allowed to update the document. Consequently, the document must be retrieved from the data store before authorization evaluation can occur.

Attribute evaluation occurs before data binding and before execution of the page handler or action which loads the document. For these reasons, declarative authorization with an `[Authorize]` attribute won't suffice. Instead, you can invoke a custom authorization method—a style known as imperative authorization.

Use the [sample apps](#) ([how to download](#)) to explore the features described in this topic.

[Create an ASP.NET Core app with user data protected by authorization](#) contains a sample app that uses resource-based authorization.

## Use imperative authorization

Authorization is implemented as an `IAuthorizationService` service and is registered in the service collection within the `Startup` class. The service is made available via [dependency injection](#) to page handlers or actions.

```
public class DocumentController : Controller
{
    private readonly IAuthorizationService _authorizationService;
    private readonly IDocumentRepository _documentRepository;

    public DocumentController(IAuthorizationService authorizationService,
                             IDocumentRepository documentRepository)
    {
        _authorizationService = authorizationService;
        _documentRepository = documentRepository;
    }
}
```

`IAuthorizationService` has two `AuthorizeAsync` method overloads: one accepting the resource and the policy name and the other accepting the resource and a list of requirements to evaluate.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
Task<AuthorizationResult> AuthorizeAsync(ClaimsPrincipal user,
                                         object resource,
                                         IEnumerable<IAuthorizationRequirement> requirements);
Task<AuthorizationResult> AuthorizeAsync(ClaimsPrincipal user,
                                         object resource,
                                         string policyName);
```

In the following example, the resource to be secured is loaded into a custom `Document` object. An `AuthorizeAsync` overload is invoked to determine whether the current user is allowed to edit the provided document. A custom "EditPolicy" authorization policy is factored into the decision. See [Custom policy-based authorization](#) for more on creating authorization policies.

#### NOTE

The following code samples assume authentication has run and set the `User` property.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
public async Task<IActionResult> OnGetAsync(Guid documentId)
{
    Document = _documentRepository.Find(documentId);

    if (Document == null)
    {
        return new NotFoundResult();
    }

    var authorizationResult = await _authorizationService
        .AuthorizeAsync(User, Document, "EditPolicy");

    if (authorizationResult.Succeeded)
    {
        return Page();
    }
    else if (User.Identity.IsAuthenticated)
    {
        return new ForbidResult();
    }
    else
    {
        return new ChallengeResult();
    }
}
```

## Write a resource-based handler

Writing a handler for resource-based authorization isn't much different than [writing a plain requirements handler](#). Create a custom requirement class, and implement a requirement handler class. The handler class specifies both the requirement and resource type. For example, a handler utilizing a `SameAuthorRequirement` requirement and a `Document` resource looks as follows:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```

public class DocumentAuthorizationHandler :
    AuthorizationHandler<SameAuthorRequirement, Document>
{
    protected override Task HandleRequirementAsync(AuthorizationHandlerContext context,
                                                SameAuthorRequirement requirement,
                                                Document resource)
    {
        if (context.User.Identity?.Name == resource.Author)
        {
            context.Succeed(requirement);
        }

        return Task.CompletedTask;
    }
}

public class SameAuthorRequirement : IAuthorizationRequirement { }

```

Register the requirement and handler in the `Startup.ConfigureServices` method:

```

services.AddMvc();

services.AddAuthorization(options =>
{
    options.AddPolicy("EditPolicy", policy =>
        policy.Requirements.Add(new SameAuthorRequirement()));
});

services.AddSingleton<IAuthorizationHandler, DocumentAuthorizationHandler>();
services.AddSingleton<IAuthorizationHandler, DocumentAuthorizationCrudHandler>();
services.AddScoped<IDocumentRepository, DocumentRepository>();

```

## Operational requirements

If you're making decisions based on the outcomes of CRUD (Create, Read, Update, Delete) operations, use the [OperationAuthorizationRequirement](#) helper class. This class enables you to write a single handler instead of an individual class for each operation type. To use it, provide some operation names:

```

public static class Operations
{
    public static OperationAuthorizationRequirement Create =
        new OperationAuthorizationRequirement { Name = nameof(Create) };
    public static OperationAuthorizationRequirement Read =
        new OperationAuthorizationRequirement { Name = nameof(Read) };
    public static OperationAuthorizationRequirement Update =
        new OperationAuthorizationRequirement { Name = nameof(Update) };
    public static OperationAuthorizationRequirement Delete =
        new OperationAuthorizationRequirement { Name = nameof(Delete) };
}

```

The handler is implemented as follows, using an `OperationAuthorizationRequirement` requirement and a `Document` resource:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```

public class DocumentAuthorizationCrudHandler : 
    AuthorizationHandler<OperationAuthorizationRequirement, Document>
{
    protected override Task HandleRequirementAsync(AuthorizationHandlerContext context,
                                                OperationAuthorizationRequirement requirement,
                                                Document resource)
    {
        if (context.User.Identity?.Name == resource.Author &&
            requirement.Name == Operations.Read.Name)
        {
            context.Succeed(requirement);
        }

        return Task.CompletedTask;
    }
}

```

The preceding handler validates the operation using the resource, the user's identity, and the requirement's `Name` property.

To call an operational resource handler, specify the operation when invoking `AuthorizeAsync` in your page handler or action. The following example determines whether the authenticated user is permitted to view the provided document.

#### NOTE

The following code samples assume authentication has run and set the `User` property.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```

public async Task<IActionResult> OnGetAsync(Guid documentId)
{
    Document = _documentRepository.Find(documentId);

    if (Document == null)
    {
        return new NotFoundResult();
    }

    var authorizationResult = await _authorizationService
        .AuthorizeAsync(User, Document, Operations.Read);

    if (authorizationResult.Succeeded)
    {
        return Page();
    }
    else if (User.Identity.IsAuthenticated)
    {
        return new ForbidResult();
    }
    else
    {
        return new ChallengeResult();
    }
}

```

If authorization succeeds, the page for viewing the document is returned. If authorization fails but the user is authenticated, returning `ForbidResult` informs any authentication middleware that authorization failed. A `ChallengeResult` is returned when authentication must be performed. For interactive browser clients, it may be

appropriate to redirect the user to a login page.

# View-based authorization in ASP.NET Core MVC

6/21/2018 • 2 minutes to read • [Edit Online](#)

A developer often wants to show, hide, or otherwise modify a UI based on the current user identity. You can access the authorization service within MVC views via [dependency injection](#). To inject the authorization service into a Razor view, use the `@inject` directive:

```
@using Microsoft.AspNetCore.Authorization  
@inject IAuthorizationService AuthorizationService
```

If you want the authorization service in every view, place the `@inject` directive into the `_ViewImports.cshtml` file of the `Views` directory. For more information, see [Dependency injection into views](#).

Use the injected authorization service to invoke `AuthorizeAsync` in exactly the same way you would check during [resource-based authorization](#):

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
@if ((await AuthorizationService.AuthorizeAsync(User, "PolicyName")).Succeeded)  
{  
    <p>This paragraph is displayed because you fulfilled PolicyName.</p>  
}
```

In some cases, the resource will be your view model. Invoke `AuthorizeAsync` in exactly the same way you would check during [resource-based authorization](#):

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
@if ((await AuthorizationService.AuthorizeAsync(User, Model, Operations.Edit)).Succeeded)  
{  
    <p><a class="btn btn-default" role="button"  
        href="@Url.Action("Edit", "Document", new { id = Model.Id })">Edit</a></p>  
}
```

In the preceding code, the model is passed as a resource the policy evaluation should take into consideration.

## WARNING

Don't rely on toggling visibility of your app's UI elements as the sole authorization check. Hiding a UI element may not completely prevent access to its associated controller action. For example, consider the button in the preceding code snippet. A user can invoke the `Edit` action method if he or she knows the relative resource URL is `/Document/Edit/1`. For this reason, the `Edit` action method should perform its own authorization check.

# Authorize with a specific scheme in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

In some scenarios, such as Single Page Applications (SPAs), it's common to use multiple authentication methods. For example, the app may use cookie-based authentication to log in and JWT bearer authentication for JavaScript requests. In some cases, the app may have multiple instances of an authentication handler. For example, two cookie handlers where one contains a basic identity and one is created when a multi-factor authentication (MFA) has been triggered. MFA may be triggered because the user requested an operation that requires extra security.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

An authentication scheme is named when the authentication service is configured during authentication. For example:

```
public void ConfigureServices(IServiceCollection services)
{
    // Code omitted for brevity

    services.AddAuthentication()
        .AddCookie(options => {
            options.LoginPath = "/Account/Unauthorized/";
            options.AccessDeniedPath = "/Account/Forbidden/";
        })
        .AddJwtBearer(options => {
            options.Audience = "http://localhost:5001/";
            options.Authority = "http://localhost:5000/";
        });
}
```

In the preceding code, two authentication handlers have been added: one for cookies and one for bearer.

## NOTE

Specifying the default scheme results in the `HttpContext.User` property being set to that identity. If that behavior isn't desired, disable it by invoking the parameterless form of `AddAuthentication`.

## Selecting the scheme with the `Authorize` attribute

At the point of authorization, the app indicates the handler to be used. Select the handler with which the app will authorize by passing a comma-delimited list of authentication schemes to `[Authorize]`. The `[Authorize]` attribute specifies the authentication scheme or schemes to use regardless of whether a default is configured. For example:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
[Authorize(AuthenticationSchemes = AuthSchemes)]
public class MixedController : Controller
    // Requires the following imports:
    // using Microsoft.AspNetCore.Authentication.Cookies;
    // using Microsoft.AspNetCore.Authentication.JwtBearer;
    private const string AuthSchemes =
        CookieAuthenticationDefaults.AuthenticationScheme + "," +
        JwtBearerDefaults.AuthenticationScheme;
```

In the preceding example, both the cookie and bearer handlers run and have a chance to create and append an identity for the current user. By specifying a single scheme only, the corresponding handler runs.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
[Authorize(AuthenticationSchemes =
    JwtBearerDefaults.AuthenticationScheme)]
public class MixedController : Controller
```

In the preceding code, only the handler with the "Bearer" scheme runs. Any cookie-based identities are ignored.

## Selecting the scheme with policies

If you prefer to specify the desired schemes in [policy](#), you can set the `AuthenticationSchemes` collection when adding your policy:

```
services.AddAuthorization(options =>
{
    options.AddPolicy("Over18", policy =>
    {
        policy.AuthenticationSchemes.Add(JwtBearerDefaults.AuthenticationScheme);
        policy.RequireAuthenticatedUser();
        policy.Requirements.Add(new MinimumAgeRequirement());
    });
});
```

In the preceding example, the "Over18" policy only runs against the identity created by the "Bearer" handler. Use the policy by setting the `[Authorize]` attribute's `Policy` property:

```
[Authorize(Policy = "Over18")]
public class RegistrationController : Controller
```

# Data Protection in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

- [Introduction to data protection](#)
- [Get started with the Data Protection APIs](#)
- [Consumer APIs](#)
  - [Consumer APIs overview](#)
  - [Purpose strings](#)
  - [Purpose hierarchy and multi-tenancy](#)
  - [Hash passwords](#)
  - [Limit the lifetime of protected payloads](#)
  - [Unprotect payloads whose keys have been revoked](#)
- [Configuration](#)
  - [Configure ASP.NET Core Data Protection](#)
  - [Default settings](#)
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- [Extensibility APIs](#)
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  - [Key storage providers](#)
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- o Replacing ASP.NET in ASP.NET Core

# ASP.NET Core Data Protection

6/21/2018 • 5 minutes to read • [Edit Online](#)

Web applications often need to store security-sensitive data. Windows provides DPAPI for desktop applications but this is unsuitable for web applications. The ASP.NET Core data protection stack provide a simple, easy to use cryptographic API a developer can use to protect data, including key management and rotation.

The ASP.NET Core data protection stack is designed to serve as the long-term replacement for the `<machineKey>` element in ASP.NET 1.x - 4.x. It was designed to address many of the shortcomings of the old cryptographic stack while providing an out-of-the-box solution for the majority of use cases modern applications are likely to encounter.

## Problem statement

The overall problem statement can be succinctly stated in a single sentence: I need to persist trusted information for later retrieval, but I don't trust the persistence mechanism. In web terms, this might be written as "I need to round-trip trusted state via an untrusted client."

The canonical example of this is an authentication cookie or bearer token. The server generates an "I am Groot and have xyz permissions" token and hands it to the client. At some future date the client will present that token back to the server, but the server needs some kind of assurance that the client hasn't forged the token. Thus the first requirement: authenticity (a.k.a. integrity, tamper-proofing).

Since the persisted state is trusted by the server, we anticipate that this state might contain information that's specific to the operating environment. This could be in the form of a file path, a permission, a handle or other indirect reference, or some other piece of server-specific data. Such information should generally not be disclosed to an untrusted client. Thus the second requirement: confidentiality.

Finally, since modern applications are componentized, what we've seen is that individual components will want to take advantage of this system without regard to other components in the system. For instance, if a bearer token component is using this stack, it should operate without interference from an anti-CSRF mechanism that might also be using the same stack. Thus the final requirement: isolation.

We can provide further constraints in order to narrow the scope of our requirements. We assume that all services operating within the cryptosystem are equally trusted and that the data doesn't need to be generated or consumed outside of the services under our direct control. Furthermore, we require that operations are as fast as possible since each request to the web service might go through the cryptosystem one or more times. This makes symmetric cryptography ideal for our scenario, and we can discount asymmetric cryptography until such a time that it's needed.

## Design philosophy

We started by identifying problems with the existing stack. Once we had that, we surveyed the landscape of existing solutions and concluded that no existing solution quite had the capabilities we sought. We then engineered a solution based on several guiding principles.

- The system should offer simplicity of configuration. Ideally the system would be zero-configuration and developers could hit the ground running. In situations where developers need to configure a specific aspect (such as the key repository), consideration should be given to making those specific configurations simple.
- Offer a simple consumer-facing API. The APIs should be easy to use correctly and difficult to use incorrectly.

- Developers shouldn't learn key management principles. The system should handle algorithm selection and key lifetime on the developer's behalf. Ideally the developer should never even have access to the raw key material.
- Keys should be protected at rest when possible. The system should figure out an appropriate default protection mechanism and apply it automatically.

With these principles in mind we developed a simple, [easy to use](#) data protection stack.

The ASP.NET Core data protection APIs are not primarily intended for indefinite persistence of confidential payloads. Other technologies like [Windows CNG DPAPI](#) and [Azure Rights Management](#) are more suited to the scenario of indefinite storage, and they have correspondingly strong key management capabilities. That said, there's nothing prohibiting a developer from using the ASP.NET Core data protection APIs for long-term protection of confidential data.

## Audience

The data protection system is divided into five main packages. Various aspects of these APIs target three main audiences;

1. The [Consumer APIs Overview](#) target application and framework developers.

"I don't want to learn about how the stack operates or about how it's configured. I simply want to perform some operation in as simple a manner as possible with high probability of using the APIs successfully."

2. The [configuration APIs](#) target application developers and system administrators.

"I need to tell the data protection system that my environment requires non-default paths or settings."

3. The extensibility APIs target developers in charge of implementing custom policy. Usage of these APIs would be limited to rare situations and experienced, security aware developers.

"I need to replace an entire component within the system because I have truly unique behavioral requirements. I am willing to learn uncommonly-used parts of the API surface in order to build a plugin that fulfills my requirements."

## Package Layout

The data protection stack consists of five packages.

- Microsoft.AspNetCore.DataProtection.Abstractions contains the basic `IDataProtectionProvider` and `IDataProtector` interfaces. It also contains useful extension methods that can assist working with these types (e.g., overloads of `IDataProtector.Protect`). See the consumer interfaces section for more information. If somebody else is responsible for instantiating the data protection system and you are simply consuming the APIs, you'll want to reference `Microsoft.AspNetCore.DataProtection.Abstractions`.
- Microsoft.AspNetCore.DataProtection contains the core implementation of the data protection system, including the core cryptographic operations, key management, configuration, and extensibility. If you're responsible for instantiating the data protection system (e.g., adding it to an `IServiceCollection`) or modifying or extending its behavior, you'll want to reference `Microsoft.AspNetCore.DataProtection`.
- Microsoft.AspNetCore.DataProtection.Extensions contains additional APIs which developers might find useful but which don't belong in the core package. For instance, this package contains a simple "instantiate the system pointing at a specific key storage directory with no dependency injection setup" API (more info). It also contains extension methods for limiting the lifetime of protected payloads (more info).
- Microsoft.AspNetCore.DataProtection.SystemWeb can be installed into an existing ASP.NET 4.x application to redirect its `<machineKey>` operations to instead use the new data protection stack. See [compatibility](#) for

more information.

- Microsoft.AspNetCore.Cryptography.KeyDerivation provides an implementation of the PBKDF2 password hashing routine and can be used by systems which need to handle user passwords securely. See [Hash passwords](#) for more information.

# Get started with the Data Protection APIs in ASP.NET Core

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At its simplest, protecting data consists of the following steps:

1. Create a data protector from a data protection provider.
2. Call the `Protect` method with the data you want to protect.
3. Call the `Unprotect` method with the data you want to turn back into plain text.

Most frameworks and app models, such as ASP.NET or SignalR, already configure the data protection system and add it to a service container you access via dependency injection. The following sample demonstrates configuring a service container for dependency injection and registering the data protection stack, receiving the data protection provider via DI, creating a protector and protecting then unprotecting data

```

using System;
using Microsoft.AspNetCore.DataProtection;
using Microsoft.Extensions.DependencyInjection;

public class Program
{
    public static void Main(string[] args)
    {
        // add data protection services
        var serviceCollection = new ServiceCollection();
        serviceCollection.AddDataProtection();
        var services = serviceCollection.BuildServiceProvider();

        // create an instance of MyClass using the service provider
        var instance = ActivatorUtilities.CreateInstance<MyClass>(services);
        instance.RunSample();
    }

    public class MyClass
    {
        IDataProtector _protector;

        // the 'provider' parameter is provided by DI
        public MyClass(IDataProtectionProvider provider)
        {
            _protector = provider.CreateProtector("Contoso.MyClass.v1");
        }

        public void RunSample()
        {
            Console.Write("Enter input: ");
            string input = Console.ReadLine();

            // protect the payload
            string protectedPayload = _protector.Protect(input);
            Console.WriteLine($"Protect returned: {protectedPayload}");

            // unprotect the payload
            string unprotectedPayload = _protector.Unprotect(protectedPayload);
            Console.WriteLine($"Unprotect returned: {unprotectedPayload}");
        }
    }
}

/*
 * SAMPLE OUTPUT
 *
 * Enter input: Hello world!
 * Protect returned: CfDJ8ICcgQwZZhlAltZT...OdfH66i1PnGmpCR5e441xQ
 * Unprotect returned: Hello world!
*/

```

When you create a protector you must provide one or more [Purpose Strings](#). A purpose string provides isolation between consumers. For example, a protector created with a purpose string of "green" wouldn't be able to unprotect data provided by a protector with a purpose of "purple".

**TIP**

Instances of `IDataProtectionProvider` and `IDataProtector` are thread-safe for multiple callers. It's intended that once a component gets a reference to an `IDataProtector` via a call to `CreateProtector`, it will use that reference for multiple calls to `Protect` and `Unprotect`.

A call to `Unprotect` will throw `CryptographicException` if the protected payload cannot be verified or deciphered. Some components may wish to ignore errors during unprotect operations; a component which reads authentication cookies might handle this error and treat the request as if it had no cookie at all rather than fail the request outright. Components which want this behavior should specifically catch `CryptographicException` instead of swallowing all exceptions.

# Consumer APIs for ASP.NET Core

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- [Consumer APIs Overview](#)
- [Purpose Strings](#)
- [Purpose hierarchy and multi-tenancy](#)
- [Hash passwords](#)
- [Limit the lifetime of protected payloads](#)
- [Unprotect payloads whose keys have been revoked](#)

# Consumer APIs overview for ASP.NET Core

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The `IDataProtectionProvider` and `IDataProtector` interfaces are the basic interfaces through which consumers use the data protection system. They're located in the [Microsoft.AspNetCore.DataProtection.Abstractions](#) package.

## IDataProtectionProvider

The provider interface represents the root of the data protection system. It cannot directly be used to protect or unprotect data. Instead, the consumer must get a reference to an `IDataProtector` by calling `IDataProtectionProvider.CreateProtector(purpose)`, where purpose is a string that describes the intended consumer use case. See [Purpose Strings](#) for much more information on the intent of this parameter and how to choose an appropriate value.

## IDataProtector

The protector interface is returned by a call to `CreateProtector`, and it's this interface which consumers can use to perform protect and unprotect operations.

To protect a piece of data, pass the data to the `Protect` method. The basic interface defines a method which converts `byte[]` -> `byte[]`, but there's also an overload (provided as an extension method) which converts `string` -> `string`. The security offered by the two methods is identical; the developer should choose whichever overload is most convenient for their use case. Irrespective of the overload chosen, the value returned by the `Protect` method is now protected (enciphered and tamper-proofed), and the application can send it to an untrusted client.

To unprotect a previously-protected piece of data, pass the protected data to the `Unprotect` method. (There are `byte[]`-based and `string`-based overloads for developer convenience.) If the protected payload was generated by an earlier call to `Protect` on this same `IDataProtector`, the `Unprotect` method will return the original unprotected payload. If the protected payload has been tampered with or was produced by a different `IDataProtector`, the `Unprotect` method will throw `CryptographicException`.

The concept of same vs. different `IDataProtector` ties back to the concept of purpose. If two `IDataProtector` instances were generated from the same root `IDataProtectionProvider` but via different purpose strings in the call to `IDataProtectionProvider.CreateProtector`, then they're considered [different protectors](#), and one won't be able to unprotect payloads generated by the other.

## Consuming these interfaces

For a DI-aware component, the intended usage is that the component take an `IDataProtectionProvider` parameter in its constructor and that the DI system automatically provides this service when the component is instantiated.

### NOTE

Some applications (such as console applications or ASP.NET 4.x applications) might not be DI-aware so cannot use the mechanism described here. For these scenarios consult the [Non DI Aware Scenarios](#) document for more information on getting an instance of an `IDataProtection` provider without going through DI.

The following sample demonstrates three concepts:

1. Add the data protection system to the service container,
2. Using DI to receive an instance of an `IDataProtectionProvider`, and
3. Creating an `IDataProtector` from an `IDataProtectionProvider` and using it to protect and unprotect data.

```

using System;
using Microsoft.AspNetCore.DataProtection;
using Microsoft.Extensions.DependencyInjection;

public class Program
{
    public static void Main(string[] args)
    {
        // add data protection services
        var serviceCollection = new ServiceCollection();
        serviceCollection.AddDataProtection();
        var services = serviceCollection.BuildServiceProvider();

        // create an instance of MyClass using the service provider
        var instance = ActivatorUtilities.CreateInstance<MyClass>(services);
        instance.RunSample();
    }

    public class MyClass
    {
        IDataProtector _protector;

        // the 'provider' parameter is provided by DI
        public MyClass(IDataProtectionProvider provider)
        {
            _protector = provider.CreateProtector("Contoso.MyClass.v1");
        }

        public void RunSample()
        {
            Console.Write("Enter input: ");
            string input = Console.ReadLine();

            // protect the payload
            string protectedPayload = _protector.Protect(input);
            Console.WriteLine($"Protect returned: {protectedPayload}");

            // unprotect the payload
            string unprotectedPayload = _protector.Unprotect(protectedPayload);
            Console.WriteLine($"Unprotect returned: {unprotectedPayload}");
        }
    }
}

/*
 * SAMPLE OUTPUT
 *
 * Enter input: Hello world!
 * Protect returned: CfDJ8ICcgQwZzh1ALTZT...OdfH66i1PnGmpCR5e441xQ
 * Unprotect returned: Hello world!
*/

```

The package `Microsoft.AspNetCore.DataProtection.Abstractions` contains an extension method `IServiceProvider.GetDataProtector` as a developer convenience. It encapsulates as a single operation both retrieving an `IDataProtectionProvider` from the service provider and calling `IDataProtectionProvider.CreateProtector`. The following sample demonstrates its usage.

```
using System;
using Microsoft.AspNetCore.DataProtection;
using Microsoft.Extensions.DependencyInjection;

public class Program
{
    public static void Main(string[] args)
    {
        // add data protection services
        var serviceCollection = new ServiceCollection();
        serviceCollection.AddDataProtection();
        var services = serviceCollection.BuildServiceProvider();

        // get an IDataProtector from the IServiceProvider
        var protector = services.GetDataProtector("Contoso.Example.v2");
        Console.Write("Enter input: ");
        string input = Console.ReadLine();

        // protect the payload
        string protectedPayload = protector.Protect(input);
        Console.WriteLine($"Protect returned: {protectedPayload}");

        // unprotect the payload
        string unprotectedPayload = protector.Unprotect(protectedPayload);
        Console.WriteLine($"Unprotect returned: {unprotectedPayload}");
    }
}
```

#### TIP

Instances of `IDataProtectionProvider` and `IDataProtector` are thread-safe for multiple callers. It's intended that once a component gets a reference to an `IDataProtector` via a call to `CreateProtector`, it will use that reference for multiple calls to `Protect` and `Unprotect`. A call to `Unprotect` will throw `CryptographicException` if the protected payload cannot be verified or deciphered. Some components may wish to ignore errors during unprotect operations; a component which reads authentication cookies might handle this error and treat the request as if it had no cookie at all rather than fail the request outright. Components which want this behavior should specifically catch `CryptographicException` instead of swallowing all exceptions.

# Purpose strings in ASP.NET Core

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Components which consume `IDataProtectionProvider` must pass a unique *purposes* parameter to the `CreateProtector` method. The purposes *parameter* is inherent to the security of the data protection system, as it provides isolation between cryptographic consumers, even if the root cryptographic keys are the same.

When a consumer specifies a purpose, the purpose string is used along with the root cryptographic keys to derive cryptographic subkeys unique to that consumer. This isolates the consumer from all other cryptographic consumers in the application: no other component can read its payloads, and it cannot read any other component's payloads. This isolation also renders infeasible entire categories of attack against the component.



In the diagram above, `IDataProtector` instances A and B **cannot** read each other's payloads, only their own.

The purpose string doesn't have to be secret. It should simply be unique in the sense that no other well-behaved component will ever provide the same purpose string.

## TIP

Using the namespace and type name of the component consuming the data protection APIs is a good rule of thumb, as in practice this information will never conflict.

A Contoso-authored component which is responsible for minting bearer tokens might use `Contoso.Security.BearerToken` as its purpose string. Or - even better - it might use `Contoso.Security.BearerToken.v1` as its purpose string. Appending the version number allows a future version to use `Contoso.Security.BearerToken.v2` as its purpose, and the different versions would be completely isolated from one another as far as payloads go.

Since the purposes parameter to `CreateProtector` is a string array, the above could've been instead specified as `[ "Contoso.Security.BearerToken", "v1" ]`. This allows establishing a hierarchy of purposes and opens up the possibility of multi-tenancy scenarios with the data protection system.

## WARNING

Components shouldn't allow untrusted user input to be the sole source of input for the purposes chain.

For example, consider a component `Contoso.Messaging.SecureMessage` which is responsible for storing secure messages. If the secure messaging component were to call `CreateProtector([ "username" ])`, then a malicious user might create an account with username "Contoso.Security.BearerToken" in an attempt to get the component to call `CreateProtector([ "Contoso.Security.BearerToken" ])`, thus inadvertently causing the secure messaging system to mint payloads that could be perceived as authentication tokens.

A better purposes chain for the messaging component would be

`CreateProtector([ "Contoso.Messaging.SecureMessage", "User: username" ])`, which provides proper isolation.

The isolation provided by and behaviors of `IDataProtectionProvider`, `IDataProtector`, and purposes are as follows:

- For a given `IDataProtectionProvider` object, the `CreateProtector` method will create an `IDataProtector` object uniquely tied to both the `IDataProtectionProvider` object which created it and the purposes parameter which was passed into the method.
- The purpose parameter must not be null. (If purposes is specified as an array, this means that the array must not be of zero length and all elements of the array must be non-null.) An empty string purpose is technically allowed but is discouraged.
- Two purposes arguments are equivalent if and only if they contain the same strings (using an ordinal comparer) in the same order. A single purpose argument is equivalent to the corresponding single-element purposes array.
- Two `IDataProtector` objects are equivalent if and only if they're created from equivalent `IDataProtectionProvider` objects with equivalent purposes parameters.
- For a given `IDataProtector` object, a call to `Unprotect(protectedData)` will return the original `unprotectedData` if and only if `protectedData := Protect(unprotectedData)` for an equivalent `IDataProtector` object.

## NOTE

We're not considering the case where some component intentionally chooses a purpose string which is known to conflict with another component. Such a component would essentially be considered malicious, and this system isn't intended to provide security guarantees in the event that malicious code is already running inside of the worker process.

# Purpose hierarchy and multi-tenancy in ASP.NET Core

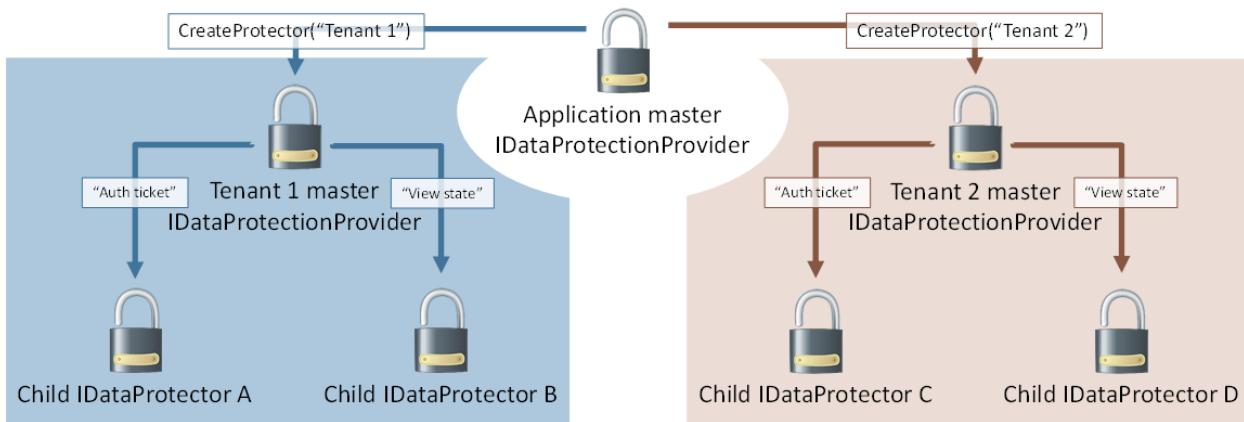
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Since an `IDataProtector` is also implicitly an `IDataProtectionProvider`, purposes can be chained together. In this sense, `provider.CreateProtector(["purpose1", "purpose2"])` is equivalent to `provider.CreateProtector("purpose1").CreateProtector("purpose2")`.

This allows for some interesting hierarchical relationships through the data protection system. In the earlier example of `Contoso.Messaging.SecureMessage`, the `SecureMessage` component can call

`provider.CreateProtector("Contoso.Messaging.SecureMessage")` once up-front and cache the result into a private `_myProvider` field. Future protectors can then be created via calls to `_myProvider.CreateProtector("User: username")`, and these protectors would be used for securing the individual messages.

This can also be flipped. Consider a single logical application which hosts multiple tenants (a CMS seems reasonable), and each tenant can be configured with its own authentication and state management system. The umbrella application has a single master provider, and it calls `provider.CreateProtector("Tenant 1")` and `provider.CreateProtector("Tenant 2")` to give each tenant its own isolated slice of the data protection system. The tenants could then derive their own individual protectors based on their own needs, but no matter how hard they try they cannot create protectors which collide with any other tenant in the system. Graphically, this is represented as below.



## WARNING

This assumes the umbrella application controls which APIs are available to individual tenants and that tenants cannot execute arbitrary code on the server. If a tenant can execute arbitrary code, they could perform private reflection to break the isolation guarantees, or they could just read the master keying material directly and derive whatever subkeys they desire.

The data protection system actually uses a sort of multi-tenancy in its default out-of-the-box configuration. By default master keying material is stored in the worker process account's user profile folder (or the registry, for IIS application pool identities). But it's actually fairly common to use a single account to run multiple applications, and thus all these applications would end up sharing the master keying material. To solve this, the data protection system automatically inserts a unique-per-application identifier as the first element in the overall purpose chain. This implicit purpose serves to [isolate individual applications](#) from one another by effectively treating each application as a unique tenant within the system, and the protector creation process looks identical to the image above.



# Hash passwords in ASP.NET Core

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The data protection code base includes a package `Microsoft.AspNetCore.Cryptography.KeyDerivation` which contains cryptographic key derivation functions. This package is a standalone component and has no dependencies on the rest of the data protection system. It can be used completely independently. The source exists alongside the data protection code base as a convenience.

The package currently offers a method `KeyDerivation.Pbkdf2` which allows hashing a password using the [PBKDF2 algorithm](#). This API is very similar to the .NET Framework's existing [Rfc2898DeriveBytes type](#), but there are three important distinctions:

1. The `KeyDerivation.Pbkdf2` method supports consuming multiple PRFs (currently `HMACSHA1`, `HMACSHA256`, and `HMACSHA512`), whereas the `Rfc2898DeriveBytes` type only supports `HMACSHA1`.
2. The `KeyDerivation.Pbkdf2` method detects the current operating system and attempts to choose the most optimized implementation of the routine, providing much better performance in certain cases. (On Windows 8, it offers around 10x the throughput of `Rfc2898DeriveBytes`.)
3. The `KeyDerivation.Pbkdf2` method requires the caller to specify all parameters (salt, PRF, and iteration count). The `Rfc2898DeriveBytes` type provides default values for these.

```
using System;
using System.Security.Cryptography;
using Microsoft.AspNetCore.Cryptography.KeyDerivation;

public class Program
{
    public static void Main(string[] args)
    {
        Console.Write("Enter a password: ");
        string password = Console.ReadLine();

        // generate a 128-bit salt using a secure PRNG
        byte[] salt = new byte[128 / 8];
        using (var rng = RandomNumberGenerator.Create())
        {
            rng.GetBytes(salt);
        }
        Console.WriteLine($"Salt: {Convert.ToBase64String(salt)}");

        // derive a 256-bit subkey (use HMACSHA1 with 10,000 iterations)
        string hashed = Convert.ToBase64String(KeyDerivation.Pbkdf2(
            password: password,
            salt: salt,
            prf: KeyDerivationPrf.HMACSHA1,
            iterationCount: 10000,
            numBytesRequested: 256 / 8));
        Console.WriteLine($"Hashed: {hashed}");
    }
}

/*
 * SAMPLE OUTPUT
 *
 * Enter a password: Xtw9NMgx
 * Salt: NZsP6NnmfBuYeJrrAKNuVQ==
 * Hashed: /0OoOer10+tGwTRDTrQSoeCxVTFr6dtYly7d0cPxIak=
 */
```

See the source code for ASP.NET Core Identity's `PasswordHasher` type for a real-world use case.

# Limit the lifetime of protected payloads in ASP.NET Core

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There are scenarios where the application developer wants to create a protected payload that expires after a set period of time. For instance, the protected payload might represent a password reset token that should only be valid for one hour. It's certainly possible for the developer to create their own payload format that contains an embedded expiration date, and advanced developers may wish to do this anyway, but for the majority of developers managing these expirations can grow tedious.

To make this easier for our developer audience, the package [Microsoft.AspNetCore.DataProtection.Extensions](#) contains utility APIs for creating payloads that automatically expire after a set period of time. These APIs hang off of the `ITimeLimitedDataProtector` type.

## API usage

The `ITimeLimitedDataProtector` interface is the core interface for protecting and unprotecting time-limited / self-expiring payloads. To create an instance of an `ITimeLimitedDataProtector`, you'll first need an instance of a regular `IDataProtector` constructed with a specific purpose. Once the `IDataProtector` instance is available, call the `IDataProtector.ToTimeLimitedDataProtector` extension method to get back a protector with built-in expiration capabilities.

`ITimeLimitedDataProtector` exposes the following API surface and extension methods:

- `CreateProtector(string purpose) : ITimeLimitedDataProtector` - This API is similar to the existing `IDataProtectionProvider.CreateProtector` in that it can be used to create [purpose chains](#) from a root time-limited protector.
- `Protect(byte[] plaintext, DateTimeOffset expiration) : byte[]`
- `Protect(byte[] plaintext, TimeSpan lifetime) : byte[]`
- `Protect(byte[] plaintext) : byte[]`
- `Protect(string plaintext, DateTimeOffset expiration) : string`
- `Protect(string plaintext, TimeSpan lifetime) : string`
- `Protect(string plaintext) : string`

In addition to the core `Protect` methods which take only the plaintext, there are new overloads which allow specifying the payload's expiration date. The expiration date can be specified as an absolute date (via a `DateTimeOffset`) or as a relative time (from the current system time, via a `TimeSpan`). If an overload which doesn't take an expiration is called, the payload is assumed never to expire.

- `Unprotect(byte[] protectedData, out DateTimeOffset expiration) : byte[]`
- `Unprotect(byte[] protectedData) : byte[]`
- `Unprotect(string protectedData, out DateTimeOffset expiration) : string`
- `Unprotect(string protectedData) : string`

The `Unprotect` methods return the original unprotected data. If the payload hasn't yet expired, the absolute

expiration is returned as an optional out parameter along with the original unprotected data. If the payload is expired, all overloads of the Unprotect method will throw CryptographicException.

#### WARNING

It's not advised to use these APIs to protect payloads which require long-term or indefinite persistence. "Can I afford for the protected payloads to be permanently unrecoverable after a month?" can serve as a good rule of thumb; if the answer is no then developers should consider alternative APIs.

The sample below uses the [non-DI code paths](#) for instantiating the data protection system. To run this sample, ensure that you have first added a reference to the Microsoft.AspNetCore.DataProtection.Extensions package.

```
using System;
using System.IO;
using System.Threading;
using Microsoft.AspNetCore.DataProtection;

public class Program
{
    public static void Main(string[] args)
    {
        // create a protector for my application

        var provider = DataProtectionProvider.Create(new DirectoryInfo(@"c:\myapp-keys\"));
        var baseProtector = provider.CreateProtector("Contoso.TimeLimitedSample");

        // convert the normal protector into a time-limited protector
        var timeLimitedProtector = baseProtector.ToTimeLimitedDataProtector();

        // get some input and protect it for five seconds
        Console.Write("Enter input: ");
        string input = Console.ReadLine();
        string protectedData = timeLimitedProtector.Protect(input, lifetime: TimeSpan.FromSeconds(5));
        Console.WriteLine($"Protected data: {protectedData}");

        // unprotect it to demonstrate that round-tripping works properly
        string roundtripped = timeLimitedProtector.Unprotect(protectedData);
        Console.WriteLine($"Round-tripped data: {roundtripped}");

        // wait 6 seconds and perform another unprotect, demonstrating that the payload self-expires
        Console.WriteLine("Waiting 6 seconds...");
        Thread.Sleep(6000);
        timeLimitedProtector.Unprotect(protectedData);
    }
}

/*
 * SAMPLE OUTPUT
 *
 * Enter input: Hello!
 * Protected data: CfDJ8Hu5z0zwxn...nLk70k
 * Round-tripped data: Hello!
 * Waiting 6 seconds...
 * <>throws CryptographicException with message 'The payload expired at ...'>
 */
```

# Unprotect payloads whose keys have been revoked in ASP.NET Core

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The ASP.NET Core data protection APIs are not primarily intended for indefinite persistence of confidential payloads. Other technologies like [Windows CNG DPAPI](#) and [Azure Rights Management](#) are more suited to the scenario of indefinite storage, and they have correspondingly strong key management capabilities. That said, there's nothing prohibiting a developer from using the ASP.NET Core data protection APIs for long-term protection of confidential data. Keys are never removed from the key ring, so `IDataProtector.Unprotect` can always recover existing payloads as long as the keys are available and valid.

However, an issue arises when the developer tries to unprotect data that has been protected with a revoked key, as `IDataProtector.Unprotect` will throw an exception in this case. This might be fine for short-lived or transient payloads (like authentication tokens), as these kinds of payloads can easily be recreated by the system, and at worst the site visitor might be required to log in again. But for persisted payloads, having `Unprotect` throw could lead to unacceptable data loss.

## IPersistedDataProtector

To support the scenario of allowing payloads to be unprotected even in the face of revoked keys, the data protection system contains an `IPersistedDataProtector` type. To get an instance of `IPersistedDataProtector`, simply get an instance of `IDataProtector` in the normal fashion and try casting the `IDataProtector` to `IPersistedDataProtector`.

### NOTE

Not all `IDataProtector` instances can be cast to `IPersistedDataProtector`. Developers should use the `as` operator or similar to avoid runtime exceptions caused by invalid casts, and they should be prepared to handle the failure case appropriately.

`IPersistedDataProtector` exposes the following API surface:

```
DangerousUnprotect(byte[] protectedData, bool ignoreRevocationErrors,
    out bool requiresMigration, out bool wasRevoked) : byte[]
```

This API takes the protected payload (as a byte array) and returns the unprotected payload. There's no string-based overload. The two out parameters are as follows.

- `requiresMigration` : will be set to true if the key used to protect this payload is no longer the active default key, e.g., the key used to protect this payload is old and a key rolling operation has since taken place. The caller may wish to consider reprotecting the payload depending on their business needs.
- `wasRevoked` : will be set to true if the key used to protect this payload was revoked.

## WARNING

Exercise extreme caution when passing `ignoreRevocationErrors: true` to the `DangerousUnprotect` method. If after calling this method the `wasRevoked` value is true, then the key used to protect this payload was revoked, and the payload's authenticity should be treated as suspect. In this case, only continue operating on the unprotected payload if you have some separate assurance that it's authentic, e.g. that it's coming from a secure database rather than being sent by an untrusted web client.

```
using System;
using System.IO;
using System.Text;
using Microsoft.AspNetCore.DataProtection;
using Microsoft.AspNetCore.DataProtection.KeyManagement;
using Microsoft.Extensions.DependencyInjection;

public class Program
{
    public static void Main(string[] args)
    {
        var serviceCollection = new ServiceCollection();
        serviceCollection.AddDataProtection()
            // point at a specific folder and use DPAPI to encrypt keys
            .PersistKeysToFileSystem(new DirectoryInfo(@"c:\temp-keys"))
            .ProtectKeysWithDpapi();
        var services = serviceCollection.BuildServiceProvider();

        // get a protector and perform a protect operation
        var protector = services.GetDataProtector("Sample.DangerousUnprotect");
        Console.WriteLine("Input: ");
        byte[] input = Encoding.UTF8.GetBytes(Console.ReadLine());
        var protectedData = protector.Protect(input);
        Console.WriteLine($"Protected payload: {Convert.ToBase64String(protectedData)}");

        // demonstrate that the payload round-trips properly
        var roundTripped = protector.Unprotect(protectedData);
        Console.WriteLine($"Round-tripped payload: {Encoding.UTF8.GetString(roundTripped)}");

        // get a reference to the key manager and revoke all keys in the key ring
        var keyManager = services.GetService<IKeyManager>();
        Console.WriteLine("Revoking all keys in the key ring...");
        keyManager.RevokeAllKeys(DateTimeOffset.Now, "Sample revocation.");

        // try calling Protect - this should throw
        Console.WriteLine("Calling Unprotect...");
        try
        {
            var unprotectedPayload = protector.Unprotect(protectedData);
            Console.WriteLine($"Unprotected payload: {Encoding.UTF8.GetString(unprotectedPayload)}");
        }
        catch (Exception ex)
        {
            Console.WriteLine($"{ex.GetType().Name}: {ex.Message}");
        }

        // try calling DangerousUnprotect
        Console.WriteLine("Calling DangerousUnprotect...");
        try
        {
            IPersistedDataProtector persistedProtector = protector as IPersistedDataProtector;
            if (persistedProtector == null)
            {
                throw new Exception("Can't call DangerousUnprotect.");
            }
        }

        bool requiresMigration, wasRevoked;
```

```
        var unprotectedPayload = persistedProtector.DangerousUnprotect(
            protectedData: protectedData,
            ignoreRevocationErrors: true,
            requiresMigration: out requiresMigration,
            wasRevoked: out wasRevoked);
        Console.WriteLine($"Unprotected payload: {Encoding.UTF8.GetString(unprotectedPayload)}");
        Console.WriteLine($"Requires migration = {requiresMigration}, was revoked = {wasRevoked}");
    }
    catch (Exception ex)
    {
        Console.WriteLine($"{ex.GetType().Name}: {ex.Message}");
    }
}

/*
 * SAMPLE OUTPUT
 *
 * Input: Hello!
 * Protected payload: CfDJ8LHIzUCX1ZVBn2BZ...
 * Round-tripped payload: Hello!
 * Revoking all keys in the key ring...
 * Calling Unprotect...
 * CryptographicException: The key {...} has been revoked.
 * Calling DangerousUnprotect...
 * Unprotected payload: Hello!
 * Requires migration = True, was revoked = True
 */

```

# Data Protection configuration in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

Visit these topics to learn about Data Protection configuration in ASP.NET Core:

- [Configure ASP.NET Core Data Protection](#)

An overview on configuring ASP.NET Core Data Protection.

- [Data Protection key management and lifetime](#)

Information on Data Protection key management and lifetime.

- [Data Protection machine-wide policy support](#)

Details on setting a default machine-wide policy for all apps that use Data Protection.

- [Non-DI aware scenarios for Data Protection in ASP.NET Core](#)

How to use the `DataProtectionProvider` concrete type to use Data Protection without going through DI-specific code paths.

# Configure ASP.NET Core Data Protection

6/21/2018 • 9 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

When the Data Protection system is initialized, it applies [default settings](#) based on the operational environment. These settings are generally appropriate for apps running on a single machine. There are cases where a developer may want to change the default settings:

- The app is spread across multiple machines.
- For compliance reasons.

For these scenarios, the Data Protection system offers a rich configuration API.

## WARNING

Similar to configuration files, the data protection key ring should be protected using appropriate permissions. You can choose to encrypt keys at rest, but this doesn't prevent attackers from creating new keys. Consequently, your app's security is impacted. The storage location configured with Data Protection should have its access limited to the app itself, similar to the way you would protect configuration files. For example, if you choose to store your key ring on disk, use file system permissions. Ensure only the identity under which your web app runs has read, write, and create access to that directory. If you use Azure Table Storage, only the web app should have the ability to read, write, or create new entries in the table store, etc.

The extension method `AddDataProtection` returns an `IDataProtectionBuilder`. `IDataProtectionBuilder` exposes extension methods that you can chain together to configure Data Protection options.

## ProtectKeysWithAzureKeyVault

To store keys in [Azure Key Vault](#), configure the system with `ProtectKeysWithAzureKeyVault` in the `Startup` class:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDataProtection()
        .PersistKeysToAzureBlobStorage(new Uri("<blobUriWithSasToken>"))
        .ProtectKeysWithAzureKeyVault("<keyIdentifier>", "<clientId>", "<clientSecret>");
}
```

Set the key ring storage location (for example, `PersistKeysToAzureBlobStorage`). The location must be set because calling `ProtectKeysWithAzureKeyVault` implements an `IXmlEncryptor` that disables automatic data protection settings, including the key ring storage location. The preceding example uses Azure Blob Storage to persist the key ring. For more information, see [Key storage providers: Azure and Redis](#). You can also persist the key ring locally with `PersistKeysToFileSystem`.

The `keyIdentifier` is the key vault key identifier used for key encryption (for example, <https://contosokeyvault.vault.azure.net/keys/dataprotection/>).

`ProtectKeysWithAzureKeyVault` overloads:

- `ProtectKeysWithAzureKeyVault(IDataProtectionBuilder, KeyVaultClient, String)` permits the use of a `KeyVaultClient` to enable the data protection system to use the key vault.

- `ProtectKeysWithAzureKeyVault(IDataProtectionBuilder, String, String, X509Certificate2)` permits the use of a `ClientId` and `X509Certificate` to enable the data protection system to use the key vault.
- `ProtectKeysWithAzureKeyVault(IDataProtectionBuilder, String, String, String)` permits the use of a `ClientId` and `ClientSecret` to enable the data protection system to use the key vault.

## PersistKeysToFileSystem

To store keys on a UNC share instead of at the `%LOCALAPPDATA%` default location, configure the system with [PersistKeysToFileSystem](#):

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDataProtection()
        .PersistKeysToFileSystem(new DirectoryInfo(@"\\server\share\directory\""));
}
```

### WARNING

If you change the key persistence location, the system no longer automatically encrypts keys at rest, since it doesn't know whether DPAPI is an appropriate encryption mechanism.

## ProtectKeysWith\*

You can configure the system to protect keys at rest by calling any of the [ProtectKeysWith\\*](#) configuration APIs. Consider the example below, which stores keys on a UNC share and encrypts those keys at rest with a specific X.509 certificate:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDataProtection()
        .PersistKeysToFileSystem(new DirectoryInfo(@"\\server\share\directory\""))
        .ProtectKeysWithCertificate("thumbprint");
}
```

See [Key Encryption At Rest](#) for more examples and discussion on the built-in key encryption mechanisms.

## SetDefaultKeyLifetime

To configure the system to use a key lifetime of 14 days instead of the default 90 days, use [SetDefaultKeyLifetime](#):

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDataProtection()
        .SetDefaultKeyLifetime(TimeSpan.FromDays(14));
}
```

## SetApplicationName

By default, the Data Protection system isolates apps from one another, even if they're sharing the same physical key repository. This prevents the apps from understanding each other's protected payloads. To share protected payloads between two apps, use [SetApplicationName](#) with the same value for each app:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDataProtection()
        .SetApplicationName("shared app name");
}
```

## DisableAutomaticKeyGeneration

You may have a scenario where you don't want an app to automatically roll keys (create new keys) as they approach expiration. One example of this might be apps set up in a primary/secondary relationship, where only the primary app is responsible for key management concerns and secondary apps simply have a read-only view of the key ring. The secondary apps can be configured to treat the key ring as read-only by configuring the system with [DisableAutomaticKeyGeneration](#):

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDataProtection()
        .DisableAutomaticKeyGeneration();
}
```

## Per-application isolation

When the Data Protection system is provided by an ASP.NET Core host, it automatically isolates apps from one another, even if those apps are running under the same worker process account and are using the same master keying material. This is somewhat similar to the `IsolateApps` modifier from System.Web's `<machineKey>` element.

The isolation mechanism works by considering each app on the local machine as a unique tenant, thus the [IDataProtector](#) rooted for any given app automatically includes the app ID as a discriminator. The app's unique ID comes from one of two places:

1. If the app is hosted in IIS, the unique identifier is the app's configuration path. If an app is deployed in a web farm environment, this value should be stable assuming that the IIS environments are configured similarly across all machines in the web farm.
2. If the app isn't hosted in IIS, the unique identifier is the physical path of the app.

The unique identifier is designed to survive resets — both of the individual app and of the machine itself.

This isolation mechanism assumes that the apps are not malicious. A malicious app can always impact any other app running under the same worker process account. In a shared hosting environment where apps are mutually untrusted, the hosting provider should take steps to ensure OS-level isolation between apps, including separating the apps' underlying key repositories.

If the Data Protection system isn't provided by an ASP.NET Core host (for example, if you instantiate it via the [DataProtectionProvider](#) concrete type) app isolation is disabled by default. When app isolation is disabled, all apps backed by the same keying material can share payloads as long as they provide the appropriate [purposes](#). To provide app isolation in this environment, call the [SetApplicationName](#) method on the configuration object and provide a unique name for each app.

## Changing algorithms with UseCryptographicAlgorithms

The Data Protection stack allows you to change the default algorithm used by newly-generated keys. The simplest way to do this is to call [UseCryptographicAlgorithms](#) from the configuration callback:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
services.AddDataProtection()
    .UseCryptographicAlgorithms(
        new AuthenticatedEncryptorConfiguration()
    {
        EncryptionAlgorithm = EncryptionAlgorithm.AES_256_CBC,
        ValidationAlgorithm = ValidationAlgorithm.HMACSHA256
    });
}
```

The default `EncryptionAlgorithm` is AES-256-CBC, and the default `ValidationAlgorithm` is HMACSHA256. The default policy can be set by a system administrator via a [machine-wide policy](#), but an explicit call to `UseCryptographicAlgorithms` overrides the default policy.

Calling `UseCryptographicAlgorithms` allows you to specify the desired algorithm from a predefined built-in list. You don't need to worry about the implementation of the algorithm. In the scenario above, the Data Protection system attempts to use the CNG implementation of AES if running on Windows. Otherwise, it falls back to the managed [System.Security.Cryptography.Aes](#) class.

You can manually specify an implementation via a call to `UseCustomCryptographicAlgorithms`.

**TIP**

Changing algorithms doesn't affect existing keys in the key ring. It only affects newly-generated keys.

## Specifying custom managed algorithms

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

To specify custom managed algorithms, create a [ManagedAuthenticatedEncryptorConfiguration](#) instance that points to the implementation types:

```
serviceCollection.AddDataProtection()
    .UseCustomCryptographicAlgorithms(
        new ManagedAuthenticatedEncryptorConfiguration()
    {
        // A type that subclasses SymmetricAlgorithm
        EncryptionAlgorithmType = typeof(Aes),

        // Specified in bits
        EncryptionAlgorithmKeySize = 256,

        // A type that subclasses KeyedHashAlgorithm
        ValidationAlgorithmType = typeof(HMACSHA256)
    });
}
```

Generally the \*Type properties must point to concrete, instantiable (via a public parameterless ctor) implementations of [SymmetricAlgorithm](#) and [KeyedHashAlgorithm](#), though the system special-cases some values like `typeof(Aes)` for convenience.

#### NOTE

The SymmetricAlgorithm must have a key length of  $\geq 128$  bits and a block size of  $\geq 64$  bits, and it must support CBC-mode encryption with PKCS #7 padding. The KeyedHashAlgorithm must have a digest size of  $\geq 128$  bits, and it must support keys of length equal to the hash algorithm's digest length. The KeyedHashAlgorithm isn't strictly required to be HMAC.

### Specifying custom Windows CNG algorithms

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

To specify a custom Windows CNG algorithm using CBC-mode encryption with HMAC validation, create a [CngCbcAuthenticatedEncryptorConfiguration](#) instance that contains the algorithmic information:

```
services.AddDataProtection()
    .UseCustomCryptographicAlgorithms(
        new CngCbcAuthenticatedEncryptorConfiguration()
    {
        // Passed to BCryptOpenAlgorithmProvider
        EncryptionAlgorithm = "AES",
        EncryptionAlgorithmProvider = null,

        // Specified in bits
        EncryptionAlgorithmKeySize = 256,

        // Passed to BCryptOpenAlgorithmProvider
        HashAlgorithm = "SHA256",
        HashAlgorithmProvider = null
    });
}
```

#### NOTE

The symmetric block cipher algorithm must have a key length of  $\geq 128$  bits, a block size of  $\geq 64$  bits, and it must support CBC-mode encryption with PKCS #7 padding. The hash algorithm must have a digest size of  $\geq 128$  bits and must support being opened with the BCRYPT\_ALG\_HANDLE\_HMAC\_FLAG flag. The \*Provider properties can be set to null to use the default provider for the specified algorithm. See the [BCryptOpenAlgorithmProvider](#) documentation for more information.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

To specify a custom Windows CNG algorithm using Galois/Counter Mode encryption with validation, create a [CngGcmAuthenticatedEncryptorConfiguration](#) instance that contains the algorithmic information:

```
services.AddDataProtection()
    .UseCustomCryptographicAlgorithms(
        new CngGcmAuthenticatedEncryptorConfiguration()
    {
        // Passed to BCryptOpenAlgorithmProvider
        EncryptionAlgorithm = "AES",
        EncryptionAlgorithmProvider = null,

        // Specified in bits
        EncryptionAlgorithmKeySize = 256
    });
}
```

**NOTE**

The symmetric block cipher algorithm must have a key length of  $\geq 128$  bits, a block size of exactly 128 bits, and it must support GCM encryption. You can set the [EncryptionAlgorithmProvider](#) property to null to use the default provider for the specified algorithm. See the [BCryptOpenAlgorithmProvider](#) documentation for more information.

## Specifying other custom algorithms

Though not exposed as a first-class API, the Data Protection system is extensible enough to allow specifying almost any kind of algorithm. For example, it's possible to keep all keys contained within a Hardware Security Module (HSM) and to provide a custom implementation of the core encryption and decryption routines. See [IAuthenticatedEncryptor](#) in [Core cryptography extensibility](#) for more information.

## Persisting keys when hosting in a Docker container

When hosting in a [Docker](#) container, keys should be maintained in either:

- A folder that's a Docker volume that persists beyond the container's lifetime, such as a shared volume or a host-mounted volume.
- An external provider, such as [Azure Key Vault](#) or [Redis](#).

## See also

- [Non DI Aware Scenarios](#)
- [Machine Wide Policy](#)

# Data Protection key management and lifetime in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

## Key management

The app attempts to detect its operational environment and handle key configuration on its own.

1. If the app is hosted in [Azure Apps](#), keys are persisted to the `%HOME%\ASP.NET\DataProtection-Keys` folder. This folder is backed by network storage and is synchronized across all machines hosting the app.
  - Keys aren't protected at rest.
  - The `DataProtection-Keys` folder supplies the key ring to all instances of an app in a single deployment slot.
  - Separate deployment slots, such as Staging and Production, don't share a key ring. When you swap between deployment slots, for example swapping Staging to Production or using A/B testing, any app using Data Protection won't be able to decrypt stored data using the key ring inside the previous slot. This leads to users being logged out of an app that uses the standard ASP.NET Core cookie authentication, as it uses Data Protection to protect its cookies. If you desire slot-independent key rings, use an external key ring provider, such as Azure Blob Storage, Azure Key Vault, a SQL store, or Redis cache.
2. If the user profile is available, keys are persisted to the `%LOCALAPPDATA%\ASP.NET\DataProtection-Keys` folder. If the operating system is Windows, the keys are encrypted at rest using DPAPI.
3. If the app is hosted in IIS, keys are persisted to the HKLM registry in a special registry key that's ACLed only to the worker process account. Keys are encrypted at rest using DPAPI.
4. If none of these conditions match, keys aren't persisted outside of the current process. When the process shuts down, all generated keys are lost.

The developer is always in full control and can override how and where keys are stored. The first three options above should provide good defaults for most apps similar to how the ASP.NET `<machineKey>` auto-generation routines worked in the past. The final, fallback option is the only scenario that requires the developer to specify [configuration](#) upfront if they want key persistence, but this fallback only occurs in rare situations.

When hosting in a Docker container, keys should be persisted in a folder that's a Docker volume (a shared volume or a host-mounted volume that persists beyond the container's lifetime) or in an external provider, such as [Azure Key Vault](#) or [Redis](#). An external provider is also useful in web farm scenarios if apps can't access a shared network volume (see [PersistKeysToFileSystem](#) for more information).

### WARNING

If the developer overrides the rules outlined above and points the Data Protection system at a specific key repository, automatic encryption of keys at rest is disabled. At-rest protection can be re-enabled via [configuration](#).

## Key lifetime

Keys have a 90-day lifetime by default. When a key expires, the app automatically generates a new key and sets

the new key as the active key. As long as retired keys remain on the system, your app can decrypt any data protected with them. See [key management](#) for more information.

## Default algorithms

The default payload protection algorithm used is AES-256-CBC for confidentiality and HMACSHA256 for authenticity. A 512-bit master key, changed every 90 days, is used to derive the two sub-keys used for these algorithms on a per-payload basis. See [subkey derivation](#) for more information.

## See also

- [Key management extensibility](#)

# Data Protection machine-wide policy support in ASP.NET Core

6/21/2018 • 3 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

When running on Windows, the Data Protection system has limited support for setting a default machine-wide policy for all apps that consume ASP.NET Core Data Protection. The general idea is that an administrator might wish to change a default setting, such as the algorithms used or key lifetime, without the need to manually update every app on the machine.

## WARNING

The system administrator can set default policy, but they can't enforce it. The app developer can always override any value with one of their own choosing. The default policy only affects apps where the developer hasn't specified an explicit value for a setting.

## Setting default policy

To set default policy, an administrator can set known values in the system registry under the following registry key:

**HKLM\SOFTWARE\Microsoft\DotNetPackages\Microsoft.AspNetCore.DataProtection**

If you're on a 64-bit operating system and want to affect the behavior of 32-bit apps, remember to configure the Wow6432Node equivalent of the above key.

The supported values are shown below.

VALUE	TYPE	DESCRIPTION
EncryptionType	string	Specifies which algorithms should be used for data protection. The value must be CNG-CBC, CNG-GCM, or Managed and is described in more detail below.
DefaultKeyLifetime	DWORD	Specifies the lifetime for newly-generated keys. The value is specified in days and must be $\geq 7$ .
KeyEscrowSinks	string	Specifies the types that are used for key escrow. The value is a semicolon-delimited list of key escrow sinks, where each element in the list is the assembly-qualified name of a type that implements <a href="#">IKeyEscrowSink</a> .

## Encryption types

If EncryptionType is CNG-CBC, the system is configured to use a CBC-mode symmetric block cipher for

confidentiality and HMAC for authenticity with services provided by Windows CNG (see [Specifying custom Windows CNG algorithms](#) for more details). The following additional values are supported, each of which corresponds to a property on the CngCbcAuthenticatedEncryptionSettings type.

VALUE	TYPE	DESCRIPTION
EncryptionAlgorithm	string	The name of a symmetric block cipher algorithm understood by CNG. This algorithm is opened in CBC mode.
EncryptionAlgorithmProvider	string	The name of the CNG provider implementation that can produce the algorithm EncryptionAlgorithm.
EncryptionAlgorithmKeySize	DWORD	The length (in bits) of the key to derive for the symmetric block cipher algorithm.
HashAlgorithm	string	The name of a hash algorithm understood by CNG. This algorithm is opened in HMAC mode.
HashAlgorithmProvider	string	The name of the CNG provider implementation that can produce the algorithm HashAlgorithm.

If EncryptionType is CNG-GCM, the system is configured to use a Galois/Counter Mode symmetric block cipher for confidentiality and authenticity with services provided by Windows CNG (see [Specifying custom Windows CNG algorithms](#) for more details). The following additional values are supported, each of which corresponds to a property on the CngGcmAuthenticatedEncryptionSettings type.

VALUE	TYPE	DESCRIPTION
EncryptionAlgorithm	string	The name of a symmetric block cipher algorithm understood by CNG. This algorithm is opened in Galois/Counter Mode.
EncryptionAlgorithmProvider	string	The name of the CNG provider implementation that can produce the algorithm EncryptionAlgorithm.
EncryptionAlgorithmKeySize	DWORD	The length (in bits) of the key to derive for the symmetric block cipher algorithm.

If EncryptionType is Managed, the system is configured to use a managed SymmetricAlgorithm for confidentiality and KeyedHashAlgorithm for authenticity (see [Specifying custom managed algorithms](#) for more details). The following additional values are supported, each of which corresponds to a property on the ManagedAuthenticatedEncryptionSettings type.

VALUE	TYPE	DESCRIPTION
EncryptionAlgorithmType	string	The assembly-qualified name of a type that implements SymmetricAlgorithm.

VALUE	TYPE	DESCRIPTION
EncryptionAlgorithmKeySize	DWORD	The length (in bits) of the key to derive for the symmetric encryption algorithm.
ValidationAlgorithmType	string	The assembly-qualified name of a type that implements KeyedHashAlgorithm.

If EncryptionType has any other value other than null or empty, the Data Protection system throws an exception at startup.

#### WARNING

When configuring a default policy setting that involves type names (EncryptionAlgorithmType, ValidationAlgorithmType, KeyEscrowSinks), the types must be available to the app. This means that for apps running on Desktop CLR, the assemblies that contain these types should be present in the Global Assembly Cache (GAC). For ASP.NET Core apps running on .NET Core, the packages that contain these types should be installed.

# Non-DI aware scenarios for Data Protection in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

The ASP.NET Core Data Protection system is normally [added to a service container](#) and consumed by dependent components via dependency injection (DI). However, there are cases where this isn't feasible or desired, especially when importing the system into an existing app.

To support these scenarios, the [Microsoft.AspNetCore.DataProtection.Extensions](#) package provides a concrete type, [DataProtectionProvider](#), which offers a simple way to use Data Protection without relying on DI. The `DataProtectionProvider` type implements [IDataProtectionProvider](#). Constructing `DataProtectionProvider` only requires providing a  [DirectoryInfo](#) instance to indicate where the provider's cryptographic keys should be stored, as seen in the following code sample:

```

using System;
using System.IO;
using Microsoft.AspNetCore.DataProtection;

public class Program
{
    public static void Main(string[] args)
    {
        // Get the path to %LOCALAPPDATA%\myapp-keys
        var destFolder = Path.Combine(
            System.Environment.GetEnvironmentVariable("LOCALAPPDATA"),
            "myapp-keys");

        // Instantiate the data protection system at this folder
        var dataProtectionProvider = DataProtectionProvider.Create(
            new DirectoryInfo(destFolder));

        var protector = dataProtectionProvider.CreateProtector("Program.No-DI");
        Console.WriteLine("Enter input: ");
        var input = Console.ReadLine();

        // Protect the payload
        var protectedPayload = protector.Protect(input);
        Console.WriteLine($"Protect returned: {protectedPayload}");

        // Unprotect the payload
        var unprotectedPayload = protector.Unprotect(protectedPayload);
        Console.WriteLine($"Unprotect returned: {unprotectedPayload}");

        Console.WriteLine();
        Console.WriteLine("Press any key...");
        Console.ReadKey();
    }
}

/*
 * SAMPLE OUTPUT
 *
 * Enter input: Hello world!
 * Protect returned: CfDJ8FWbAn6...ch3hAPm1NJA
 * Unprotect returned: Hello world!
 *
 * Press any key...
*/

```

By default, the `DataProtectionProvider` concrete type doesn't encrypt raw key material before persisting it to the file system. This is to support scenarios where the developer points to a network share and the Data Protection system can't automatically deduce an appropriate at-rest key encryption mechanism.

Additionally, the `DataProtectionProvider` concrete type doesn't [isolate apps](#) by default. All apps using the same key directory can share payloads as long as their [purpose parameters](#) match.

The `DataProtectionProvider` constructor accepts an optional configuration callback that can be used to adjust the behaviors of the system. The sample below demonstrates restoring isolation with an explicit call to [SetApplicationName](#). The sample also demonstrates configuring the system to automatically encrypt persisted keys using Windows DPAPI. If the directory points to a UNC share, you may wish to distribute a shared certificate across all relevant machines and to configure the system to use certificate-based encryption with a call to [ProtectKeysWithCertificate](#).

```

using System;
using System.IO;
using Microsoft.AspNetCore.DataProtection;

public class Program
{
    public static void Main(string[] args)
    {
        // Get the path to %LOCALAPPDATA%\myapp-keys
        var destFolder = Path.Combine(
            System.Environment.GetEnvironmentVariable("LOCALAPPDATA"),
            "myapp-keys");

        // Instantiate the data protection system at this folder
        var dataProtectionProvider = DataProtectionProvider.Create(
            new DirectoryInfo(destFolder),
            configuration =>
            {
                configuration.SetApplicationName("my app name");
                configuration.ProtectKeysWithDpapi();
            });

        var protector = dataProtectionProvider.CreateProtector("Program.No-DI");
        Console.WriteLine("Enter input: ");
        var input = Console.ReadLine();

        // Protect the payload
        var protectedPayload = protector.Protect(input);
        Console.WriteLine($"Protect returned: {protectedPayload}");

        // Unprotect the payload
        var unprotectedPayload = protector.Unprotect(protectedPayload);
        Console.WriteLine($"Unprotect returned: {unprotectedPayload}");

        Console.WriteLine();
        Console.WriteLine("Press any key...");
        Console.ReadKey();
    }
}

```

#### TIP

Instances of the `DataProtectionProvider` concrete type are expensive to create. If an app maintains multiple instances of this type and if they're all using the same key storage directory, app performance might degrade. If you use the `DataProtectionProvider` type, we recommend that you create this type once and reuse it as much as possible. The `DataProtectionProvider` type and all `IDataProtector` instances created from it are thread-safe for multiple callers.

# ASP.NET Core Data Protection extensibility APIs

6/21/2018 • 2 minutes to read • [Edit Online](#)

- [Core cryptography extensibility](#)
- [Key management extensibility](#)
- [Miscellaneous APIs](#)

# Core cryptography extensibility in ASP.NET Core

6/21/2018 • 5 minutes to read • [Edit Online](#)

## WARNING

Types that implement any of the following interfaces should be thread-safe for multiple callers.

## IAuthenticatedEncryptor

The **IAuthenticatedEncryptor** interface is the basic building block of the cryptographic subsystem. There's generally one **IAuthenticatedEncryptor** per key, and the **IAuthenticatedEncryptor** instance wraps all cryptographic key material and algorithmic information necessary to perform cryptographic operations.

As its name suggests, the type is responsible for providing authenticated encryption and decryption services. It exposes the following two APIs.

- `Decrypt(ArraySegment ciphertext, ArraySegment additionalAuthenticatedData) : byte[]`
- `Encrypt(ArraySegment plaintext, ArraySegment additionalAuthenticatedData) : byte[]`

The `Encrypt` method returns a blob that includes the enciphered plaintext and an authentication tag. The authentication tag must encompass the additional authenticated data (AAD), though the AAD itself need not be recoverable from the final payload. The `Decrypt` method validates the authentication tag and returns the deciphered payload. All failures (except `ArgumentNullException` and similar) should be homogenized to `CryptographicException`.

## NOTE

The **IAuthenticatedEncryptor** instance itself doesn't actually need to contain the key material. For example, the implementation could delegate to an HSM for all operations.

## How to create an IAuthenticatedEncryptor

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

The **IAuthenticatedEncryptorFactory** interface represents a type that knows how to create an **IAuthenticatedEncryptor** instance. Its API is as follows.

- `CreateEncryptorInstance(IKey key) : IAuthenticatedEncryptor`

For any given **IKey** instance, any authenticated encryptors created by its `CreateEncryptorInstance` method should be considered equivalent, as in the below code sample.

```

// we have an IAuthenticatedEncryptorFactory instance and an IKey instance
IAuthenticatedEncryptorFactory factory = ...;
IKey key = ...;

// get an encryptor instance and perform an authenticated encryption operation
ArraySegment<byte> plaintext = new ArraySegment<byte>(Encoding.UTF8.GetBytes("plaintext"));
ArraySegment<byte> aad = new ArraySegment<byte>(Encoding.UTF8.GetBytes("AAD"));
var encryptor1 = factory.CreateEncryptorInstance(key);
byte[] ciphertext = encryptor1.Encrypt(plaintext, aad);

// get another encryptor instance and perform an authenticated decryption operation
var encryptor2 = factory.CreateEncryptorInstance(key);
byte[] roundTripped = encryptor2.Decrypt(new ArraySegment<byte>(ciphertext), aad);

// the 'roundTripped' and 'plaintext' buffers should be equivalent

```

## IAuthenticatedEncryptorDescriptor (ASP.NET Core 2.x only)

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

The **IAuthenticatedEncryptorDescriptor** interface represents a type that knows how to export itself to XML. Its API is as follows.

- ExportToXml() : XmlSerializedDescriptorInfo

## XML Serialization

The primary difference between IAuthenticatedEncryptor and IAuthenticatedEncryptorDescriptor is that the descriptor knows how to create the encryptor and supply it with valid arguments. Consider an IAuthenticatedEncryptor whose implementation relies on SymmetricAlgorithm and KeyedHashAlgorithm. The encryptor's job is to consume these types, but it doesn't necessarily know where these types came from, so it can't really write out a proper description of how to recreate itself if the application restarts. The descriptor acts as a higher level on top of this. Since the descriptor knows how to create the encryptor instance (e.g., it knows how to create the required algorithms), it can serialize that knowledge in XML form so that the encryptor instance can be recreated after an application reset.

The descriptor can be serialized via its ExportToXml routine. This routine returns an XmlSerializedDescriptorInfo which contains two properties: the XElement representation of the descriptor and the Type which represents an **IAuthenticatedEncryptorDescriptorDeserializer** which can be used to resurrect this descriptor given the corresponding XElement.

The serialized descriptor may contain sensitive information such as cryptographic key material. The data protection system has built-in support for encrypting information before it's persisted to storage. To take advantage of this, the descriptor should mark the element which contains sensitive information with the attribute name "requiresEncryption" (xmlns "<http://schemas.asp.net/2015/03/dataProtection>"), value "true".

### TIP

There's a helper API for setting this attribute. Call the extension method XElement.MarkAsRequiresEncryption() located in namespace Microsoft.AspNetCore.DataProtection.AuthenticatedEncryption.ConfigurationModel.

There can also be cases where the serialized descriptor doesn't contain sensitive information. Consider again the case of a cryptographic key stored in an HSM. The descriptor cannot write out the key material when serializing itself since the HSM won't expose the material in plaintext form. Instead, the descriptor might write out the key-

wrapped version of the key (if the HSM allows export in this fashion) or the HSM's own unique identifier for the key.

## IAuthenticatedEncryptorDescriptorDeserializer

The **IAuthenticatedEncryptorDescriptorDeserializer** interface represents a type that knows how to deserialize an **IAuthenticatedEncryptorDescriptor** instance from an **XElement**. It exposes a single method:

- `ImportFromXml(XElement element) : IAuthenticatedEncryptorDescriptor`

The `ImportFromXml` method takes the **XElement** that was returned by **IAuthenticatedEncryptorDescriptor.ExportToXml** and creates an equivalent of the original **IAuthenticatedEncryptorDescriptor**.

Types which implement **IAuthenticatedEncryptorDescriptorDeserializer** should have one of the following two public constructors:

- `.ctor(IServiceProvider)`
- `.ctor()`

### NOTE

The **IServiceProvider** passed to the constructor may be null.

## The top-level factory

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

The **AlgorithmConfiguration** class represents a type which knows how to create **IAuthenticatedEncryptorDescriptor** instances. It exposes a single API.

- `CreateNewDescriptor() : IAuthenticatedEncryptorDescriptor`

Think of **AlgorithmConfiguration** as the top-level factory. The configuration serves as a template. It wraps algorithmic information (e.g., this configuration produces descriptors with an AES-128-GCM master key), but it's not yet associated with a specific key.

When `CreateNewDescriptor` is called, fresh key material is created solely for this call, and a new **IAuthenticatedEncryptorDescriptor** is produced which wraps this key material and the algorithmic information required to consume the material. The key material could be created in software (and held in memory), it could be created and held within an HSM, and so on. The crucial point is that any two calls to `CreateNewDescriptor` should never create equivalent **IAuthenticatedEncryptorDescriptor** instances.

The **AlgorithmConfiguration** type serves as the entry point for key creation routines such as [automatic key rolling](#). To change the implementation for all future keys, set the **AuthenticatedEncryptorConfiguration** property in **KeyManagementOptions**.

# Key management extensibility in ASP.NET Core

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## TIP

Read the [key management](#) section before reading this section, as it explains some of the fundamental concepts behind these APIs.

## WARNING

Types that implement any of the following interfaces should be thread-safe for multiple callers.

## Key

The `IKey` interface is the basic representation of a key in cryptosystem. The term key is used here in the abstract sense, not in the literal sense of "cryptographic key material". A key has the following properties:

- Activation, creation, and expiration dates
- Revocation status
- Key identifier (a GUID)
- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

Additionally, `IKey` exposes a `CreateEncryptor` method which can be used to create an `IAuthenticatedEncryptor` instance tied to this key.

## NOTE

There's no API to retrieve the raw cryptographic material from an `IKey` instance.

## IKeyManager

The `IKeyManager` interface represents an object responsible for general key storage, retrieval, and manipulation. It exposes three high-level operations:

- Create a new key and persist it to storage.
- Get all keys from storage.
- Revoke one or more keys and persist the revocation information to storage.

## WARNING

Writing an `IKeyManager` is a very advanced task, and the majority of developers shouldn't attempt it. Instead, most developers should take advantage of the facilities offered by the `XmlKeyManager` class.

# XmlKeyManager

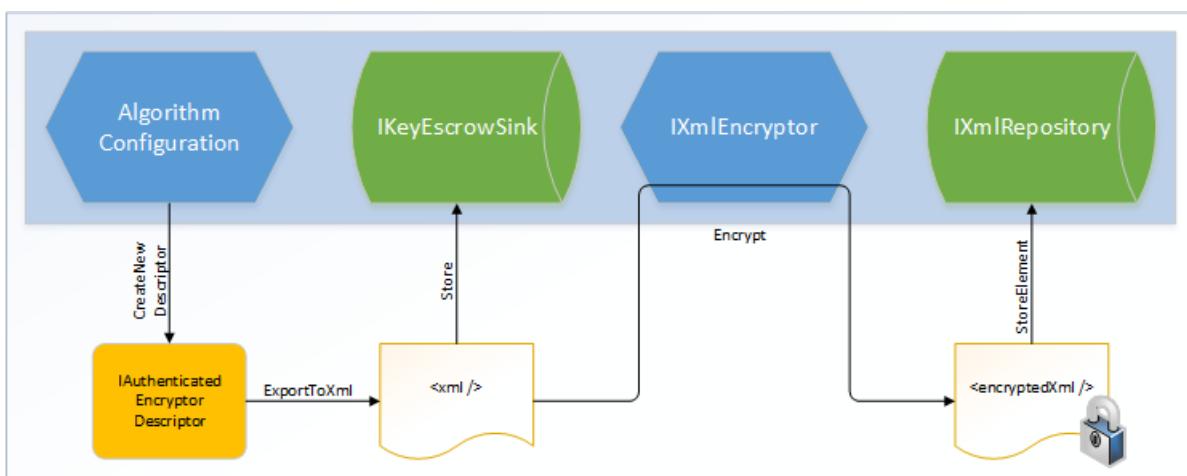
The `XmlKeyManager` type is the in-box concrete implementation of `IKeyManager`. It provides several useful facilities, including key escrow and encryption of keys at rest. Keys in this system are represented as XML elements (specifically, `XElement`).

`XmlKeyManager` depends on several other components in the course of fulfilling its tasks:

- `ASP.NET Core 2.x`
- `ASP.NET Core 1.x`
- `AlgorithmConfiguration`, which dictates the algorithms used by new keys.
- `IXmlRepository`, which controls where keys are persisted in storage.
- `IXmlEncryptor` [optional], which allows encrypting keys at rest.
- `IKeyEscrowSink` [optional], which provides key escrow services.

Below are high-level diagrams which indicate how these components are wired together within `XmlKeyManager`.

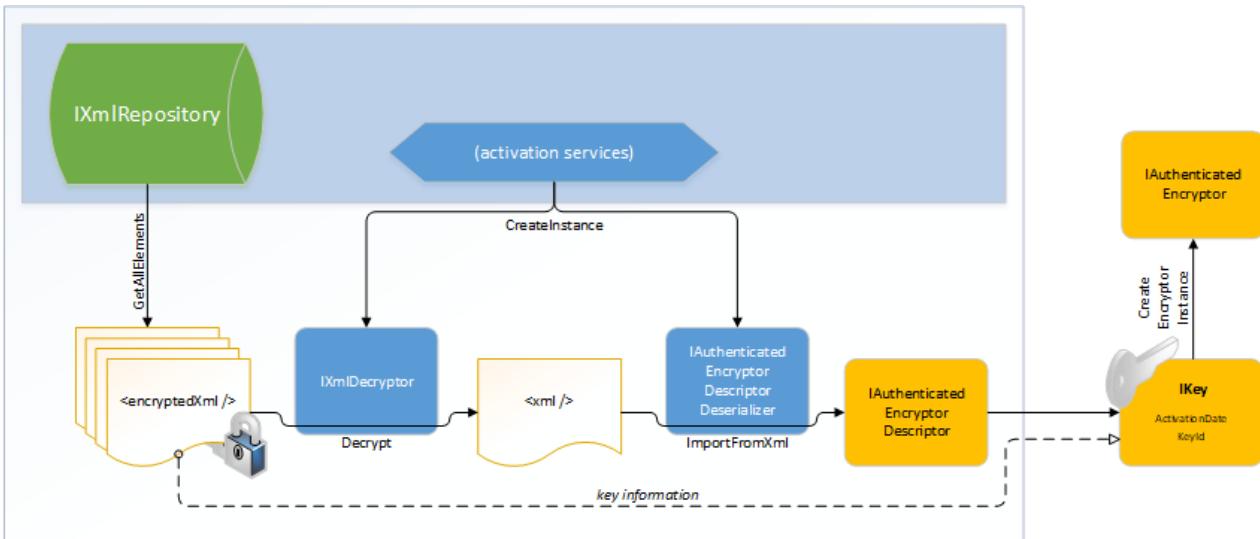
- `ASP.NET Core 2.x`
- `ASP.NET Core 1.x`



## Key Creation / `CreateNewKey`

In the implementation of `CreateNewKey`, the `AlgorithmConfiguration` component is used to create a unique `IAuthenticatedEncryptorDescriptor`, which is then serialized as XML. If a key escrow sink is present, the raw (unencrypted) XML is provided to the sink for long-term storage. The unencrypted XML is then run through an `IXmlEncryptor` (if required) to generate the encrypted XML document. This encrypted document is persisted to long-term storage via the `IXmlRepository`. (If no `IXmlEncryptor` is configured, the unencrypted document is persisted in the `IXmlRepository`.)

- `ASP.NET Core 2.x`
- `ASP.NET Core 1.x`



### Key Retrieval / GetAllKeys

In the implementation of `GetAllKeys`, the XML documents representing keys and revocations are read from the underlying **IXmlRepository**. If these documents are encrypted, the system will automatically decrypt them.

**XmlKeyManager** creates the appropriate **IAuthenticatedEncryptorDescriptorDeserializer** instances to deserialize the documents back into **IAuthenticatedEncryptorDescriptor** instances, which are then wrapped in individual **IKey** instances. This collection of **IKey** instances is returned to the caller.

Further information on the particular XML elements can be found in the [key storage format document](#).

## IXmlRepository

The **IXmlRepository** interface represents a type that can persist XML to and retrieve XML from a backing store. It exposes two APIs:

- `GetAllElements() : IReadOnlyCollection<XmlElement>`
- `StoreElement(XElement element, string friendlyName)`

Implementations of **IXmlRepository** don't need to parse the XML passing through them. They should treat the XML documents as opaque and let higher layers worry about generating and parsing the documents.

There are two built-in concrete types which implement **IXmlRepository** : **FileSystemXmlRepository** and **RegistryXmlRepository**. See the [key storage providers document](#) for more information. Registering a custom **IXmlRepository** would be the appropriate manner to use a different backing store, e.g., Azure Blob Storage.

To change the default repository application-wide, register a custom **IXmlRepository** instance:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
services.Configure<KeyManagementOptions>(options => options.XmlRepository = new MyCustomXmlRepository());
```

## IXmlEncryptor

The **IXmlEncryptor** interface represents a type that can encrypt a plaintext XML element. It exposes a single API:

- `Encrypt(XElement plaintextElement) : EncryptedXmlInfo`

If a serialized **IAuthenticatedEncryptorDescriptor** contains any elements marked as "requires encryption", then **XmlKeyManager** will run those elements through the configured **IXmlEncryptor**'s `Encrypt` method, and it will

persist the enciphered element rather than the plaintext element to the `IXmlRepository`. The output of the `Encrypt` method is an `EncryptedXmlInfo` object. This object is a wrapper which contains both the resultant enciphered `XElement` and the Type which represents an `IXmlDecryptor` which can be used to decipher the corresponding element.

There are four built-in concrete types which implement `IXmlEncryptor`:

- `CertificateXmlEncryptor`
- `DpapiNGXmlEncryptor`
- `DpapiXmlEncryptor`
- `NullXmlEncryptor`

See the [key encryption at rest document](#) for more information.

To change the default key-encryption-at-rest mechanism application-wide, register a custom `IXmlEncryptor` instance:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
services.Configure<KeyManagementOptions>(options => options.XmlEncryptor = new MyCustomXmlEncryptor());
```

## IXmlAttribute

The `IXmlAttribute` interface represents a type that knows how to decrypt an `XElement` that was enciphered via an `IXmlEncryptor`. It exposes a single API:

- `Decrypt(XElement encryptedElement) : XElement`

The `Decrypt` method undoes the encryption performed by `IXmlEncryptor.Encrypt`. Generally, each concrete `IXmlAttribute` implementation will have a corresponding concrete `IXmlAttribute` implementation.

Types which implement `IXmlAttribute` should have one of the following two public constructors:

- `.ctor(IServiceProvider)`
- `.ctor()`

### NOTE

The `IServiceProvider` passed to the constructor may be null.

## IKeyEscrowSink

The `IKeyEscrowSink` interface represents a type that can perform escrow of sensitive information. Recall that serialized descriptors might contain sensitive information (such as cryptographic material), and this is what led to the introduction of the `IXmlAttribute` type in the first place. However, accidents happen, and key rings can be deleted or become corrupted.

The escrow interface provides an emergency escape hatch, allowing access to the raw serialized XML before it's transformed by any configured `IXmlAttribute`. The interface exposes a single API:

- `Store(Guid keyId, XElement element)`

It's up to the `IKeyEscrowSink` implementation to handle the provided element in a secure manner consistent with business policy. One possible implementation could be for the escrow sink to encrypt the XML element using a

known corporate X.509 certificate where the certificate's private key has been escrowed; the `CertificateXmlEncryptor` type can assist with this. The `IKeyEscrowSink` implementation is also responsible for persisting the provided element appropriately.

By default no escrow mechanism is enabled, though server administrators can [configure this globally](#). It can also be configured programmatically via the `IDataProtectionBuilder.AddKeyEscrowSink` method as shown in the sample below. The `AddKeyEscrowSink` method overloads mirror the `IServiceCollection.AddSingleton` and `IServiceCollection.AddInstance` overloads, as `IKeyEscrowSink` instances are intended to be singletons. If multiple `IKeyEscrowSink` instances are registered, each one will be called during key generation, so keys can be escrowed to multiple mechanisms simultaneously.

There's no API to read material from an `IKeyEscrowSink` instance. This is consistent with the design theory of the escrow mechanism: it's intended to make the key material accessible to a trusted authority, and since the application is itself not a trusted authority, it shouldn't have access to its own escrowed material.

The following sample code demonstrates creating and registering an `IKeyEscrowSink` where keys are escrowed such that only members of "CONTOSO\Domain Admins" can recover them.

#### NOTE

To run this sample, you must be on a domain-joined Windows 8 / Windows Server 2012 machine, and the domain controller must be Windows Server 2012 or later.

```
using System;
using System.IO;
using System.Xml.Linq;
using Microsoft.AspNetCore.DataProtection;
using Microsoft.AspNetCore.DataProtection.KeyManagement;
using Microsoft.AspNetCore.DataProtection.XmlEncryption;
using Microsoft.Extensions.DependencyInjection;

public class Program
{
    public static void Main(string[] args)
    {
        var serviceCollection = new ServiceCollection();
        serviceCollection.AddDataProtection()
            .PersistKeysToFileSystem(new DirectoryInfo(@"c:\temp-keys"))
            .ProtectKeysWithDpapi()
            .AddKeyEscrowSink(sp => new MyKeyEscrowSink(sp));
        var services = serviceCollection.BuildServiceProvider();

        // get a reference to the key manager and force a new key to be generated
        Console.WriteLine("Generating new key...");
        var keyManager = services.GetService<IKeyManager>();
        keyManager.CreateNewKey(
            activationDate: DateTimeOffset.Now,
            expirationDate: DateTimeOffset.Now.AddDays(7));
    }

    // A key escrow sink where keys are escrowed such that they
    // can be read by members of the CONTOSO\Domain Admins group.
    private class MyKeyEscrowSink : IKeyEscrowSink
    {
        private readonly IXmlEncryptor _escrowEncryptor;

        public MyKeyEscrowSink(IServiceProvider services)
        {
            // Assuming I'm on a machine that's a member of the CONTOSO
            // domain, I can use the Domain Admins SID to generate an
            // encrypted payload that only they can read. Sample SID from
            // https://technet.microsoft.com/library/cc778824(v=ws.10).aspx.
        }
    }
}
```

```
        _escrowEncryptor = new DpapiNGXmlEncryptor(
            "SID=S-1-5-21-1004336348-1177238915-682003330-512",
            DpapiNGProtectionDescriptorFlags.None,
            services);
    }

    public void Store(Guid keyId, XElement element)
    {
        // Encrypt the key element to the escrow encryptor.
        var encryptedXmlInfo = _escrowEncryptor.Encrypt(element);

        // A real implementation would save the escrowed key to a
        // write-only file share or some other stable storage, but
        // in this sample we'll just write it out to the console.
        Console.WriteLine($"Escrowing key {keyId}");
        Console.WriteLine(encryptedXmlInfo.EncryptedElement);

        // Note: We cannot read the escrowed key material ourselves.
        // We need to get a member of CONTOSO\Domain Admins to read
        // it for us in the event we need to recover it.
    }
}

/*
 * SAMPLE OUTPUT
 *
 * Generating new key...
 * Escrowing key 38e74534-c1b8-4b43-aea1-79e856a822e5
 * <encryptedKey>
 *   <!-- This key is encrypted with Windows DPAPI-NG. -->
 *   <!-- Rule: SID=S-1-5-21-1004336348-1177238915-682003330-512 -->
 *   <value>MIIIfAYJKoZIhvcNAQcDoIIIbTCCGkCAQ...T5rA4g==</value>
 * </encryptedKey>
 */
```

# Miscellaneous ASP.NET Core Data Protection APIs

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## WARNING

Types that implement any of the following interfaces should be thread-safe for multiple callers.

## ISecret

The `ISecret` interface represents a secret value, such as cryptographic key material. It contains the following API surface:

- `Length : int`
- `Dispose() : void`
- `WriteSecretIntoBuffer(ArraySegment<byte> buffer) : void`

The `WriteSecretIntoBuffer` method populates the supplied buffer with the raw secret value. The reason this API takes the buffer as a parameter rather than returning a `byte[]` directly is that this gives the caller the opportunity to pin the buffer object, limiting secret exposure to the managed garbage collector.

The `Secret` type is a concrete implementation of `ISecret` where the secret value is stored in in-process memory. On Windows platforms, the secret value is encrypted via `CryptProtectMemory`.

# ASP.NET Core Data Protection implementation

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- [Authenticated encryption details](#)
- [Subkey Derivation and Authenticated Encryption](#)
- [Context headers](#)
- [Key Management](#)
- [Key Storage Providers](#)
- [Key Encryption At Rest](#)
- [Key immutability and settings](#)
- [Key Storage Format](#)
- [Ephemeral data protection providers](#)

# Authenticated encryption details in ASP.NET Core

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Calls to `IDataProtector.Protect` are authenticated encryption operations. The `Protect` method offers both confidentiality and authenticity, and it's tied to the purpose chain that was used to derive this particular `IDataProtector` instance from its root `IDataProtectionProvider`.

`IDataProtector.Protect` takes a `byte[]` plaintext parameter and produces a `byte[]` protected payload, whose format is described below. (There's also an extension method overload which takes a string plaintext parameter and returns a string protected payload. If this API is used the protected payload format will still have the below structure, but it will be [base64url-encoded](#).)

## Protected payload format

The protected payload format consists of three primary components:

- A 32-bit magic header that identifies the version of the data protection system.
- A 128-bit key id that identifies the key used to protect this particular payload.
- The remainder of the protected payload is [specific to the encryptor encapsulated by this key](#). In the example below the key represents an AES-256-CBC + HMACSHA256 encryptor, and the payload is further subdivided as follows:
  - \* A 128-bit key modifier.
  - \* A 128-bit initialization vector.
  - \* 48 bytes of AES-256-CBC output.
  - \* An HMACSHA256 authentication tag.

A sample protected payload is illustrated below.

```
09 F0 C9 F0 80 9C 81 0C 19 66 19 40 95 36 53 F8
AA FF EE 57 57 2F 40 4C 3F 7F CC 9D CC D9 32 3E
84 17 99 16 EC BA 1F 4A A1 18 45 1F 2D 13 7A 28
79 6B 86 9C F8 B7 84 F9 26 31 FC B1 86 0A F1 56
61 CF 14 58 D3 51 6F CF 36 50 85 82 08 2D 3F 73
5F B0 AD 9E 1A B2 AE 13 57 90 C8 F5 7C 95 4E 6A
8A AA 06 EF 43 CA 19 62 84 7C 11 B2 C8 71 9D AA
52 19 2E 5B 4C 1E 54 F0 55 BE 88 92 12 C1 4B 5E
52 C9 74 A0
```

From the payload format above the first 32 bits, or 4 bytes are the magic header identifying the version (09 F0 C9 F0)

The next 128 bits, or 16 bytes is the key identifier (80 9C 81 0C 19 66 19 40 95 36 53 F8 AA FF EE 57)

The remainder contains the payload and is specific to the format used.

### WARNING

All payloads protected to a given key will begin with the same 20-byte (magic value, key id) header. Administrators can use this fact for diagnostic purposes to approximate when a payload was generated. For example, the payload above corresponds to key {0c819c80-6619-4019-9536-53f8aaffee57}. If after checking the key repository you find that this specific key's activation date was 2015-01-01 and its expiration date was 2015-03-01, then it's reasonable to assume that the payload (if not tampered with) was generated within that window, give or take a small fudge factor on either side.

# Subkey derivation and authenticated encryption in ASP.NET Core

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Most keys in the key ring will contain some form of entropy and will have algorithmic information stating "CBC-mode encryption + HMAC validation" or "GCM encryption + validation". In these cases, we refer to the embedded entropy as the master keying material (or KM) for this key, and we perform a key derivation function to derive the keys that will be used for the actual cryptographic operations.

## NOTE

Keys are abstract, and a custom implementation might not behave as below. If the key provides its own implementation of `IAuthenticatedEncryptor` rather than using one of our built-in factories, the mechanism described in this section no longer applies.

## Additional authenticated data and subkey derivation

The `IAuthenticatedEncryptor` interface serves as the core interface for all authenticated encryption operations. Its `Encrypt` method takes two buffers: plaintext and additionalAuthenticatedData (AAD). The plaintext contents flow unchanged the call to `IDataProtector.Protect`, but the AAD is generated by the system and consists of three components:

1. The 32-bit magic header 09 F0 C9 F0 that identifies this version of the data protection system.
2. The 128-bit key id.
3. A variable-length string formed from the purpose chain that created the `IDataProtector` that's performing this operation.

Because the AAD is unique for the tuple of all three components, we can use it to derive new keys from KM instead of using KM itself in all of our cryptographic operations. For every call to `IAuthenticatedEncryptor.Encrypt`, the following key derivation process takes place:

$$(K_E, K_H) = \text{SP800\_108\_CTR\_HMACSHA512}(K_M, \text{AAD}, \text{contextHeader} \parallel \text{keyModifier})$$

Here, we're calling the NIST SP800-108 KDF in Counter Mode (see [NIST SP800-108](#), Sec. 5.1) with the following parameters:

- Key derivation key (KDK) =  $K_M$
- PRF = HMACSHA512
- label = additionalAuthenticatedData
- context = contextHeader || keyModifier

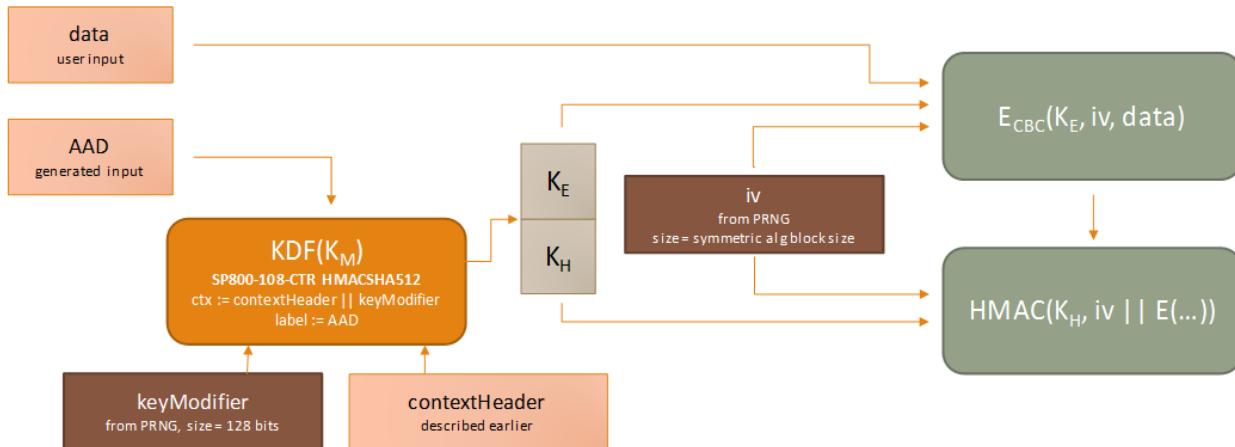
The context header is of variable length and essentially serves as a thumbprint of the algorithms for which we're deriving  $K_E$  and  $K_H$ . The key modifier is a 128-bit string randomly generated for each call to `Encrypt` and serves to ensure with overwhelming probability that  $K_E$  and  $K_H$  are unique for this specific authentication encryption operation, even if all other input to the KDF is constant.

For CBC-mode encryption + HMAC validation operations,  $|K_E|$  is the length of the symmetric block cipher key,

and  $| K_H |$  is the digest size of the HMAC routine. For GCM encryption + validation operations,  $| K_H | = 0$ .

## CBC-mode encryption + HMAC validation

Once  $K_E$  is generated via the above mechanism, we generate a random initialization vector and run the symmetric block cipher algorithm to encipher the plaintext. The initialization vector and ciphertext are then run through the HMAC routine initialized with the key  $K_H$  to produce the MAC. This process and the return value is represented graphically below.



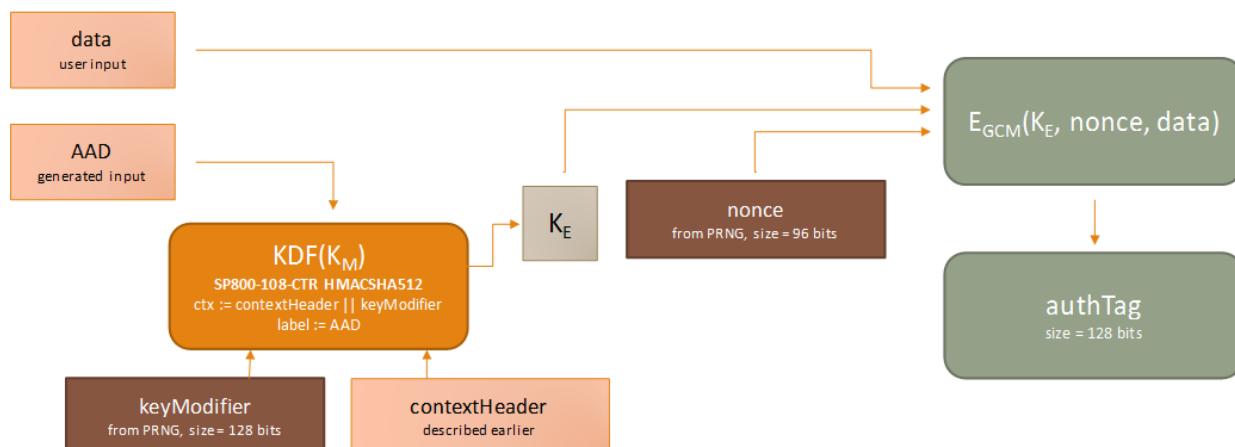
*output:= keyModifier || iv ||  $E_{cbc}(K_E, iv, data)$  ||  $HMAC(K_H, iv || E_{cbc}(K_E, iv, data))$*

### NOTE

The `IDataProtector.Protect` implementation will [prepend the magic header and key id](#) to output before returning it to the caller. Because the magic header and key id are implicitly part of `AAD`, and because the key modifier is fed as input to the KDF, this means that every single byte of the final returned payload is authenticated by the MAC.

## Galois/Counter Mode encryption + validation

Once  $K_E$  is generated via the above mechanism, we generate a random 96-bit nonce and run the symmetric block cipher algorithm to encipher the plaintext and produce the 128-bit authentication tag.



*output:= keyModifier || nonce ||  $E_{gcm}(K_E, nonce, data)$  || authTag*

#### **NOTE**

Even though GCM natively supports the concept of AAD, we're still feeding AAD only to the original KDF, opting to pass an empty string into GCM for its AAD parameter. The reason for this is two-fold. First, [to support agility](#) we never want to use K\_M directly as the encryption key. Additionally, GCM imposes very strict uniqueness requirements on its inputs. The probability that the GCM encryption routine is ever invoked on two or more distinct sets of input data with the same (key, nonce) pair must not exceed  $2^{32}$ . If we fix K\_E we cannot perform more than  $2^{32}$  encryption operations before we run afoul of the  $2^{32}$  limit. This might seem like a very large number of operations, but a high-traffic web server can go through 4 billion requests in mere days, well within the normal lifetime for these keys. To stay compliant of the  $2^{32}$  probability limit, we continue to use a 128-bit key modifier and 96-bit nonce, which radically extends the usable operation count for any given K\_M. For simplicity of design we share the KDF code path between CBC and GCM operations, and since AAD is already considered in the KDF there's no need to forward it to the GCM routine.

# Context headers in ASP.NET Core

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## Background and theory

In the data protection system, a "key" means an object that can provide authenticated encryption services. Each key is identified by a unique id (a GUID), and it carries with it algorithmic information and entropic material. It's intended that each key carry unique entropy, but the system cannot enforce that, and we also need to account for developers who might change the key ring manually by modifying the algorithmic information of an existing key in the key ring. To achieve our security requirements given these cases the data protection system has a concept of [cryptographic agility](#), which allows securely using a single entropic value across multiple cryptographic algorithms.

Most systems which support cryptographic agility do so by including some identifying information about the algorithm inside the payload. The algorithm's OID is generally a good candidate for this. However, one problem that we ran into is that there are multiple ways to specify the same algorithm: "AES" (CNG) and the managed Aes, AesManaged, AesCryptoServiceProvider, AesCng, and RijndaelManaged (given specific parameters) classes are all actually the same thing, and we'd need to maintain a mapping of all of these to the correct OID. If a developer wanted to provide a custom algorithm (or even another implementation of AES!), they'd have to tell us its OID. This extra registration step makes system configuration particularly painful.

Stepping back, we decided that we were approaching the problem from the wrong direction. An OID tells you what the algorithm is, but we don't actually care about this. If we need to use a single entropic value securely in two different algorithms, it's not necessary for us to know what the algorithms actually are. What we actually care about is how they behave. Any decent symmetric block cipher algorithm is also a strong pseudorandom permutation (PRP): fix the inputs (key, chaining mode, IV, plaintext) and the ciphertext output will with overwhelming probability be distinct from any other symmetric block cipher algorithm given the same inputs. Similarly, any decent keyed hash function is also a strong pseudorandom function (PRF), and given a fixed input set its output will overwhelmingly be distinct from any other keyed hash function.

We use this concept of strong PRPs and PRFs to build up a context header. This context header essentially acts as a stable thumbprint over the algorithms in use for any given operation, and it provides the cryptographic agility needed by the data protection system. This header is reproducible and is used later as part of the [subkey derivation process](#). There are two different ways to build the context header depending on the modes of operation of the underlying algorithms.

## CBC-mode encryption + HMAC authentication

The context header consists of the following components:

- [16 bits] The value 00 00, which is a marker meaning "CBC encryption + HMAC authentication".
- [32 bits] The key length (in bytes, big-endian) of the symmetric block cipher algorithm.
- [32 bits] The block size (in bytes, big-endian) of the symmetric block cipher algorithm.
- [32 bits] The key length (in bytes, big-endian) of the HMAC algorithm. (Currently the key size always matches the digest size.)
- [32 bits] The digest size (in bytes, big-endian) of the HMAC algorithm.
- EncCBC(K\_E, IV, ""), which is the output of the symmetric block cipher algorithm given an empty string input and where IV is an all-zero vector. The construction of K\_E is described below.

- $\text{MAC}(K_H, "")$ , which is the output of the HMAC algorithm given an empty string input. The construction of  $K_H$  is described below.

Ideally, we could pass all-zero vectors for  $K_E$  and  $K_H$ . However, we want to avoid the situation where the underlying algorithm checks for the existence of weak keys before performing any operations (notably DES and 3DES), which precludes using a simple or repeatable pattern like an all-zero vector.

Instead, we use the NIST SP800-108 KDF in Counter Mode (see [NIST SP800-108](#), Sec. 5.1) with a zero-length key, label, and context and HMACSHA512 as the underlying PRF. We derive  $|K_E| + |K_H|$  bytes of output, then decompose the result into  $K_E$  and  $K_H$  themselves. Mathematically, this is represented as follows.

$$(K_E \parallel K_H) = \text{SP800\_108\_CTR}(\text{prf} = \text{HMACSHA512}, \text{key} = "", \text{label} = "", \text{context} = "")$$

#### **Example: AES-192-CBC + HMACSHA256**

As an example, consider the case where the symmetric block cipher algorithm is AES-192-CBC and the validation algorithm is HMACSHA256. The system would generate the context header using the following steps.

First, let  $(K_E \parallel K_H) = \text{SP800\_108\_CTR}(\text{prf} = \text{HMACSHA512}, \text{key} = "", \text{label} = "", \text{context} = "")$ , where  $|K_E| = 192$  bits and  $|K_H| = 256$  bits per the specified algorithms. This leads to  $K_E = 5BB6..21DD$  and  $K_H = A04A..00A9$  in the example below:

```
5B B6 C9 83 13 78 22 1D 8E 10 73 CA CF 65 8E B0
61 62 42 71 CB 83 21 DD A0 4A 05 00 5B AB C0 A2
49 6F A5 61 E3 E2 49 87 AA 63 55 CD 74 0A DA C4
B7 92 3D BF 59 90 00 A9
```

Next, compute  $\text{Enc\_CBC}(K_E, IV, "")$  for AES-192-CBC given  $IV = 0^*$  and  $K_E$  as above.

result := F474B1872B3B53E4721DE19C0841DB6F

Next, compute  $\text{MAC}(K_H, "")$  for HMACSHA256 given  $K_H$  as above.

result := D4791184B996092EE1202F36E8608FA8FBD98ABDFF5402F264B1D7211536220C

This produces the full context header below:

```
00 00 00 00 00 18 00 00 00 10 00 00 00 20 00 00
00 20 F4 74 B1 87 2B 3B 53 E4 72 1D E1 9C 08 41
DB 6F D4 79 11 84 B9 96 09 2E E1 20 2F 36 E8 60
8F A8 FB D9 8A BD FF 54 02 F2 64 B1 D7 21 15 36
22 0C
```

This context header is the thumbprint of the authenticated encryption algorithm pair (AES-192-CBC encryption + HMACSHA256 validation). The components, as described [above](#) are:

- the marker (00 00)
- the block cipher key length (00 00 00 18)
- the block cipher block size (00 00 00 10)
- the HMAC key length (00 00 00 20)
- the HMAC digest size (00 00 00 20)
- the block cipher PRP output (F4 74 - DB 6F) and
- the HMAC PRF output (D4 79 - end).

#### NOTE

The CBC-mode encryption + HMAC authentication context header is built the same way regardless of whether the algorithms implementations are provided by Windows CNG or by managed SymmetricAlgorithm and KeyedHashAlgorithm types. This allows applications running on different operating systems to reliably produce the same context header even though the implementations of the algorithms differ between OSes. (In practice, the KeyedHashAlgorithm doesn't have to be a proper HMAC. It can be any keyed hash algorithm type.)

#### Example: 3DES-192-CBC + HMACSHA1

First, let ( $K_E \parallel K_H$ ) = SP800\_108\_CTR(prf = HMACSHA512, key = "", label = "", context = ""), where  $|K_E| = 192$  bits and  $|K_H| = 160$  bits per the specified algorithms. This leads to  $K_E = A219..E2BB$  and  $K_H = DC4A..B464$  in the example below:

```
A2 19 60 2F 83 A9 13 EA B0 61 3A 39 B8 A6 7E 22  
61 D9 F8 6C 10 51 E2 BB DC 4A 00 D7 03 A2 48 3E  
D1 F7 5A 34 EB 28 3E D7 D4 67 B4 64
```

Next, compute  $\text{Enc\_CBC}(K_E, IV, "")$  for 3DES-192-CBC given  $IV = 0^*$  and  $K_E$  as above.

```
result := ABB100F81E53E10E
```

Next, compute  $\text{MAC}(K_H, "")$  for HMACSHA1 given  $K_H$  as above.

```
result := 76EB189B35CF03461DDF877CD9F4B1B4D63A7555
```

This produces the full context header which is a thumbprint of the authenticated encryption algorithm pair (3DES-192-CBC encryption + HMACSHA1 validation), shown below:

```
00 00 00 00 00 18 00 00 00 08 00 00 00 14 00 00  
00 14 AB B1 00 F8 1E 53 E1 0E 76 EB 18 9B 35 CF  
03 46 1D DF 87 7C D9 F4 B1 B4 D6 3A 75 55
```

The components break down as follows:

- the marker (00 00)
- the block cipher key length (00 00 00 18)
- the block cipher block size (00 00 00 08)
- the HMAC key length (00 00 00 14)
- the HMAC digest size (00 00 00 14)
- the block cipher PRP output (AB B1 - E1 0E) and
- the HMAC PRF output (76 EB - end).

## Galois/Counter Mode encryption + authentication

The context header consists of the following components:

- [16 bits] The value 00 01, which is a marker meaning "GCM encryption + authentication".
- [32 bits] The key length (in bytes, big-endian) of the symmetric block cipher algorithm.
- [32 bits] The nonce size (in bytes, big-endian) used during authenticated encryption operations. (For our system, this is fixed at nonce size = 96 bits.)

- [32 bits] The block size (in bytes, big-endian) of the symmetric block cipher algorithm. (For GCM, this is fixed at block size = 128 bits.)
- [32 bits] The authentication tag size (in bytes, big-endian) produced by the authenticated encryption function. (For our system, this is fixed at tag size = 128 bits.)
- [128 bits] The tag of Enc\_GCM ( $K_E$ , nonce, ""), which is the output of the symmetric block cipher algorithm given an empty string input and where nonce is a 96-bit all-zero vector.

$K_E$  is derived using the same mechanism as in the CBC encryption + HMAC authentication scenario. However, since there's no  $K_H$  in play here, we essentially have  $|K_H| = 0$ , and the algorithm collapses to the below form.

$K_E = SP800\_108\_CTR(prf = HMACSHA512, key = "", label = "", context = "")$

#### **Example: AES-256-GCM**

First, let  $K_E = SP800\_108\_CTR(prf = HMACSHA512, key = "", label = "", context = "")$ , where  $|K_E| = 256$  bits.

$K_E := 22BC6F1B171C08C4AE2F27444AF8FC8B3087A90006CAEA91FDCFB47C1B8733B8$

Next, compute the authentication tag of Enc\_GCM ( $K_E$ , nonce, "") for AES-256-GCM given nonce = 096 and  $K_E$  as above.

result := E7DCCE66DF855A323A6BB7BD7A59BE45

This produces the full context header below:

```
00 01 00 00 00 20 00 00 00 0C 00 00 00 10 00 00
00 10 E7 DC CE 66 DF 85 5A 32 3A 6B B7 BD 7A 59
BE 45
```

The components break down as follows:

- the marker (00 01)
- the block cipher key length (00 00 00 20)
- the nonce size (00 00 00 0C)
- the block cipher block size (00 00 00 10)
- the authentication tag size (00 00 00 10) and
- the authentication tag from running the block cipher (E7 DC - end).

# Key management in ASP.NET Core

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The data protection system automatically manages the lifetime of master keys used to protect and unprotect payloads. Each key can exist in one of four stages:

- Created - the key exists in the key ring but has not yet been activated. The key shouldn't be used for new Protect operations until sufficient time has elapsed that the key has had a chance to propagate to all machines that are consuming this key ring.
- Active - the key exists in the key ring and should be used for all new Protect operations.
- Expired - the key has run its natural lifetime and should no longer be used for new Protect operations.
- Revoked - the key is compromised and must not be used for new Protect operations.

Created, active, and expired keys may all be used to unprotect incoming payloads. Revoked keys by default may not be used to unprotect payloads, but the application developer can [override this behavior](#) if necessary.

## WARNING

The developer might be tempted to delete a key from the key ring (e.g., by deleting the corresponding file from the file system). At that point, all data protected by the key is permanently undecipherable, and there's no emergency override like there's with revoked keys. Deleting a key is truly destructive behavior, and consequently the data protection system exposes no first-class API for performing this operation.

## Default key selection

When the data protection system reads the key ring from the backing repository, it will attempt to locate a "default" key from the key ring. The default key is used for new Protect operations.

The general heuristic is that the data protection system chooses the key with the most recent activation date as the default key. (There's a small fudge factor to allow for server-to-server clock skew.) If the key is expired or revoked, and if the application has not disabled automatic key generation, then a new key will be generated with immediate activation per the [key expiration and rolling](#) policy below.

The reason the data protection system generates a new key immediately rather than falling back to a different key is that new key generation should be treated as an implicit expiration of all keys that were activated prior to the new key. The general idea is that new keys may have been configured with different algorithms or encryption-at-rest mechanisms than old keys, and the system should prefer the current configuration over falling back.

There's an exception. If the application developer has [disabled automatic key generation](#), then the data protection system must choose something as the default key. In this fallback scenario, the system will choose the non-revoked key with the most recent activation date, with preference given to keys that have had time to propagate to other machines in the cluster. The fallback system may end up choosing an expired default key as a result. The fallback system will never choose a revoked key as the default key, and if the key ring is empty or every key has been revoked then the system will produce an error upon initialization.

## Key expiration and rolling

When a key is created, it's automatically given an activation date of { now + 2 days } and an expiration date of { now + 90 days }. The 2-day delay before activation gives the key time to propagate through the system. That is, it

allows other applications pointing at the backing store to observe the key at their next auto-refresh period, thus maximizing the chances that when the key ring does become active it has propagated to all applications that might need to use it.

If the default key will expire within 2 days and if the key ring doesn't already have a key that will be active upon expiration of the default key, then the data protection system will automatically persist a new key to the key ring. This new key has an activation date of { default key's expiration date } and an expiration date of { now + 90 days }. This allows the system to automatically roll keys on a regular basis with no interruption of service.

There might be circumstances where a key will be created with immediate activation. One example would be when the application hasn't run for a time and all keys in the key ring are expired. When this happens, the key is given an activation date of { now } without the normal 2-day activation delay.

The default key lifetime is 90 days, though this is configurable as in the following example.

```
services.AddDataProtection()
    // use 14-day lifetime instead of 90-day lifetime
    .SetDefaultKeyLifetime(TimeSpan.FromDays(14));
```

An administrator can also change the default system-wide, though an explicit call to `SetDefaultKeyLifetime` will override any system-wide policy. The default key lifetime cannot be shorter than 7 days.

## Automatic key ring refresh

When the data protection system initializes, it reads the key ring from the underlying repository and caches it in memory. This cache allows Protect and Unprotect operations to proceed without hitting the backing store. The system will automatically check the backing store for changes approximately every 24 hours or when the current default key expires, whichever comes first.

### WARNING

Developers should very rarely (if ever) need to use the key management APIs directly. The data protection system will perform automatic key management as described above.

The data protection system exposes an interface `IKeyManager` that can be used to inspect and make changes to the key ring. The DI system that provided the instance of `IDataProtectionProvider` can also provide an instance of `IKeyManager` for your consumption. Alternatively, you can pull the `IKeyManager` straight from the `IServiceProvider` as in the example below.

Any operation which modifies the key ring (creating a new key explicitly or performing a revocation) will invalidate the in-memory cache. The next call to `Protect` or `Unprotect` will cause the data protection system to reread the key ring and recreate the cache.

The sample below demonstrates using the `IKeyManager` interface to inspect and manipulate the key ring, including revoking existing keys and generating a new key manually.

```
using System;
using System.IO;
using System.Threading;
using Microsoft.AspNetCore.DataProtection;
using Microsoft.AspNetCore.DataProtection.KeyManagement;
using Microsoft.Extensions.DependencyInjection;

public class Program
{
    public static void Main(string[] args)
    {
```

```

var serviceCollection = new ServiceCollection();
serviceCollection.AddDataProtection()
    // point at a specific folder and use DPAPI to encrypt keys
    .PersistKeysToFileSystem(new DirectoryInfo(@"c:\temp-keys"))
    .ProtectKeysWithDpapi();
var services = serviceCollection.BuildServiceProvider();

// perform a protect operation to force the system to put at least
// one key in the key ring
services.GetDataProtector("Sample.KeyManager.v1").Protect("payload");
Console.WriteLine("Performed a protect operation.");
Thread.Sleep(2000);

// get a reference to the key manager
var keyManager = services.GetService<IKeyManager>();

// list all keys in the key ring
var allKeys = keyManager.GetAllKeys();
Console.WriteLine($"The key ring contains {allKeys.Count} key(s).");
foreach (var key in allKeys)
{
    Console.WriteLine($"Key {key.KeyId:B}: Created = {key.CreationDate:u}, IsRevoked =
{key.IsRevoked}");
}

// revoke all keys in the key ring
keyManager.RevokeAllKeys(DateTimeOffset.Now, reason: "Revocation reason here.");
Console.WriteLine("Revoked all existing keys.");

// add a new key to the key ring with immediate activation and a 1-month expiration
keyManager.CreateNewKey(
    activationDate: DateTimeOffset.Now,
    expirationDate: DateTimeOffset.Now.AddMonths(1));
Console.WriteLine("Added a new key.");

// list all keys in the key ring
allKeys = keyManager.GetAllKeys();
Console.WriteLine($"The key ring contains {allKeys.Count} key(s.).");
foreach (var key in allKeys)
{
    Console.WriteLine($"Key {key.KeyId:B}: Created = {key.CreationDate:u}, IsRevoked =
{key.IsRevoked}");
}
}

/*
 * SAMPLE OUTPUT
 *
 * Performed a protect operation.
 * The key ring contains 1 key(s).
 * Key {1b948618-be1f-440b-b204-64ff5a152552}: Created = 2015-03-18 22:20:49Z, IsRevoked = False
 * Revoked all existing keys.
 * Added a new key.
 * The key ring contains 2 key(s).
 * Key {1b948618-be1f-440b-b204-64ff5a152552}: Created = 2015-03-18 22:20:49Z, IsRevoked = True
 * Key {2266fc40-e2fb-48c6-8ce2-5fde6b1493f7}: Created = 2015-03-18 22:20:51Z, IsRevoked = False
*/

```

## Key storage

The data protection system has a heuristic whereby it tries to deduce an appropriate key storage location and encryption at rest mechanism automatically. This is also configurable by the app developer. The following documents discuss the in-box implementations of these mechanisms:

- In-box key storage providers
- In-box key encryption at rest providers

# Key storage providers in ASP.NET Core

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By default the data protection system [employs a heuristic](#) to determine where cryptographic key material should be persisted. The developer can override the heuristic and manually specify the location.

## NOTE

If you specify an explicit key persistence location, the data protection system will deregister the default key encryption at rest mechanism that the heuristic provided, so keys will no longer be encrypted at rest. It's recommended that you additionally [specify an explicit key encryption mechanism](#) for production applications.

The data protection system ships with several in-box key storage providers.

## File system

We anticipate that many apps will use a file system-based key repository. To configure this, call the [PersistKeysToFileSystem](#) configuration routine as shown below. Provide a `DirectoryInfo` pointing to the repository where keys should be stored.

```
sc.AddDataProtection()
    // persist keys to a specific directory
    .PersistKeysToFileSystem(new DirectoryInfo(@"c:\temp-keys\"));
```

The `DirectoryInfo` can point to a directory on the local machine, or it can point to a folder on a network share. If pointing to a directory on the local machine (and the scenario is that only applications on the local machine will need to use this repository), consider using [Windows DPAPI](#) to encrypt the keys at rest. Otherwise consider using an [X.509 certificate](#) to encrypt keys at rest.

## Azure and Redis

The `Microsoft.AspNetCore.DataProtection.AzureStorage` and `Microsoft.AspNetCore.DataProtection.Redis` packages allow storing your data protection keys in Azure Storage or a Redis cache. Keys can be shared across several instances of a web app. Your ASP.NET Core app can share authentication cookies or CSRF protection across multiple servers. To configure on Azure, call one of the [PersistKeysToAzureBlobStorage](#) overloads as shown below.

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDataProtection()
        .PersistKeysToAzureBlobStorage(new Uri("<blob URI including SAS token>"));

    services.AddMvc();
}
```

See also the [Azure test code](#).

To configure on Redis, call one of the [PersistKeysToRedis](#) overloads as shown below.

```
public void ConfigureServices(IServiceCollection services)
{
    // Connect to Redis database.
    var redis = ConnectionMultiplexer.Connect("<URI>");
    services.AddDataProtection()
        .PersistKeysToRedis(redis, "DataProtection-Keys");

    services.AddMvc();
}
```

See the following for more information:

- [StackExchange.Redis ConnectionMultiplexer](#)
- [Azure Redis Cache](#)
- [Redis test code.](#)

## Registry

Sometimes the app might not have write access to the file system. Consider a scenario where an app is running as a virtual service account (such as w3wp.exe's app pool identity). In these cases, the administrator may have provisioned a registry key that's appropriate ACLed for the service account identity. Call the [PersistKeysToRegistry](#) configuration routine as shown below. Provide a `RegistryKey` pointing to the location where cryptographic keys/values should be stored.

```
sc.AddDataProtection()
    // persist keys to a specific location in the system registry
    .PersistKeysToRegistry(Registry.CurrentUser.OpenSubKey(@"SOFTWARE\Sample\keys"));
```

If you use the system registry as a persistence mechanism, consider using [Windows DPAPI](#) to encrypt the keys at rest.

## Custom key repository

If the in-box mechanisms are not appropriate, the developer can specify their own key persistence mechanism by providing a custom `IXmlRepository`.

# Key encryption at rest in ASP.NET Core

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By default, the data protection system [employs a heuristic](#) to determine how cryptographic key material should be encrypted at rest. The developer can override the heuristic and manually specify how keys should be encrypted at rest.

## NOTE

If you specify an explicit key encryption at rest mechanism, the data protection system will deregister the default key storage mechanism that the heuristic provided. You must [specify an explicit key storage mechanism](#), otherwise the data protection system will fail to start.

The data protection system ships with three in-box key encryption mechanisms.

## Windows DPAPI

*This mechanism is available only on Windows.*

When Windows DPAPI is used, key material will be encrypted via [CryptProtectData](#) before being persisted to storage. DPAPI is an appropriate encryption mechanism for data that will never be read outside of the current machine (though it's possible to back these keys up to Active Directory; see [DPAPI and Roaming Profiles](#)). For example to configure DPAPI key-at-rest encryption.

```
sc.AddDataProtection()
    // only the local user account can decrypt the keys
    .ProtectKeysWithDpapi();
```

If `ProtectKeysWithDpapi` is called with no parameters, only the current Windows user account can decipher the persisted key material. You can optionally specify that any user account on the machine (not just the current user account) should be able to decipher the key material, as shown in the below example.

```
sc.AddDataProtection()
    // all user accounts on the machine can decrypt the keys
    .ProtectKeysWithDpapi(protectToLocalMachine: true);
```

## X.509 certificate

*This mechanism isn't available on [.NET Core 1.0](#) or [1.1](#).*

If your application is spread across multiple machines, it may be convenient to distribute a shared X.509 certificate across the machines and to configure applications to use this certificate for encryption of keys at rest. See below for an example.

```
sc.AddDataProtection()
    // searches the cert store for the cert with this thumbprint
    .ProtectKeysWithCertificate("3BCE558E2AD3E0E34A7743EAB5AEA2A9BD2575A0");
```

Due to .NET Framework limitations only certificates with CAPI private keys are supported. See [Certificate-based](#)

encryption with Windows DPAPI-NG below for possible workarounds to these limitations.

## Windows DPAPI-NG

*This mechanism is available only on Windows 8 / Windows Server 2012 and later.*

Beginning with Windows 8, the operating system supports DPAPI-NG (also called CNG DPAPI). Microsoft lays out its usage scenario as follows.

Cloud computing, however, often requires that content encrypted on one computer be decrypted on another. Therefore, beginning with Windows 8, Microsoft extended the idea of using a relatively straightforward API to encompass cloud scenarios. This new API, called DPAPI-NG, enables you to securely share secrets (keys, passwords, key material) and messages by protecting them to a set of principals that can be used to unprotect them on different computers after proper authentication and authorization.

From [About CNG DPAPI](#)

The principal is encoded as a protection descriptor rule. Consider the below example, which encrypts key material such that only the domain-joined user with the specified SID can decrypt the key material.

```
sc.AddDataProtection()
    // uses the descriptor rule "SID=S-1-5-21-..."
    .ProtectKeysWithDpapiNG("SID=S-1-5-21-...", 
    flags: DpapiNGProtectionDescriptorFlags.None);
```

There's also a parameterless overload of `ProtectKeysWithDpapiNG`. This is a convenience method for specifying the rule "SID=mine", where mine is the SID of the current Windows user account.

```
sc.AddDataProtection()
    // uses the descriptor rule "SID={current account SID}"
    .ProtectKeysWithDpapiNG();
```

In this scenario, the AD domain controller is responsible for distributing the encryption keys used by the DPAPI-NG operations. The target user will be able to decipher the encrypted payload from any domain-joined machine (provided that the process is running under their identity).

## Certificate-based encryption with Windows DPAPI-NG

If you're running on Windows 8.1 / Windows Server 2012 R2 or later, you can use Windows DPAPI-NG to perform certificate-based encryption, even if the application is running on .NET Core. To take advantage of this, use the rule descriptor string "CERTIFICATE=HashId:thumbprint", where thumbprint is the hex-encoded SHA1 thumbprint of the certificate to use. See below for an example.

```
sc.AddDataProtection()
    // searches the cert store for the cert with this thumbprint
    .ProtectKeysWithDpapiNG("CERTIFICATE=HashId:3BCE558E2AD3E0E34A7743EAB5AEA2A9BD2575A0",
    flags: DpapiNGProtectionDescriptorFlags.None);
```

Any application which is pointed at this repository must be running on Windows 8.1 / Windows Server 2012 R2 or later to be able to decipher this key.

## Custom key encryption

If the in-box mechanisms are not appropriate, the developer can specify their own key encryption mechanism by providing a custom `IXmlEncryptor`.

# Key immutability and key settings in ASP.NET Core

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Once an object is persisted to the backing store, its representation is forever fixed. New data can be added to the backing store, but existing data can never be mutated. The primary purpose of this behavior is to prevent data corruption.

One consequence of this behavior is that once a key is written to the backing store, it's immutable. Its creation, activation, and expiration dates can never be changed, though it can be revoked by using `IKeyManager`. Additionally, its underlying algorithmic information, master keying material, and encryption at rest properties are also immutable.

If the developer changes any setting that affects key persistence, those changes won't go into effect until the next time a key is generated, either via an explicit call to `IKeyManager.CreateNewKey` or via the data protection system's own [automatic key generation](#) behavior. The settings that affect key persistence are as follows:

- [The default key lifetime](#)
- [The key encryption at rest mechanism](#)
- [The algorithmic information contained within the key](#)

If you need these settings to kick in earlier than the next automatic key rolling time, consider making an explicit call to `IKeyManager.CreateNewKey` to force the creation of a new key. Remember to provide an explicit activation date (`{ now + 2 days }` is a good rule of thumb to allow time for the change to propagate) and expiration date in the call.

## TIP

All applications touching the repository should specify the same settings with the `IDataProtectionBuilder` extension methods. Otherwise, the properties of the persisted key will be dependent on the particular application that invoked the key generation routines.

# Key storage format in ASP.NET Core

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Objects are stored at rest in XML representation. The default directory for key storage is %LOCALAPPDATA%\ASP.NET\DataProtection-Keys.

## The <key> element

Keys exist as top-level objects in the key repository. By convention keys have the filename **key-{guid}.xml**, where {guid} is the id of the key. Each such file contains a single key. The format of the file is as follows.

```
<?xml version="1.0" encoding="utf-8"?>
<key id="80732141-ec8f-4b80-af9c-c4d2d1ff8901" version="1">
  <creationDate>2015-03-19T23:32:02.3949887Z</creationDate>
  <activationDate>2015-03-19T23:32:02.3839429Z</activationDate>
  <expirationDate>2015-06-17T23:32:02.3839429Z</expirationDate>
  <descriptor deserializerType="{deserializerType}">
    <descriptor>
      <encryption algorithm="AES_256_CBC" />
      <validation algorithm="HMACSHA256" />
      <enc:encryptedSecret decryptorType="{decryptorType}" xmlns:enc="...">
        <encryptedKey>
          <!-- This key is encrypted with Windows DPAPI. -->
          <value>AQAAANCM...8/zeP8lcwAg==</value>
        </encryptedKey>
      </enc:encryptedSecret>
    </descriptor>
  </descriptor>
</key>
```

The <key> element contains the following attributes and child elements:

- The key id. This value is treated as authoritative; the filename is simply a nicety for human readability.
- The version of the <key> element, currently fixed at 1.
- The key's creation, activation, and expiration dates.
- A <descriptor> element, which contains information on the authenticated encryption implementation contained within this key.

In the above example, the key's id is {80732141-ec8f-4b80-af9c-c4d2d1ff8901}, it was created and activated on March 19, 2015, and it has a lifetime of 90 days. (Occasionally the activation date might be slightly before the creation date as in this example. This is due to a nit in how the APIs work and is harmless in practice.)

## The <descriptor> element

The outer <descriptor> element contains an attribute deserializerType, which is the assembly-qualified name of a type which implements IAuthenticatedEncryptorDescriptorDeserializer. This type is responsible for reading the inner <descriptor> element and for parsing the information contained within.

The particular format of the <descriptor> element depends on the authenticated encryptor implementation encapsulated by the key, and each serializer type expects a slightly different format for this. In general, though, this element will contain algorithmic information (names, types, OIDs, or similar) and secret key material. In the above example, the descriptor specifies that this key wraps AES-256-CBC encryption + HMACSHA256 validation.

## The <encryptedSecret> element

An element which contains the encrypted form of the secret key material may be present if [encryption of secrets at rest is enabled](#). The attribute decryptorType will be the assembly-qualified name of a type which implements IXmDecryptor. This type is responsible for reading the inner element and decrypting it to recover the original plaintext.

As with <descriptor>, the particular format of the element depends on the at-rest encryption mechanism in use. In the above example, the master key is encrypted using Windows DPAPI per the comment.

## The <revocation> element

Revocations exist as top-level objects in the key repository. By convention revocations have the filename **revocation-{timestamp}.xml** (for revoking all keys before a specific date) or **revocation-{guid}.xml** (for revoking a specific key). Each file contains a single <revocation> element.

For revocations of individual keys, the file contents will be as below.

```
<?xml version="1.0" encoding="utf-8"?>
<revocation version="1">
  <revocationDate>2015-03-20T22:45:30.2616742Z</revocationDate>
  <key id="eb4fc299-8808-409d-8a34-23fc83d026c9" />
  <reason>human-readable reason</reason>
</revocation>
```

In this case, only the specified key is revoked. If the key id is "\*", however, as in the below example, all keys whose creation date is prior to the specified revocation date are revoked.

```
<?xml version="1.0" encoding="utf-8"?>
<revocation version="1">
  <revocationDate>2015-03-20T15:45:45.7366491-07:00</revocationDate>
  <!-- All keys created before the revocation date are revoked. -->
  <key id="*" />
  <reason>human-readable reason</reason>
</revocation>
```

The <reason> element is never read by the system. It's simply a convenient place to store a human-readable reason for revocation.

# Ephemeral data protection providers in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

There are scenarios where an application needs a throwaway `IDataProtectionProvider`. For example, the developer might just be experimenting in a one-off console application, or the application itself is transient (it's scripted or a unit test project). To support these scenarios the `Microsoft.AspNetCore.DataProtection` package includes a type `EphemeralDataProtectionProvider`. This type provides a basic implementation of `IDataProtectionProvider` whose key repository is held solely in-memory and isn't written out to any backing store.

Each instance of `EphemeralDataProtectionProvider` uses its own unique master key. Therefore, if an `IDataProtector` rooted at an `EphemeralDataProtectionProvider` generates a protected payload, that payload can only be unprotected by an equivalent `IDataProtector` (given the same `purpose` chain) rooted at the same `EphemeralDataProtectionProvider` instance.

The following sample demonstrates instantiating an `EphemeralDataProtectionProvider` and using it to protect and unprotect data.

```
using System;
using Microsoft.AspNetCore.DataProtection;

public class Program
{
    public static void Main(string[] args)
    {
        const string purpose = "Ephemeral.App.v1";

        // create an ephemeral provider and demonstrate that it can round-trip a payload
        var provider = new EphemeralDataProtectionProvider();
        var protector = provider.CreateProtector(purpose);
        Console.Write("Enter input: ");
        string input = Console.ReadLine();

        // protect the payload
        string protectedPayload = protector.Protect(input);
        Console.WriteLine($"Protect returned: {protectedPayload}");

        // unprotect the payload
        string unprotectedPayload = protector.Unprotect(protectedPayload);
        Console.WriteLine($"Unprotect returned: {unprotectedPayload}");

        // if I create a new ephemeral provider, it won't be able to unprotect existing
        // payloads, even if I specify the same purpose
        provider = new EphemeralDataProtectionProvider();
        protector = provider.CreateProtector(purpose);
        unprotectedPayload = protector.Unprotect(protectedPayload); // THROWS
    }
}

/*
 * SAMPLE OUTPUT
 *
 * Enter input: Hello!
 * Protect returned: CfDJ8AAAAAAAAAAAAAAA...uGoxWLjGKtm1SkNACQ
 * Unprotect returned: Hello!
 * << throws CryptographicException >>
 */
```

# Compatibility in ASP.NET Core

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- Replacing ASP.NET <machineKey> in ASP.NET Core

# Replace the ASP.NET machineKey in ASP.NET Core

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The implementation of the `<machineKey>` element in ASP.NET is replaceable. This allows most calls to ASP.NET cryptographic routines to be routed through a replacement data protection mechanism, including the new data protection system.

## Package installation

### NOTE

The new data protection system can only be installed into an existing ASP.NET application targeting .NET 4.5.1 or higher. Installation will fail if the application targets .NET 4.5 or lower.

To install the new data protection system into an existing ASP.NET 4.5.1+ project, install the package `Microsoft.AspNetCore.DataProtection.SystemWeb`. This will instantiate the data protection system using the [default configuration](#) settings.

When you install the package, it inserts a line into `Web.config` that tells ASP.NET to use it for [most cryptographic operations](#), including forms authentication, view state, and calls to `MachineKey.Protect`. The line that's inserted reads as follows.

```
<machineKey compatibilityMode="Framework45" dataProtectorType="..." />
```

### TIP

You can tell if the new data protection system is active by inspecting fields like `__VIEWSTATE`, which should begin with "CfDJ8" as in the example below. "CfDJ8" is the base64 representation of the magic "09 F0 C9 F0" header that identifies a payload protected by the data protection system.

```
<input type="hidden" name="__VIEWSTATE" id="__VIEWSTATE" value="CfDJ8AWPr2EQPTBGs3L2GCZ0pk..." />
```

## Package configuration

The data protection system is instantiated with a default zero-setup configuration. However, since by default keys are persisted to the local file system, this won't work for applications which are deployed in a farm. To resolve this, you can provide configuration by creating a type which subclasses `DataProtectionStartup` and overrides its `ConfigureServices` method.

Below is an example of a custom data protection startup type which configured both where keys are persisted and how they're encrypted at rest. It also overrides the default app isolation policy by providing its own application name.

```

using System;
using System.IO;
using Microsoft.AspNetCore.DataProtection;
using Microsoft.AspNetCore.DataProtection.SystemWeb;
using Microsoft.Extensions.DependencyInjection;

namespace DataProtectionDemo
{
    public class MyDataProtectionStartup : DataProtectionStartup
    {
        public override void ConfigureServices(IServiceCollection services)
        {
            services.AddDataProtection()
                .SetApplicationName("my-app")
                .PersistKeysToFileSystem(new DirectoryInfo(@"\\server\share\myapp-keys\"))  

                .ProtectKeysWithCertificate("thumbprint");
        }
    }
}

```

#### TIP

You can also use `<machineKey applicationName="my-app" ... />` in place of an explicit call to SetApplicationName. This is a convenience mechanism to avoid forcing the developer to create a DataProtectionStartup-derived type if all they wanted to configure was setting the application name.

To enable this custom configuration, go back to Web.config and look for the `<appSettings>` element that the package install added to the config file. It will look like the following markup:

```

<appSettings>
    <!--
    If you want to customize the behavior of the ASP.NET Core Data Protection stack, set the
    "aspnet:dataProtectionStartupType" switch below to be the fully-qualified name of a
    type which subclasses Microsoft.AspNetCore.DataProtection.SystemWeb.DataProtectionStartup.
    -->
    <add key="aspnet:dataProtectionStartupType" value="" />
</appSettings>

```

Fill in the blank value with the assembly-qualified name of the DataProtectionStartup-derived type you just created. If the name of the application is DataProtectionDemo, this would look like the below.

```

<add key="aspnet:dataProtectionStartupType"
    value="DataProtectionDemo.MyDataProtectionStartup, DataProtectionDemo" />

```

The newly-configured data protection system is now ready for use inside the application.

# Enforce HTTPS in ASP.NET Core

6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

This document shows how to:

- Require HTTPS for all requests.
- Redirect all HTTP requests to HTTPS.

## WARNING

Do **not** use `RequireHttpsAttribute` on Web APIs that receive sensitive information. `RequireHttpsAttribute` uses HTTP status codes to redirect browsers from HTTP to HTTPS. API clients may not understand or obey redirects from HTTP to HTTPS. Such clients may send information over HTTP. Web APIs should either:

- Not listen on HTTP.
- Close the connection with status code 400 (Bad Request) and not serve the request.

## Require HTTPS

We recommend all ASP.NET Core web apps call HTTPS Redirection Middleware ([UseHttpsRedirection](#)) to redirect all HTTP requests to HTTPS.

The following code calls `UseHttpsRedirection` in the `Startup` class:

```
public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
    }
    else
    {
        app.UseExceptionHandler("/Error");
        app.UseHsts();
    }

    app.UseHttpsRedirection();
    app.UseStaticFiles();
    app.UseCookiePolicy();

    app.UseMvc();
}
```

The following code calls `AddHttpsRedirection` to configure middleware options:

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc();

    services.AddHsts(options =>
    {
        options.Preload = true;
        options.IncludeSubDomains = true;
        options.MaxAge = TimeSpan.FromDays(60);
        options.ExcludedHosts.Add("example.com");
        options.ExcludedHosts.Add("www.example.com");
    });

    services.AddHttpsRedirection(options =>
    {
        options.RedirectStatusCode = StatusCodes.Status307TemporaryRedirect;
        options.HttpsPort = 5001;
    });
}

```

The preceding highlighted code:

- Sets [HttpsRedirectionOptions.RedirectStatusCode](#) to `Status307TemporaryRedirect`, which is the default value. Production apps should call [UseHsts](#).
- Sets the HTTPS port to 5001. The default value is 443.

The following mechanisms set the port automatically:

- The middleware can discover the ports via [IServerAddressesFeature](#) when the following conditions apply:
  - Kestrel or HTTP.sys is used directly with HTTPS endpoints (also applies to running the app with Visual Studio Code's debugger).
  - Only **one HTTPS port** is used by the app.
- Visual Studio is used:
- IIS Express has HTTPS enabled.
- *launchSettings.json* sets the `sslPort` for IIS Express.

#### NOTE

When an app is run behind a reverse proxy (for example, IIS, IIS Express), [IServerAddressesFeature](#) isn't available. The port must be manually configured. When the port isn't set, requests aren't redirected.

The port can be configured by setting the:

- `ASPNETCORE_HTTPS_PORT` environment variable.
- `http_port` host configuration key (for example, via *hostsettings.json* or a command line argument).
- [HttpsRedirectionOptions.HttpsPort](#). See the preceding example that shows how to set the port to 5001.

#### NOTE

The port can be configured indirectly by setting the URL with the `ASPNETCORE_URLS` environment variable. The environment variable configures the server, and then the middleware indirectly discovers the HTTPS port via [IServerAddressesFeature](#).

If no port is set:

- Requests aren't redirected.
- The middleware logs a warning.

#### NOTE

An alternative to using HTTPS Redirection Middleware (`UseHttpsRedirection`) is to use URL Rewriting Middleware (`AddRedirectToHttps`). `AddRedirectToHttps` can also set the status code and port when the redirect is executed. For more information, see [URL Rewriting Middleware](#).

When redirecting to HTTPS without the requirement for additional redirect rules, we recommend using HTTPS Redirection Middleware (`UseHttpsRedirection`) described in this topic.

The `RequireHttpsAttribute` is used to require HTTPS. `[RequireHttpsAttribute]` can decorate controllers or methods, or can be applied globally. To apply the attribute globally, add the following code to `ConfigureServices` in `Startup`:

```
// Requires using Microsoft.AspNetCore.Mvc;
public void ConfigureServices(IServiceCollection services)
{
    services.Configure<MvcOptions>(options =>
    {
        options.Filters.Add(new RequireHttpsAttribute());
    });
}
```

The preceding highlighted code requires all requests use `HTTPS`; therefore, HTTP requests are ignored. The following highlighted code redirects all HTTP requests to HTTPS:

```
// Requires using Microsoft.AspNetCore.Rewrite;
public void Configure(IApplicationBuilder app, IHostingEnvironment env, ILoggerFactory loggerFactory)
{
    loggerFactory.AddConsole(Configuration.GetSection("Logging"));
    loggerFactory.AddDebug();

    var options = new RewriteOptions()
        .AddRedirectToHttps();

    app.UseRewriter(options);
}
```

For more information, see [URL Rewriting Middleware](#). The middleware also permits the app to set the status code or the status code and the port when the redirect is executed.

Requiring HTTPS globally (`options.Filters.Add(new RequireHttpsAttribute());`) is a security best practice. Applying the `[RequireHttps]` attribute to all controllers/Razor Pages isn't considered as secure as requiring HTTPS globally. You can't guarantee the `[RequireHttps]` attribute is applied when new controllers and Razor Pages are added.

## HTTP Strict Transport Security Protocol (HSTS)

Per [OWASP](#), [HTTP Strict Transport Security \(HSTS\)](#) is an opt-in security enhancement that is specified by a web application through the use of a special response header. Once a supported browser receives this header that browser will prevent any communications from being sent over HTTP to the specified domain and will instead send all communications over HTTPS. It also prevents HTTPS click through prompts on browsers.

ASP.NET Core 2.1 or later implements HSTS with the `UseHsts` extension method. The following code calls `UseHsts` when the app isn't in [development mode](#):

```

public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
    }
    else
    {
        app.UseExceptionHandler("/Error");
        app.UseHsts();
    }

    app.UseHttpsRedirection();
    app.UseStaticFiles();
    app.UseCookiePolicy();

    app.UseMvc();
}

```

`UseHsts` isn't recommended in development because the HSTS header is highly cacheable by browsers. By default, `UseHsts` excludes the local loopback address.

The following code:

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc();

    services.AddHsts(options =>
    {
        options.Preload = true;
        options.IncludeSubDomains = true;
        options.MaxAge = TimeSpan.FromDays(60);
        options.ExcludedHosts.Add("example.com");
        options.ExcludedHosts.Add("www.example.com");
    });

    services.AddHttpsRedirection(options =>
    {
        options.RedirectStatusCode = StatusCodes.Status307TemporaryRedirect;
        options.HttpsPort = 5001;
    });
}

```

- Sets the preload parameter of the Strict-Transport-Security header. Preload is not part of the [RFC HSTS specification](#), but is supported by web browsers to preload HSTS sites on fresh install. See <https://hstspreload.org/> for more information.
- Enables `includeSubDomain`, which applies the HSTS policy to Host subdomains.
- Explicitly sets the max-age parameter of the Strict-Transport-Security header to to 60 days. If not set, defaults to 30 days. See the [max-age directive](#) for more information.
- Adds `example.com` to the list of hosts to exclude.

`UseHsts` excludes the following loopback hosts:

- `localhost` : The IPv4 loopback address.
- `127.0.0.1` : The IPv4 loopback address.
- `[::1]` : The IPv6 loopback address.

The preceding example shows how to add additional hosts.

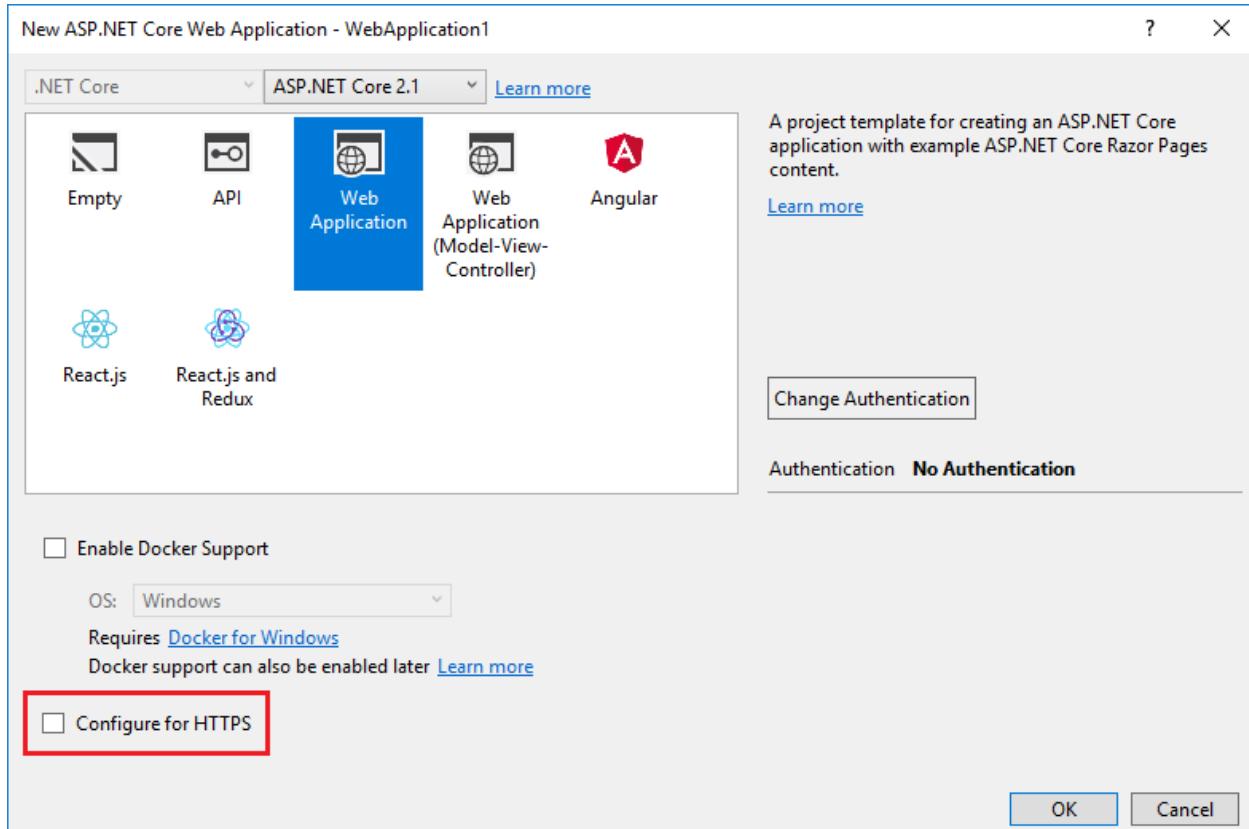
## Opt-out of HTTPS on project creation

The ASP.NET Core 2.1 or later web application templates (from Visual Studio or the dotnet command line) enable [HTTPS redirection](#) and [HSTS](#). For deployments that don't require HTTPS, you can opt-out of HTTPS. For example, some backend services where HTTPS is being handled externally at the edge, using HTTPS at each node is not needed.

To opt-out of HTTPS:

- [Visual Studio](#)
- [.NET Core CLI](#)

Uncheck the **Configure for HTTPS** checkbox.



## How to setup a developer certificate for Docker

See [this GitHub issue](#).

# EU General Data Protection Regulation (GDPR) support in ASP.NET Core

7/5/2018 • 5 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

ASP.NET Core provides APIs and templates to help meet some of the [EU General Data Protection Regulation \(GDPR\)](#) requirements:

- The project templates include extension points and stubbed markup that you can replace with your privacy and cookie use policy.
- A cookie consent feature allows you to ask for (and track) consent from your users for storing personal information. If a user hasn't consented to data collection and the app has `CheckConsentNeeded` set to `true`, non-essential cookies aren't sent to the browser.
- Cookies can be marked as essential. Essential cookies are sent to the browser even when the user hasn't consented and tracking is disabled.
- [TempData](#) and [Session cookies](#) aren't functional when tracking is disabled.
- The [Identity manage](#) page provides a link to download and delete user data.

The [sample app](#) allows you test most of the GDPR extension points and APIs added to the ASP.NET Core 2.1 templates. See the [ReadMe](#) file for testing instructions.

[View or download sample code \(how to download\)](#)

## ASP.NET Core GDPR support in template generated code

Razor Pages and MVC projects created with the project templates include the following GDPR support:

- `CookiePolicyOptions` and `UseCookiePolicy` are set in `Startup`.
- The `_CookieConsentPartial.cshtml` partial view.
- The `Pages/Privacy.cshtml` page or `Views/Home/Privacy.cshtml` view provides a page to detail your site's privacy policy. The `_CookieConsentPartial.cshtml` file generates a link to the Privacy page.
- For apps created with individual user accounts, the Manage page provides links to download and delete [personal user data](#).

### **CookiePolicyOptions and UseCookiePolicy**

`CookiePolicyOptions` are initialized in `Startup.ConfigureServices`:

```

public class Startup
{
    public Startup(IConfiguration configuration)
    {
        Configuration = configuration;
    }

    public IConfiguration Configuration { get; }

    // This method gets called by the runtime. Use this method to add services
    // to the container.
    public void ConfigureServices(IServiceCollection services)
    {
        services.Configure<CookiePolicyOptions>(options =>
        {
            // This lambda determines whether user consent for non-essential cookies
            // is needed for a given request.
            options.CheckConsentNeeded = context => true;
            options.MinimumSameSitePolicy = SameSiteMode.None;
        });

        services.AddDbContext<ApplicationDbContext>(options =>
            options.UseSqlServer(
                Configuration.GetConnectionString("DefaultConnection")));
        services.AddDefaultIdentity<IdentityUser>()
            .AddEntityFrameworkStores<ApplicationDbContext>();

        services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
    }

    // This method gets called by the runtime. Use this method to configure the
    // HTTP request pipeline.
    public void Configure(IApplicationBuilder app, IHostingEnvironment env)
    {
        if (env.IsDevelopment())
        {
            app.UseDeveloperExceptionPage();
            app.UseDatabaseErrorPage();
        }
        else
        {
            app.UseExceptionHandler("/Error");
            app.UseHsts();
        }

        app.UseHttpsRedirection();
        app.UseStaticFiles();
        app.UseCookiePolicy();

        app.UseAuthentication();

        app.UseMvc();
    }
}

```

[UseCookiePolicy](#) is called in `Startup.Configure`:

```

public class Startup
{
    public Startup(IConfiguration configuration)
    {
        Configuration = configuration;
    }

    public IConfiguration Configuration { get; }

    // This method gets called by the runtime. Use this method to add services
    // to the container.
    public void ConfigureServices(IServiceCollection services)
    {
        services.Configure<CookiePolicyOptions>(options =>
        {
            // This lambda determines whether user consent for non-essential cookies
            // is needed for a given request.
            options.CheckConsentNeeded = context => true;
            options.MinimumSameSitePolicy = SameSiteMode.None;
        });

        services.AddDbContext<ApplicationDbContext>(options =>
            options.UseSqlServer(
                Configuration.GetConnectionString("DefaultConnection")));
        services.AddDefaultIdentity<IdentityUser>()
            .AddEntityFrameworkStores<ApplicationDbContext>();

        services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
    }

    // This method gets called by the runtime. Use this method to configure the
    // HTTP request pipeline.
    public void Configure(IApplicationBuilder app, IHostingEnvironment env)
    {
        if (env.IsDevelopment())
        {
            app.UseDeveloperExceptionPage();
            app.UseDatabaseErrorPage();
        }
        else
        {
            app.UseExceptionHandler("/Error");
            app.UseHsts();
        }

        app.UseHttpsRedirection();
        app.UseStaticFiles();
        app.UseCookiePolicy();

        app.UseAuthentication();

        app.UseMvc();
    }
}

```

### **\_CookieConsentPartial.cshtml partial view**

The `_CookieConsentPartial.cshtml` partial view:

```

@using Microsoft.AspNetCore.Http.Features

#{@
    var consentFeature = Context.Features.Get<ITrackingConsentFeature>();
    var showBanner = !consentFeature?.CanTrack ?? false;
    var cookieString = consentFeature?.CreateConsentCookie();
}

@if (showBanner)
{
    <nav id="cookieConsent" class="navbar navbar-default navbar-fixed-top" role="alert">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-
target="#cookieConsent .navbar-collapse">
                    <span class="sr-only">Toggle cookie consent banner</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <span class="navbar-brand"><span class="glyphicon glyphicon-info-sign" aria-hidden="true">
                    </span></span>
            </div>
            <div class="collapse navbar-collapse">
                <p class="navbar-text">
                    Use this space to summarize your privacy and cookie use policy.
                </p>
                <div class="navbar-right">
                    <a asp-page="/Privacy" class="btn btn-info navbar-btn">Learn More</a>
                    <button type="button" class="btn btn-default navbar-btn" data-cookie-
string="@cookieString">Accept</button>
                </div>
            </div>
        </div>
    </nav>
    <script>
        (function () {
            document.querySelector("#cookieConsent button[data-cookie-string]").addEventListener("click",
            function (el) {
                document.cookie = el.target.dataset.cookieString;
                document.querySelector("#cookieConsent").classList.add("hidden");
            }, false);
        })();
    </script>
}

```

This partial:

- Obtains the state of tracking for the user. If the app is configured to require consent, the user must consent before cookies can be tracked. If consent is required, the cookie consent panel is fixed at top of the navigation bar created by the `_Layout.cshtml` file.
- Provides an HTML `<p>` element to summarize your privacy and cookie use policy.
- Provides a link to Privacy page or view where you can detail your site's privacy policy.

## Essential cookies

If consent has not been given, only cookies marked essential are sent to the browser. The following code makes a cookie essential:

```
public IActionResult OnPostCreateEssentialAsync()
{
    HttpContext.Response.Cookies.Append(Constants.EssentialSec,
        DateTime.Now.Second.ToString(),
        new CookieOptions() { IsEssential = true });

    ResponseCookies = Response.Headers[HeaderNames.SetCookie].ToString();

    return RedirectToPage("./Index");
}
```

## Tempdata provider and session state cookies are not essential

The [Tempdata provider](#) cookie isn't essential. If tracking is disabled, the Tempdata provider isn't functional. To enable the Tempdata provider when tracking is disabled, mark the TempData cookie as essential in

`Startup.ConfigureServices` :

```
// The Tempdata provider cookie is not essential. Make it essential
// so Tempdata is functional when tracking is disabled.
services.Configure<CookieTempDataProviderOptions>(options => {
    options.Cookie.IsEssential = true;
});
```

[Session state](#) cookies are not essential. Session state isn't functional when tracking is disabled.

## Personal data

ASP.NET Core apps created with individual user accounts include code to download and delete personal data.

Select the user name and then select **Personal data**:

The screenshot shows a web application titled "WebApp1" running on a local host. The URL in the address bar is <https://localhost:44306/Identity/Account/Manage/PersonalData>. The page header includes a "Guest" button, a window control bar (minimize, maximize, close), and a navigation bar with "Home", "About", "Contact", "Logout", and the user's name "Hello rick@example.com!". The main content area has a heading "Manage your account" and a sub-section "Change your account settings". Below this are several links: "Profile", "Password", "Two-factor authentication", and "Personal data". The "Personal data" link is highlighted with a blue background. Under "Personal Data", there is a note: "Your account contains personal data that you have given us. This page allows you to download or delete that data. Deleting this data will permanently remove your account, and this cannot be recovered." Below this note are two buttons: "Download" and "Delete". At the bottom of the page, there is a footer with the text "© 2018 - WebApp1".

Notes:

- To generate the `Account/Manage` code, see [Scaffold Identity](#).
- Delete and download only impact the default identity data. Apps that create custom user data must be extended to delete/download the custom user data. For more information, see [Add, download, and delete custom user data to Identity](#).
- Saved tokens for the user that are stored in the Identity database table `AspNetUserTokens` are deleted when the user is deleted via the cascading delete behavior due to the [foreign key](#).

## Encryption at rest

Some databases and storage mechanisms allow for encryption at rest. Encryption at rest:

- Encrypts stored data automatically.
- Encrypts without configuration, programming, or other work for the software that accesses the data.
- Is the easiest and safest option.
- Allows the database to manage keys and encryption.

For example:

- Microsoft SQL and Azure SQL provide [Transparent Data Encryption \(TDE\)](#).
- [SQL Azure encrypts the database by default](#)
- [Azure Blobs, Files, Table, and Queue Storage are encrypted by default](#).

For databases that don't provide built-in encryption at rest, you may be able to use disk encryption to provide the same protection. For example:

- [BitLocker for Windows Server](#)
- Linux:
  - [eCryptfs](#)
  - [EncFS](#).

## Additional resources

- [Microsoft.com/GDPR](#)

# Safe storage of app secrets in development in ASP.NET Core

6/22/2018 • 8 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [Daniel Roth](#), and [Scott Addie](#)

[View or download sample code \(how to download\)](#)

This document explains techniques for storing and retrieving sensitive data during the development of an ASP.NET Core app. You should never store passwords or other sensitive data in source code, and you shouldn't use production secrets in development or test mode. You can store and protect Azure test and production secrets with the [Azure Key Vault configuration provider](#).

## Environment variables

Environment variables are used to avoid storage of app secrets in code or in local configuration files. Environment variables override configuration values for all previously specified configuration sources.

Configure the reading of environment variable values by calling `AddEnvironmentVariables` in the `Startup` constructor:

```
public Startup(IHostingEnvironment env)
{
    var builder = new ConfigurationBuilder()
        .SetBasePath(env.ContentRootPath)
        .AddJsonFile("appsettings.json",
            optional: false,
            reloadOnChange: true)
        .AddEnvironmentVariables();

    if (env.IsDevelopment())
    {
        builder.AddUserSecrets<Startup>();
    }

    Configuration = builder.Build();
}
```

Consider an ASP.NET Core web app in which **Individual User Accounts** security is enabled. A default database connection string is included in the project's `appsettings.json` file with the key `DefaultConnection`. The default connection string is for LocalDB, which runs in user mode and doesn't require a password. During app deployment, the `DefaultConnection` key value can be overridden with an environment variable's value. The environment variable may store the complete connection string with sensitive credentials.

### WARNING

Environment variables are generally stored in plain, unencrypted text. If the machine or process is compromised, environment variables can be accessed by untrusted parties. Additional measures to prevent disclosure of user secrets may be required.

## Secret Manager

The Secret Manager tool stores sensitive data during the development of an ASP.NET Core project. In this context, a piece of sensitive data is an app secret. App secrets are stored in a separate location from the project tree. The app secrets are associated with a specific project or shared across several projects. The app secrets aren't checked into source control.

**WARNING**

The Secret Manager tool doesn't encrypt the stored secrets and shouldn't be treated as a trusted store. It's for development purposes only. The keys and values are stored in a JSON configuration file in the user profile directory.

## How the Secret Manager tool works

The Secret Manager tool abstracts away the implementation details, such as where and how the values are stored. You can use the tool without knowing these implementation details. The values are stored in a JSON configuration file in a system-protected user profile folder on the local machine:

- [Windows](#)
- [macOS](#)
- [Linux](#)

File system path:

```
%APPDATA%\Microsoft\UserSecrets\<user_secrets_id>\secrets.json
```

In the preceding file paths, replace `<user_secrets_id>` with the `UserSecretsId` value specified in the `.csproj` file.

Don't write code that depends on the location or format of data saved with the Secret Manager tool. These implementation details may change. For example, the secret values aren't encrypted, but could be in the future.

## Install the Secret Manager tool

The Secret Manager tool is bundled with the .NET Core CLI as of .NET Core SDK 2.1.300. For .NET Core SDK versions before 2.1.300, tool installation is necessary.

**TIP**

Run `dotnet --version` from a command shell to see the installed .NET Core SDK version number.

A warning is displayed if the .NET Core SDK being used includes the tool:

```
The tool 'Microsoft.Extensions.SecretManager.Tools' is now included in the .NET Core SDK. Information on resolving this warning is available at (https://aka.ms/dotnetclitools-in-box).
```

Install the [Microsoft.Extensions.SecretManager.Tools](#) NuGet package in your ASP.NET Core project. For example:

```
<Project Sdk="Microsoft.NET.Sdk.Web">
  <PropertyGroup>
    <TargetFramework>netcoreapp1.1</TargetFramework>
    <UserSecretsId>1242d6d6-9df3-4031-b031-d9b27d13c25a</UserSecretsId>
  </PropertyGroup>
  <ItemGroup>
    <PackageReference Include="Microsoft.AspNetCore"
      Version="1.1.6" />
    <PackageReference Include="Microsoft.Extensions.Configuration.UserSecrets"
      Version="1.1.2" />
    <PackageReference Include="System.Data.SqlClient"
      Version="4.5.0" />
  </ItemGroup>
  <ItemGroup>
    <DotNetCliToolReference Include="Microsoft.Extensions.SecretManager.Tools"
      Version="1.0.1" />
  </ItemGroup>
</Project>
```

Execute the following command in a command shell to validate the tool installation:

```
dotnet user-secrets -h
```

The Secret Manager tool displays sample usage, options, and command help:

```
Usage: dotnet user-secrets [options] [command]

Options:
-?|-h|--help           Show help information
--version               Show version information
-v|--verbose            Show verbose output
-p|--project <PROJECT> Path to project. Defaults to searching the current directory.
-c|--configuration <CONFIGURATION> The project configuration to use. Defaults to 'Debug'.
--id                   The user secret ID to use.

Commands:
clear     Deletes all the application secrets
list      Lists all the application secrets
remove    Removes the specified user secret
set      Sets the user secret to the specified value

Use "dotnet user-secrets [command] --help" for more information about a command.
```

#### NOTE

You must be in the same directory as the `.csproj` file to run tools defined in the `.csproj` file's `DotNetCliToolReference` elements.

## Set a secret

The Secret Manager tool operates on project-specific configuration settings stored in your user profile. To use user secrets, define a `UserSecretsId` element within a `PropertyGroup` of the `.csproj` file. The value of `UserSecretsId` is arbitrary, but is unique to the project. Developers typically generate a GUID for the `UserSecretsId`.

```
<PropertyGroup>
  <TargetFramework>netcoreapp1.1</TargetFramework>
  <UserSecretsId>1242d6d6-9df3-4031-b031-d9b27d13c25a</UserSecretsId>
</PropertyGroup>
```

```
<PropertyGroup>
  <TargetFramework>netcoreapp2.1</TargetFramework>
  <UserSecretsId>79a3edd0-2092-40a2-a04d-dcb46d5ca9ed</UserSecretsId>
</PropertyGroup>
```

#### TIP

In Visual Studio, right-click the project in Solution Explorer, and select **Manage User Secrets** from the context menu.

This gesture adds a `UserSecretsId` element, populated with a GUID, to the `.csproj` file. Visual Studio opens a `secrets.json` file in the text editor. Replace the contents of `secrets.json` with the key-value pairs to be stored. For example:

```
{
  "Movies": {
    "ServiceApiKey": "12345",
    "ConnectionString": "Server=(localdb)\\mssqllocaldb;Database=Movie-
1;Trusted_Connection=True;MultipleActiveResultSets=true"
  }
}
```

Define an app secret consisting of a key and its value. The secret is associated with the project's `UserSecretsId` value. For example, run the following command from the directory in which the `.csproj` file exists:

```
dotnet user-secrets set "Movies:ServiceApiKey" "12345"
```

In the preceding example, the colon denotes that `Movies` is an object literal with a `ServiceApiKey` property.

The Secret Manager tool can be used from other directories too. Use the `--project` option to supply the file system path at which the `.csproj` file exists. For example:

```
dotnet user-secrets set "Movies:ServiceApiKey" "12345" --project "C:\apps\WebApp1\src\WebApp1"
```

## Set multiple secrets

A batch of secrets can be set by piping JSON to the `set` command. In the following example, the `input.json` file's contents are piped to the `set` command.

- Windows
- macOS
- Linux

Open a command shell, and execute the following command:

```
type .\input.json | dotnet user-secrets set
```

## Access a secret

The [ASP.NET Core Configuration API](#) provides access to Secret Manager secrets. Install the `Microsoft.Extensions.Configuration.UserSecrets` NuGet package.

Add the user secrets configuration source with a call to `AddUserSecrets` in the `Startup` constructor:

```
public Startup(IHostingEnvironment env)
{
    var builder = new ConfigurationBuilder()
        .SetBasePath(env.ContentRootPath)
        .AddJsonFile("appsettings.json",
            optional: false,
            reloadOnChange: true)
        .AddEnvironmentVariables();

    if (env.IsDevelopment())
    {
        builder.AddUserSecrets<Startup>();
    }

    Configuration = builder.Build();
}
```

The [ASP.NET Core Configuration API](#) provides access to Secret Manager secrets. If your project targets the .NET Framework, install the `Microsoft.Extensions.Configuration.UserSecrets` NuGet package.

In ASP.NET Core 2.0 or later, the user secrets configuration source is automatically added in development mode when the project calls `CreateDefaultBuilder` to initialize a new instance of the host with preconfigured defaults. `CreateDefaultBuilder` calls `AddUserSecrets` when the `EnvironmentName` is `Development`:

```
public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
    WebHost.CreateDefaultBuilder(args)
        .UseStartup<Startup>();
```

When `CreateDefaultBuilder` isn't called during host construction, add the user secrets configuration source with a call to `AddUserSecrets` in the `Startup` constructor:

```
public Startup(IHostingEnvironment env)
{
    var builder = new ConfigurationBuilder()
        .SetBasePath(env.ContentRootPath)
        .AddJsonFile("appsettings.json",
            optional: false,
            reloadOnChange: true)
        .AddEnvironmentVariables();

    if (env.IsDevelopment())
    {
        builder.AddUserSecrets<Startup>();
    }

    Configuration = builder.Build();
}
```

User secrets can be retrieved via the `Configuration` API:

```

public class Startup
{
    private string _moviesApiKey = null;

    public Startup(IHostingEnvironment env)
    {
        var builder = new ConfigurationBuilder()
            .SetBasePath(env.ContentRootPath)
            .AddJsonFile("appsettings.json",
                optional: false,
                reloadOnChange: true)
            .AddEnvironmentVariables();

        if (env.IsDevelopment())
        {
            builder.AddUserSecrets<Startup>();
        }

        Configuration = builder.Build();
    }

    public IConfigurationRoot Configuration { get; }

    public void ConfigureServices(IServiceCollection services)
    {
        _moviesApiKey = Configuration["Movies:ServiceApiKey"];
    }

    public void Configure(IApplicationBuilder app)
    {
        var result = string.IsNullOrEmpty(_moviesApiKey) ? "Null" : "Not Null";
        app.Run(async (context) =>
        {
            await context.Response.WriteAsync($"Secret is {result}");
        });
    }
}

```

```

public class Startup
{
    private string _moviesApiKey = null;

    public Startup(IConfiguration configuration)
    {
        Configuration = configuration;
    }

    public IConfiguration Configuration { get; }

    public void ConfigureServices(IServiceCollection services)
    {
        _moviesApiKey = Configuration["Movies:ServiceApiKey"];
    }

    public void Configure(IApplicationBuilder app)
    {
        var result = string.IsNullOrEmpty(_moviesApiKey) ? "Null" : "Not Null";
        app.Run(async (context) =>
        {
            await context.Response.WriteAsync($"Secret is {result}");
        });
    }
}

```

## String replacement with secrets

Storing passwords in plain text is insecure. For example, a database connection string stored in `appsettings.json` may include a password for the specified user:

```
{  
  "ConnectionStrings": {  
    "Movies": "Server=(localdb)\\mssqllocaldb;Database=Movie-1;User  
Id=johndoe;Password=pass123;MultipleActiveResultSets=true"  
  }  
}
```

A more secure approach is to store the password as a secret. For example:

```
dotnet user-secrets set "DbPassword" "pass123"
```

Remove the `Password` key-value pair from the connection string in `appsettings.json`. For example:

```
{  
  "ConnectionStrings": {  
    "Movies": "Server=(localdb)\\mssqllocaldb;Database=Movie-1;User  
Id=johndoe;MultipleActiveResultSets=true"  
  }  
}
```

The secret's value can be set on a `SqlConnectionStringBuilder` object's `Password` property to complete the connection string:

```
public class Startup
{
    private string _connection = null;

    public Startup(IHostingEnvironment env)
    {
        var builder = new ConfigurationBuilder()
            .SetBasePath(env.ContentRootPath)
            .AddJsonFile("appsettings.json",
                optional: false,
                reloadOnChange: true)
            .AddEnvironmentVariables();

        if (env.IsDevelopment())
        {
            builder.AddUserSecrets<Startup>();
        }

        Configuration = builder.Build();
    }

    public IConfigurationRoot Configuration { get; }

    public void ConfigureServices(IServiceCollection services)
    {
        var builder = new SqlConnectionStringBuilder(
            Configuration.GetConnectionString("Movies"));
        builder.Password = Configuration["DbPassword"];
        _connection = builder.ConnectionString;
    }

    public void Configure(IApplicationBuilder app)
    {
        app.Run(async (context) =>
        {
            await context.Response.WriteAsync($"DB Connection: {_connection}");
        });
    }
}
```

```

public class Startup
{
    private string _connection = null;

    public Startup(IConfiguration configuration)
    {
        Configuration = configuration;
    }

    public IConfiguration Configuration { get; }

    public void ConfigureServices(IServiceCollection services)
    {
        var builder = new SqlConnectionStringBuilder(
            Configuration.GetConnectionString("Movies"));
        builder.Password = Configuration["DbPassword"];
        _connection = builder.ConnectionString;
    }

    public void Configure(IApplicationBuilder app)
    {
        app.Run(async (context) =>
        {
            await context.Response.WriteAsync($"DB Connection: {_connection}");
        });
    }
}

```

## List the secrets

Assume the app's *secrets.json* file contains the following two secrets:

```
{
    "Movies": {
        "ServiceApiKey": "12345",
        "ConnectionString": "Server=(localdb)\\mssqllocaldb;Database=Movie-1;Trusted_Connection=True;MultipleActiveResultSets=true"
    }
}
```

Run the following command from the directory in which the *.csproj* file exists:

```
dotnet user-secrets list
```

The following output appears:

```
Movies:ServiceApiKey = 12345
Movies:ConnectionString = Server=(localdb)\\mssqllocaldb;Database=Movie-1;Trusted_Connection=True;MultipleActiveResultSets=true
```

In the preceding example, a colon in the key names denotes the object hierarchy within *secrets.json*.

## Remove a single secret

Assume the app's *secrets.json* file contains the following two secrets:

```
{
  "Movies": {
    "ServiceApiKey": "12345",
    "ConnectionString": "Server=(localdb)\\mssqllocaldb;Database=Movie-1;Trusted_Connection=True;MultipleActiveResultSets=true"
  }
}
```

Run the following command from the directory in which the `.csproj` file exists:

```
dotnet user-secrets remove "Movies:ConnectionString"
```

The app's `secrets.json` file was modified to remove the key-value pair associated with the `MoviesConnectionString` key:

```
{
  "Movies": {
    "ServiceApiKey": "12345"
  }
}
```

Running `dotnet user-secrets list` displays the following message:

```
Movies:ServiceApiKey = 12345
```

## Remove all secrets

Assume the app's `secrets.json` file contains the following two secrets:

```
{
  "Movies": {
    "ServiceApiKey": "12345",
    "ConnectionString": "Server=(localdb)\\mssqllocaldb;Database=Movie-1;Trusted_Connection=True;MultipleActiveResultSets=true"
  }
}
```

Run the following command from the directory in which the `.csproj` file exists:

```
dotnet user-secrets clear
```

All user secrets for the app have been deleted from the `secrets.json` file:

```
{}
```

Running `dotnet user-secrets list` displays the following message:

```
No secrets configured for this application.
```

## Additional resources

- Configuration in ASP.NET Core
- Azure Key Vault configuration provider in ASP.NET Core

# Azure Key Vault configuration provider in ASP.NET Core

6/21/2018 • 8 minutes to read • [Edit Online](#)

By [Luke Latham](#) and [Andrew Stanton-Nurse](#)

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

View or download sample code for 2.x:

- [Basic sample \(how to download\)](#) - Reads secret values into an app.
- [Key name prefix sample \(how to download\)](#) - Reads secret values using a key name prefix that represents the version of an app, which allows you to load a different set of secret values for each app version.

This document explains how to use the [Microsoft Azure Key Vault](#) configuration provider to load application configuration values from Azure Key Vault secrets. Azure Key Vault is a cloud-based service that helps you safeguard cryptographic keys and secrets used by apps and services. Common scenarios include controlling access to sensitive configuration data and meeting the requirement for FIPS 140-2 Level 2 validated Hardware Security Modules (HSM's) when storing configuration data. This feature is available for applications that target ASP.NET Core 1.1 or higher.

## Package

To use the provider, add a reference to the [Microsoft.Extensions.Configuration.AzureKeyVault](#) package.

## Application configuration

You can explore the provider with the [sample apps](#). Once you establish a key vault and create secrets in the vault, the sample apps securely load the secret values into their configurations and display them in webpages.

The provider is added to the `ConfigurationBuilder` with the `AddAzureKeyVault` extension. In the sample apps, the extension uses three configuration values loaded from the `appsettings.json` file.

APP SETTING	DESCRIPTION	EXAMPLE
<code>Vault</code>	Azure Key Vault name	contosovault
<code>ClientId</code>	Azure Active Directory App Id	627e911e-43cc-61d4-992e-12db9c81b413
<code>ClientSecret</code>	Azure Active Directory App Key	g58K3dtg59o1Pa+e59v2Tx829w6VxTB2yv9sv/101di=

```

public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
    WebHost.CreateDefaultBuilder(args)
        .ConfigureAppConfiguration((context, config) =>
    {
        var builtConfig = config.Build();

        var keyVaultConfigBuilder = new ConfigurationBuilder();

        keyVaultConfigBuilder.AddAzureKeyVault(
            $"https://{{builtConfig["Vault"]}}.vault.azure.net/",
            builtConfig["ClientId"],
            builtConfig["ClientSecret"]);

        var keyVaultConfig = keyVaultConfigBuilder.Build();

        config.AddConfiguration(keyVaultConfig);
    })
    .UseStartup<Startup>();

```

## Creating key vault secrets and loading configuration values (basic-sample)

1. Create a key vault and set up Azure Active Directory (Azure AD) for the application following the guidance in [Get started with Azure Key Vault](#).
  - Add secrets to the key vault using the [AzureRM Key Vault PowerShell Module](#) available from the [PowerShell Gallery](#), the [Azure Key Vault REST API](#), or the [Azure Portal](#). Secrets are created as either *Manual* or *Certificate* secrets. *Certificate* secrets are certificates for use by apps and services but are not supported by the configuration provider. You should use the *Manual* option to create name-value pair secrets for use with the configuration provider.
    - Simple secrets are created as name-value pairs. Azure Key Vault secret names are limited to alphanumeric characters and dashes.
    - Hierarchical values (configuration sections) use `--` (two dashes) as a separator in the sample. Colons, which are normally used to delimit a section from a subkey in [ASP.NET Core configuration](#), aren't allowed in secret names. Therefore, two dashes are used and swapped for a colon when the secrets are loaded into the app's configuration.
    - Create two *Manual* secrets with the following name-value pairs. The first secret is a simple name and value, and the second secret creates a secret value with a section and subkey in the secret name:
      - `SecretName : secret_value_1`
      - `Section--SecretName : secret_value_2`
  - Register the sample app with Azure Active Directory.
  - Authorize the app to access the key vault. When you use the `Set-AzureRmKeyVaultAccessPolicy` PowerShell cmdlet to authorize the app to access the key vault, provide `List` and `Get` access to secrets with `-PermissionsToSecrets list,get`.
2. Update the app's `appsettings.json` file with the values of `Vault`, `ClientId`, and `ClientSecret`.
3. Run the sample app, which obtains its configuration values from `IConfigurationRoot` with the same name as the secret name.
  - Non-hierarchical values: The value for `SecretName` is obtained with `config["SecretName"]`.
  - Hierarchical values (sections): Use `:` (colon) notation or the `GetSection` extension method. Use either of these approaches to obtain the configuration value:
    - `config["Section:SecretName"]`

- o `config.GetSection("Section")["SecretName"]`

When you run the app, a webpage shows the loaded secret values:

## Key Vault Configuration Provider Sample

Secret	Name in Key Vault	Obtained from Configuration	Value
SecretName	<b>SecretName</b>	<code>Configuration["SecretName"]</code>	<code>secret_value_1</code>
Section:SecretName	<b>Section--SecretName</b>	<code>Configuration["Section:SecretName"]</code>	<code>secret_value_2</code>
		<code>Configuration.GetSection("Section")["SecretName"]</code>	<code>secret_value_2</code>

### Creating prefixed key vault secrets and loading configuration values (key-name-prefix-sample)

`AddAzureKeyVault` also provides an overload that accepts an implementation of `IKeyVaultSecretManager`, which allows you to control how key vault secrets are converted into configuration keys. For example, you can implement the interface to load secret values based on a prefix value you provide at app startup. This allows you, for example, to load secrets based on the version of the app.

#### WARNING

Don't use prefixes on key vault secrets to place secrets for multiple apps into the same key vault or to place environmental secrets (for example, *development* versus *production* secrets) into the same vault. We recommend that different apps and development/production environments use separate key vaults to isolate app environments for the highest level of security.

Using the second sample app, you create a secret in the key vault for `5000-AppSecret` (periods aren't allowed in key vault secret names) representing an app secret for version 5.0.0.0 of your app. For another version, 5.1.0.0, you create a secret for `5100-AppSecret`. Each app version loads its own secret value into its configuration as `AppSecret`, stripping off the version as it loads the secret. The sample's implementation is shown below:

```

public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
    WebHost.CreateDefaultBuilder(args)
        .ConfigureAppConfiguration((context, config) =>
    {
        // The appVersion obtains the app version (5.0.0.0), which
        // is set in the project file and obtained from the entry
        // assembly. The versionPrefix holds the version without
        // dot notation for the PrefixKeyVaultSecretManager.
        var appVersion = Assembly.GetEntryAssembly().GetName().Version.ToString();
        var versionPrefix = appVersion.Replace(".", string.Empty);

        var builtConfig = config.Build();

        var keyVaultConfigBuilder = new ConfigurationBuilder();

        keyVaultConfigBuilder.AddAzureKeyVault(
            $"https://{{builtConfig["Vault"]}}.vault.azure.net/",
            builtConfig["ClientId"],
            builtConfig["ClientSecret"],
            new PrefixKeyVaultSecretManager(versionPrefix));

        var keyVaultConfig = keyVaultConfigBuilder.Build();

        config.AddConfiguration(keyVaultConfig);
    })
    .UseStartup<Startup>();

```

```

public class PrefixKeyVaultSecretManager : IKeyVaultSecretManager
{
    private readonly string _prefix;

    public PrefixKeyVaultSecretManager(string prefix)
    {
        _prefix = $"{prefix}-";
    }

    public bool Load(SecretItem secret)
    {
        // Load a vault secret when its secret name starts with the
        // prefix. Other secrets won't be loaded.
        return secret.Identifier.Name.StartsWith(_prefix);
    }

    public string GetKey(SecretBundle secret)
    {
        // Remove the prefix from the secret name and replace two
        // dashes in any name with the KeyDelimiter, which is the
        // delimiter used in configuration (usually a colon). Azure
        // Key Vault doesn't allow a colon in secret names.
        return secret.SecretIdentifier.Name
            .Substring(_prefix.Length)
            .Replace("--", ConfigurationPath.KeyDelimiter);
    }
}

```

The `Load` method is called by a provider algorithm that iterates through the vault secrets to find the ones that have the version prefix. When a version prefix is found with `Load`, the algorithm uses the `GetKey` method to return the configuration name of the secret name. It strips off the version prefix from the secret's name and returns the rest of the secret name for loading into the app's configuration name-value pairs.

When you implement this approach:

1. The key vault secrets are loaded.

2. The string secret for `5000-AppSecret` is matched.
3. The version, `5000` (with the dash), is stripped off of the key name leaving `AppSecret` to load with the secret value into the app's configuration.

**NOTE**

You can also provide your own `KeyVaultClient` implementation to `AddAzureKeyVault`. Supplying a custom client allows you to share a single instance of the client between the configuration provider and other parts of your app.

1. Create a key vault and set up Azure Active Directory (Azure AD) for the application following the guidance in [Get started with Azure Key Vault](#).
  - Add secrets to the key vault using the [AzureRM Key Vault PowerShell Module](#) available from the [PowerShell Gallery](#), the [Azure Key Vault REST API](#), or the [Azure Portal](#). Secrets are created as either *Manual* or *Certificate* secrets. *Certificate* secrets are certificates for use by apps and services but are not supported by the configuration provider. You should use the *Manual* option to create name-value pair secrets for use with the configuration provider.
    - Hierarchical values (configuration sections) use `--` (two dashes) as a separator.
    - Create two *Manual* secrets with the following name-value pairs:
      - `5000-AppSecret` : `5.0.0.0_secret_value`
      - `5100-AppSecret` : `5.1.0.0_secret_value`
  - Register the sample app with Azure Active Directory.
  - Authorize the app to access the key vault. When you use the `Set-AzureRmKeyVaultAccessPolicy` PowerShell cmdlet to authorize the app to access the key vault, provide `List` and `Get` access to secrets with `-PermissionsToSecrets list,get`.
2. Update the app's `appsettings.json` file with the values of `Vault`, `ClientId`, and `ClientSecret`.
3. Run the sample app, which obtains its configuration values from `IConfigurationRoot` with the same name as the prefixed secret name. In this sample, the prefix is the app's version, which you provided to the `PrefixKeyVaultSecretManager` when you added the Azure Key Vault configuration provider. The value for `AppSecret` is obtained with `config["AppSecret"]`. The webpage generated by the app shows the loaded value:

## Key Vault Configuration Provider Sample

Secret	Name in Key Vault	Obtained from Configuration	Value
AppSecret	<b>5000-AppSecret</b>	<code>Configuration["AppSecret"]</code>	<code>5.0.0.0_secret_value</code>

4. Change the version of the app assembly in the project file from `5.0.0.0` to `5.1.0.0` and run the app again. This time, the secret value returned is `5.1.0.0_secret_value`. The webpage generated by the app shows the loaded value:

## Key Vault Configuration Provider Sample

Secret	Name in Key Vault	Obtained from Configuration	Value
AppSecret	<b>5100-AppSecret</b>	<code>Configuration["AppSecret"]</code>	<code>5.1.0.0_secret_value</code>

## Controlling access to the ClientSecret

Use the [Secret Manager tool](#) to maintain the `ClientSecret` outside of your project source tree. With Secret Manager, you associate app secrets with a specific project and share them across multiple projects.

When developing a .NET Framework app in an environment that supports certificates, you can authenticate to Azure Key Vault with an X.509 certificate. The X.509 certificate's private key is managed by the OS. For more information, see [Authenticate with a Certificate instead of a Client Secret](#). Use the `AddAzureKeyVault` overload that accepts an `X509Certificate2`.

```
var store = new X509Store(StoreLocation.CurrentUser);
store.Open(OpenFlags.ReadOnly);
var cert = store.Certificates.Find(X509FindType.FindByThumbprint, config["CertificateThumbprint"], false);

builder.AddAzureKeyVault(
    config["Vault"],
    config["ClientId"],
    cert.OfType<X509Certificate2>().Single(),
    new EnvironmentSecretManager(env.ApplicationName));
store.Close();

Configuration = builder.Build();
```

## Reloading secrets

Secrets are cached until `IConfigurationRoot.Reload()` is called. Expired, disabled, and updated secrets in the key vault are not respected by the application until `Reload` is executed.

```
Configuration.Reload();
```

## Disabled and expired secrets

Disabled and expired secrets throw a `KeyVaultClientException`. To prevent your app from throwing, replace your app or update the disabled/expired secret.

## Troubleshooting

When the application fails to load configuration using the provider, an error message is written to the [ASP.NET Logging infrastructure](#). The following conditions will prevent configuration from loading:

- The app isn't configured correctly in Azure Active Directory.
- The key vault doesn't exist in Azure Key Vault.
- The app isn't authorized to access the key vault.
- The access policy doesn't include `Get` and `List` permissions.
- In the key vault, the configuration data (name-value pair) is incorrectly named, missing, disabled, or expired.
- The app has the wrong key vault name (`vault`), Azure AD App Id (`clientId`), or Azure AD Key (`clientSecret`).
- The Azure AD Key (`clientSecret`) is expired.
- The configuration key (name) is incorrect in the app for the value you're trying to load.

## Additional resources

- [Configuration](#)

- [Microsoft Azure: Key Vault](#)
- [Microsoft Azure: Key Vault Documentation](#)
- [How to generate and transfer HSM-protected keys for Azure Key Vault](#)
- [KeyVaultClient Class](#)

# Prevent Cross-Site Request Forgery (XSRF/CSRF) attacks in ASP.NET Core

6/21/2018 • 13 minutes to read • [Edit Online](#)

By [Steve Smith](#), [Fiyaz Hasan](#), and [Rick Anderson](#)

Cross-site request forgery (also known as XSRF or CSRF, pronounced *see-surf*) is an attack against web-hosted apps whereby a malicious web app can influence the interaction between a client browser and a web app that trusts that browser. These attacks are possible because web browsers send some types of authentication tokens automatically with every request to a website. This form of exploit is also known as a *one-click attack* or *session riding* because the attack takes advantage of the user's previously authenticated session.

An example of a CSRF attack:

1. A user signs into `www.good-banking-site.com` using forms authentication. The server authenticates the user and issues a response that includes an authentication cookie. The site is vulnerable to attack because it trusts any request that it receives with a valid authentication cookie.
2. The user visits a malicious site, `www.bad-crook-site.com`.

The malicious site, `www.bad-crook-site.com`, contains an HTML form similar to the following:

```
<h1>Congratulations! You're a Winner!</h1>
<form action="http://good-banking-site.com/api/account" method="post">
    <input type="hidden" name="Transaction" value="withdraw">
    <input type="hidden" name="Amount" value="1000000">
    <input type="submit" value="Click to collect your prize!">
</form>
```

Notice that the form's `action` posts to the vulnerable site, not to the malicious site. This is the "cross-site" part of CSRF.

3. The user selects the submit button. The browser makes the request and automatically includes the authentication cookie for the requested domain, `www.good-banking-site.com`.
4. The request runs on the `www.good-banking-site.com` server with the user's authentication context and can perform any action that an authenticated user is allowed to perform.

In addition to the scenario where the user selects the button to submit the form, the malicious site could:

- Run a script that automatically submits the form.
- Send the form submission as an AJAX request.
- Hide the form using CSS.

These alternative scenarios don't require any action or input from the user other than initially visiting the malicious site.

Using HTTPS doesn't prevent a CSRF attack. The malicious site can send an

`https://www.good-banking-site.com/` request just as easily as it can send an insecure request.

Some attacks target endpoints that respond to GET requests, in which case an image tag can be used to perform the action. This form of attack is common on forum sites that permit images but block JavaScript.

Apps that change state on GET requests, where variables or resources are altered, are vulnerable to malicious attacks. **GET requests that change state are insecure. A best practice is to never change state on a GET request.**

CSRF attacks are possible against web apps that use cookies for authentication because:

- Browsers store cookies issued by a web app.
- Stored cookies include session cookies for authenticated users.
- Browsers send all of the cookies associated with a domain to the web app every request regardless of how the request to app was generated within the browser.

However, CSRF attacks aren't limited to exploiting cookies. For example, Basic and Digest authentication are also vulnerable. After a user signs in with Basic or Digest authentication, the browser automatically sends the credentials until the session<sup>†</sup> ends.

<sup>†</sup>In this context, *session* refers to the client-side session during which the user is authenticated. It's unrelated to server-side sessions or [ASP.NET Core Session Middleware](#).

Users can guard against CSRF vulnerabilities by taking precautions:

- Sign off of web apps when finished using them.
- Clear browser cookies periodically.

However, CSRF vulnerabilities are fundamentally a problem with the web app, not the end user.

## Authentication fundamentals

Cookie-based authentication is a popular form of authentication. Token-based authentication systems are growing in popularity, especially for Single Page Applications (SPAs).

### Cookie-based authentication

When a user authenticates using their username and password, they're issued a token, containing an authentication ticket that can be used for authentication and authorization. The token is stored as a cookie that accompanies every request the client makes. Generating and validating this cookie is performed by the Cookie Authentication Middleware. The [middleware](#) serializes a user principal into an encrypted cookie. On subsequent requests, the middleware validates the cookie, recreates the principal, and assigns the principal to the [User](#) property of [HttpContext](#).

### Token-based authentication

When a user is authenticated, they're issued a token (not an antiforgery token). The token contains user information in the form of [claims](#) or a reference token that points the app to user state maintained in the app. When a user attempts to access a resource requiring authentication, the token is sent to the app with an additional authorization header in form of Bearer token. This makes the app stateless. In each subsequent request, the token is passed in the request for server-side validation. This token isn't *encrypted*; it's *encoded*. On the server, the token is decoded to access its information. To send the token on subsequent requests, store the token in the browser's local storage. Don't be concerned about CSRF vulnerability if the token is stored in the browser's local storage. CSRF is a concern when the token is stored in a cookie.

### Multiple apps hosted at one domain

Shared hosting environments are vulnerable to session hijacking, login CSRF, and other attacks.

Although `example1.contoso.net` and `example2.contoso.net` are different hosts, there's an implicit trust relationship between hosts under the `*.contoso.net` domain. This implicit trust relationship allows potentially untrusted hosts to affect each other's cookies (the same-origin policies that govern AJAX requests don't necessarily apply to HTTP cookies).

Attacks that exploit trusted cookies between apps hosted on the same domain can be prevented by not sharing domains. When each app is hosted on its own domain, there is no implicit cookie trust relationship to exploit.

## ASP.NET Core antiforgery configuration

### WARNING

ASP.NET Core implements antiforgery using [ASP.NET Core Data Protection](#). The data protection stack must be configured to work in a server farm. See [Configuring data protection](#) for more information.

In ASP.NET Core 2.0 or later, the [FormTagHelper](#) injects antiforgery tokens into HTML form elements. The following markup in a Razor file automatically generates antiforgery tokens:

```
<form method="post">
  ...
</form>
```

Similarly, [IHtmlHelper.BeginForm](#) generates antiforgery tokens by default if the form's method isn't GET.

The automatic generation of antiforgery tokens for HTML form elements happens when the `<form>` tag contains the `method="post"` attribute and either of the following are true:

- The action attribute is empty (`action=""`).
- The action attribute isn't supplied (`<form method="post">`).

Automatic generation of antiforgery tokens for HTML form elements can be disabled:

- Explicitly disable antiforgery tokens with the `asp-antiforgery` attribute:

```
<form method="post" asp-antiforgery="false">
  ...
</form>
```

- The form element is opted-out of Tag Helpers by using the Tag Helper [! opt-out symbol](#):

```
<!form method="post">
  ...
</!form>
```

- Remove the `FormTagHelper` from the view. The `FormTagHelper` can be removed from a view by adding the following directive to the Razor view:

```
@removeTagHelper Microsoft.AspNetCore.Mvc.TagHelpers.FormTagHelper,
Microsoft.AspNetCore.Mvc.TagHelpers
```

### NOTE

[Razor Pages](#) are automatically protected from XSRF/CSRF. For more information, see [XSRF/CSRF and Razor Pages](#).

The most common approach to defending against CSRF attacks is to use the [Synchronizer Token Pattern](#) (STP). STP is used when the user requests a page with form data:

1. The server sends a token associated with the current user's identity to the client.
2. The client sends back the token to the server for verification.
3. If the server receives a token that doesn't match the authenticated user's identity, the request is rejected.

The token is unique and unpredictable. The token can also be used to ensure proper sequencing of a series of requests (for example, ensuring the request sequence of: page 1 – page 2 – page 3). All of the forms in ASP.NET Core MVC and Razor Pages templates generate antiforgery tokens. The following pair of view examples generate antiforgery tokens:

```
<form asp-controller="Manage" asp-action="ChangePassword" method="post">
    ...
</form>

@using (Html.BeginForm("ChangePassword", "Manage"))
{
    ...
}
```

Explicitly add an antiforgery token to a `<form>` element without using Tag Helpers with the HTML helper `@Html.AntiForgeryToken`:

```
<form action="/" method="post">
    @Html.AntiForgeryToken()
</form>
```

In each of the preceding cases, ASP.NET Core adds a hidden form field similar to the following:

```
<input name="__RequestVerificationToken" type="hidden" value="CfDJ8NrAks ... s2-m9Yw">
```

ASP.NET Core includes three [filters](#) for working with antiforgery tokens:

- [ValidateAntiForgeryToken](#)
- [AutoValidateAntiforgeryToken](#)
- [IgnoreAntiforgeryToken](#)

## Antiforgery options

Customize [antiforgery options](#) in `Startup.ConfigureServices` :

```
services.AddAntiforgery(options =>
{
    options.CookieDomain = "contoso.com";
    options.CookieName = "X-CSRF-TOKEN-COOKIENAME";
    options.CookiePath = "Path";
    options.FormFieldName = "AntiforgeryFieldname";
    options.HeaderName = "X-CSRF-TOKEN-HEADERNAME";
    options.RequireSsl = false;
    options.SuppressXFrameOptionsHeader = false;
});
```

OPTION	DESCRIPTION
<a href="#">Cookie</a>	Determines the settings used to create the antiforgery cookies.

OPTION	DESCRIPTION
CookieDomain	The domain of the cookie. Defaults to <code>null</code> . This property is obsolete and will be removed in a future version. The recommended alternative is <code>Cookie.Domain</code> .
CookieName	The name of the cookie. If not set, the system generates a unique name beginning with the <code>DefaultCookiePrefix</code> (". <code>AspNetCore.Antiforgery</code> "). This property is obsolete and will be removed in a future version. The recommended alternative is <code>Cookie.Name</code> .
CookiePath	The path set on the cookie. This property is obsolete and will be removed in a future version. The recommended alternative is <code>Cookie.Path</code> .
FormFieldName	The name of the hidden form field used by the antiforgery system to render antiforgery tokens in views.
HeaderName	The name of the header used by the antiforgery system. If <code>null</code> , the system considers only form data.
RequireSsl	Specifies whether SSL is required by the antiforgery system. If <code>true</code> , non-SSL requests fail. Defaults to <code>false</code> . This property is obsolete and will be removed in a future version. The recommended alternative is to set <code>Cookie.SecurePolicy</code> .
SuppressXFrameOptionsHeader	Specifies whether to suppress generation of the <code>X-Frame-Options</code> header. By default, the header is generated with a value of "SAMEORIGIN". Defaults to <code>false</code> .

For more information, see [CookieAuthenticationOptions](#).

## Configure antiforgery features with `IAntiforgery`

`IAntiforgery` provides the API to configure antiforgery features. `IAntiforgery` can be requested in the `Configure` method of the `Startup` class. The following example uses middleware from the app's home page to generate an antiforgery token and send it in the response as a cookie (using the default Angular naming convention described later in this topic):

```

public void Configure(IApplicationBuilder app, IAntiforgery antiforgery)
{
    app.Use(next => context =>
    {
        string path = context.Request.Path.Value;

        if (
            string.Equals(path, "/", StringComparison.OrdinalIgnoreCase) ||
            string.Equals(path, "/index.html", StringComparison.OrdinalIgnoreCase))
        {
            // The request token can be sent as a JavaScript-readable cookie,
            // and Angular uses it by default.
            var tokens = antiforgery.GetAndStoreTokens(context);
            context.Response.Cookies.Append("XSRF-TOKEN", tokens.RequestToken,
                new CookieOptions() { HttpOnly = false });
        }

        return next(context);
    });
}

```

## Require antiforgery validation

[ValidateAntiForgeryToken](#) is an action filter that can be applied to an individual action, a controller, or globally. Requests made to actions that have this filter applied are blocked unless the request includes a valid antiforgery token.

```

[HttpPost]
[ValidateAntiForgeryToken]
public async Task<IActionResult> RemoveLogin(RemoveLoginViewModel account)
{
    ManageMessageId? message = ManageMessageId.Error;
    var user = await GetCurrentUserAsync();

    if (user != null)
    {
        var result =
            await _userManager.RemoveLoginAsync(
                user, account.LoginProvider, account.ProviderKey);

        if (result.Succeeded)
        {
            await _signInManager.SignInAsync(user, isPersistent: false);
            message = ManageMessageId.RemoveLoginSuccess;
        }
    }

    return RedirectToAction(nameof(ManageLogins), new { Message = message });
}

```

The `[ValidateAntiForgeryToken]` attribute requires a token for requests to the action methods it decorates, including HTTP GET requests. If the `[ValidateAntiForgeryToken]` attribute is applied across the app's controllers, it can be overridden with the `[IgnoreAntiforgeryToken]` attribute.

### NOTE

ASP.NET Core doesn't support adding antiforgery tokens to GET requests automatically.

## Automatically validate antiforgery tokens for unsafe HTTP methods only

ASP.NET Core apps don't generate antiforgery tokens for safe HTTP methods (GET, HEAD, OPTIONS,

and TRACE). Instead of broadly applying the `ValidateAntiForgeryToken` attribute and then overriding it with `IgnoreAntiForgeryToken` attributes, the `AutoValidateAntiforgeryToken` attribute can be used. This attribute works identically to the `ValidateAntiForgeryToken` attribute, except that it doesn't require tokens for requests made using the following HTTP methods:

- GET
- HEAD
- OPTIONS
- TRACE

We recommend use of `AutoValidateAntiforgeryToken` broadly for non-API scenarios. This ensures POST actions are protected by default. The alternative is to ignore antiforgery tokens by default, unless `ValidateAntiForgeryToken` is applied to individual action methods. It's more likely in this scenario for a POST action method to be left unprotected by mistake, leaving the app vulnerable to CSRF attacks. All POSTs should send the antiforgery token.

APIs don't have an automatic mechanism for sending the non-cookie part of the token. The implementation probably depends on the client code implementation. Some examples are shown below:

Class-level example:

```
[Authorize]
[AutoValidateAntiforgeryToken]
public class ManageController : Controller
{
```

Global example:

```
services.AddMvc(options =>
    options.Filters.Add(new AutoValidateAntiforgeryTokenAttribute()));
```

### Override global or controller antiforgery attributes

The `IgnoreAntiforgeryToken` filter is used to eliminate the need for an antiforgery token for a given action (or controller). When applied, this filter overrides `ValidateAntiForgeryToken` and `AutoValidateAntiforgeryToken` filters specified at a higher level (globally or on a controller).

```
[Authorize]
[AutoValidateAntiforgeryToken]
public class ManageController : Controller
{
    [HttpPost]
    [IgnoreAntiforgeryToken]
    public async Task<IActionResult> DoSomethingSafe(SomeViewModel model)
    {
        // no antiforgery token required
    }
}
```

## Refresh tokens after authentication

Tokens should be refreshed after the user is authenticated by redirecting the user to a view or Razor Pages page.

## JavaScript, AJAX, and SPAs

In traditional HTML-based apps, antiforgery tokens are passed to the server using hidden form fields. In modern JavaScript-based apps and SPAs, many requests are made programmatically. These AJAX requests may use other techniques (such as request headers or cookies) to send the token.

If cookies are used to store authentication tokens and to authenticate API requests on the server, CSRF is a potential problem. If local storage is used to store the token, CSRF vulnerability might be mitigated because values from local storage aren't sent automatically to the server with every request. Thus, using local storage to store the antiforgery token on the client and sending the token as a request header is a recommended approach.

## JavaScript

Using JavaScript with views, the token can be created using a service from within the view. Inject the `Microsoft.AspNetCore.Antiforgery.IAntiforgery` service into the view and call `GetAndStoreTokens`:

```
@{
    ViewData["Title"] = "AJAX Demo";
}
@inject Microsoft.AspNetCore.Antiforgery.IAntiforgery Xsrf
@functions{
    public string GetAntiXsrfRequestToken()
    {
        return Xsrf.GetAndStoreTokens(Context).RequestToken;
    }
}

<input type="hidden" id="RequestVerificationToken"
       name="RequestVerificationToken" value="@GetAntiXsrfRequestToken()">

<h2>@ViewData["Title"].</h2>
<h3>@ViewData["Message"]</h3>

<div class="row">
    <p><input type="button" id="antiforgery" value="Antiforgery"></p>
    <script>
        var xhttp = new XMLHttpRequest();
        xhttp.onreadystatechange = function() {
            if (xhttp.readyState == XMLHttpRequest.DONE) {
                if (xhttp.status == 200) {
                    alert(xhttp.responseText);
                } else {
                    alert('There was an error processing the AJAX request.');
                }
            }
        };
        document.addEventListener('DOMContentLoaded', function() {
            document.getElementById("antiforgery").onclick = function () {
                xhttp.open('POST', '@Url.Action("Antiforgery", "Home")', true);
                xhttp.setRequestHeader("RequestVerificationToken",
                    document.getElementById('RequestVerificationToken').value);
                xhttp.send();
            }
        });
    </script>
</div>
```

This approach eliminates the need to deal directly with setting cookies from the server or reading them from the client.

The preceding example uses JavaScript to read the hidden field value for the AJAX POST header.

JavaScript can also access tokens in cookies and use the cookie's contents to create a header with the token's value.

```
context.Response.Cookies.Append("CSRF-TOKEN", tokens.RequestToken,  
    new Microsoft.AspNetCore.Http.CookieOptions { HttpOnly = false });
```

Assuming the script requests to send the token in a header called `X-CSRF-TOKEN`, configure the antiforgery service to look for the `X-CSRF-TOKEN` header:

```
services.AddAntiforgery(options => options.HeaderName = "X-CSRF-TOKEN");
```

The following example uses JavaScript to make an AJAX request with the appropriate header:

```
function getCookie cname) {  
    var name = cname + "=";  
    var decodedCookie = decodeURIComponent(document.cookie);  
    var ca = decodedCookie.split('');  
    for(var i = 0; i < ca.length; i++) {  
        var c = ca[i];  
        while (c.charAt(0) == ' ') {  
            c = c.substring(1);  
        }  
        if (c.indexOf(name) == 0) {  
            return c.substring(name.length, c.length);  
        }  
    }  
    return "";  
}  
  
var csrfToken = getCookie("CSRF-TOKEN");  
  
var xhttp = new XMLHttpRequest();  
xhttp.onreadystatechange = function() {  
    if (xhttp.readyState == XMLHttpRequest.DONE) {  
        if (xhttp.status == 200) {  
            alert(xhttp.responseText);  
        } else {  
            alert('There was an error processing the AJAX request.');  
        }  
    }  
};  
xhttp.open('POST', '/api/password/changepassword', true);  
xhttp.setRequestHeader("Content-type", "application/json");  
xhttp.setRequestHeader("X-CSRF-TOKEN", csrfToken);  
xhttp.send(JSON.stringify({ "newPassword": "ReallySecurePassword999$$$$" }));
```

## AngularJS

AngularJS uses a convention to address CSRF. If the server sends a cookie with the name `XSRF-TOKEN`, the AngularJS `$http` service adds the cookie value to a header when it sends a request to the server. This process is automatic. The header doesn't need to be set explicitly. The header name is `X-XSRF-TOKEN`. The server should detect this header and validate its contents.

For ASP.NET Core API work with this convention:

- Configure your app to provide a token in a cookie called `XSRF-TOKEN`.
- Configure the antiforgery service to look for a header named `X-XSRF-TOKEN`.

```
services.AddAntiforgery(options => options.HeaderName = "X-XSRF-TOKEN");
```

[View or download sample code \(how to download\)](#)

## Extend antiforgery

The [IAntiForgeryAdditionalDataProvider](#) type allows developers to extend the behavior of the anti-CSRF system by round-tripping additional data in each token. The [GetAdditionalData](#) method is called each time a field token is generated, and the return value is embedded within the generated token. An implementer could return a timestamp, a nonce, or any other value and then call [ValidateAdditionalData](#) to validate this data when the token is validated. The client's username is already embedded in the generated tokens, so there's no need to include this information. If a token includes supplemental data but no [IAntiForgeryAdditionalDataProvider](#) is configured, the supplemental data isn't validated.

## Additional resources

- [CSRF](#) on [Open Web Application Security Project](#) (OWASP).

# Prevent open redirect attacks in ASP.NET Core

6/21/2018 • 3 minutes to read • [Edit Online](#)

A web app that redirects to a URL that's specified via the request such as the querystring or form data can potentially be tampered with to redirect users to an external, malicious URL. This tampering is called an open redirection attack.

Whenever your application logic redirects to a specified URL, you must verify that the redirection URL hasn't been tampered with. ASP.NET Core has built-in functionality to help protect apps from open redirect (also known as open redirection) attacks.

## What is an open redirect attack?

Web applications frequently redirect users to a login page when they access resources that require authentication. The redirection typically includes a `returnUrl` querystring parameter so that the user can be returned to the originally requested URL after they have successfully logged in. After the user authenticates, they're redirected to the URL they had originally requested.

Because the destination URL is specified in the querystring of the request, a malicious user could tamper with the querystring. A tampered querystring could allow the site to redirect the user to an external, malicious site. This technique is called an open redirect (or redirection) attack.

### An example attack

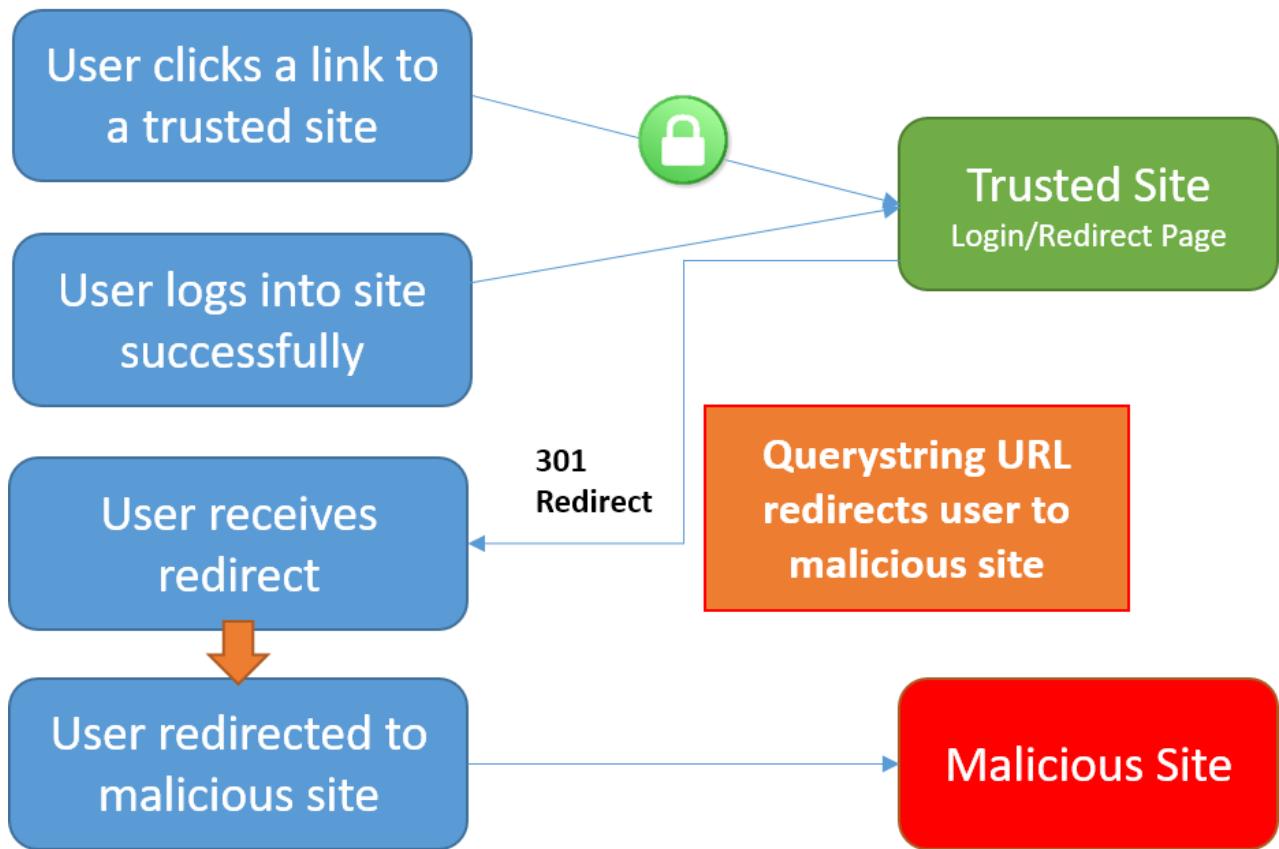
A malicious user could develop an attack intended to allow the malicious user access to a user's credentials or sensitive information on your app. To begin the attack, they convince the user to click a link to your site's login page, with a `returnUrl` querystring value added to the URL. For example, the [NerdDinner.com](#) sample application (written for ASP.NET MVC) includes such a login page here:

`http://nerddinner.com/Account/LogOn?returnUrl=/Home/About`. The attack then follows these steps:

1. User clicks a link to `http://nerddinner.com/Account/LogOn?returnUrl=http://nerddiner.com/Account/LogOn` (note, second URL is `nerddiner`, not `nerddinnner`).
2. The user logs in successfully.
3. The user is redirected (by the site) to `http://nerddiner.com/Account/LogOn` (malicious site that looks like real site).
4. The user logs in again (giving malicious site their credentials) and is redirected back to the real site.

The user will likely believe their first attempt to log in failed, and their second one was successful. They will most likely remain unaware their credentials have been compromised.

# Open Redirection Attack Process



In addition to login pages, some sites provide redirect pages or endpoints. Imagine your app has a page with an open redirect, `/Home/Redirect`. An attacker could create, for example, a link in an email that goes to `[yoursite]/Home/Redirect?url=http://phishingsite.com/Home/Login`. A typical user will look at the URL and see it begins with your site name. Trusting that, they will click the link. The open redirect would then send the user to the phishing site, which looks identical to yours, and the user would likely login to what they believe is your site.

## Protecting against open redirect attacks

When developing web applications, treat all user-provided data as untrustworthy. If your application has functionality that redirects the user based on the contents of the URL, ensure that such redirects are only done locally within your app (or to a known URL, not any URL that may be supplied in the querystring).

### LocalRedirect

Use the `LocalRedirect` helper method from the base `Controller` class:

```
public IActionResult SomeAction(string redirectUrl)
{
    return LocalRedirect(redirectUrl);
}
```

`LocalRedirect` will throw an exception if a non-local URL is specified. Otherwise, it behaves just like the `Redirect` method.

### IsLocalUrl

Use the `IsLocalUrl` method to test URLs before redirecting:

The following example shows how to check whether a URL is local before redirecting.

```
private IActionResult RedirectToLocal(string returnUrl)
{
    if (Url.IsLocalUrl(returnUrl))
    {
        return Redirect(returnUrl);
    }
    else
    {
        return RedirectToAction(nameof(HomeController.Index), "Home");
    }
}
```

The `IsLocalUrl` method protects users from being inadvertently redirected to a malicious site. You can log the details of the URL that was provided when a non-local URL is supplied in a situation where you expected a local URL. Logging redirect URLs may help in diagnosing redirection attacks.

# Prevent Cross-Site Scripting (XSS) in ASP.NET Core

6/21/2018 • 6 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

Cross-Site Scripting (XSS) is a security vulnerability which enables an attacker to place client side scripts (usually JavaScript) into web pages. When other users load affected pages the attackers scripts will run, enabling the attacker to steal cookies and session tokens, change the contents of the web page through DOM manipulation or redirect the browser to another page. XSS vulnerabilities generally occur when an application takes user input and outputs it in a page without validating, encoding or escaping it.

## Protecting your application against XSS

At a basic level XSS works by tricking your application into inserting a `<script>` tag into your rendered page, or by inserting an `on*` event into an element. Developers should use the following prevention steps to avoid introducing XSS into their application.

1. Never put untrusted data into your HTML input, unless you follow the rest of the steps below. Untrusted data is any data that may be controlled by an attacker, HTML form inputs, query strings, HTTP headers, even data sourced from a database as an attacker may be able to breach your database even if they cannot breach your application.
2. Before putting untrusted data inside an HTML element ensure it's HTML encoded. HTML encoding takes characters such as < and changes them into a safe form like &lt;
3. Before putting untrusted data into an HTML attribute ensure it's HTML attribute encoded. HTML attribute encoding is a superset of HTML encoding and encodes additional characters such as " and '.
4. Before putting untrusted data into JavaScript place the data in an HTML element whose contents you retrieve at runtime. If this isn't possible then ensure the data is JavaScript encoded. JavaScript encoding takes dangerous characters for JavaScript and replaces them with their hex, for example < would be encoded as `\u003C`.
5. Before putting untrusted data into a URL query string ensure it's URL encoded.

## HTML Encoding using Razor

The Razor engine used in MVC automatically encodes all output sourced from variables, unless you work really hard to prevent it doing so. It uses HTML Attribute encoding rules whenever you use the @ directive. As HTML attribute encoding is a superset of HTML encoding this means you don't have to concern yourself with whether you should use HTML encoding or HTML attribute encoding. You must ensure that you only use @ in an HTML context, not when attempting to insert untrusted input directly into JavaScript. Tag helpers will also encode input you use in tag parameters.

Take the following Razor view:

```
@{  
    var untrustedInput = "<\\"123\\">";  
}  
  
@untrustedInput
```

This view outputs the contents of the `untrustedInput` variable. This variable includes some characters which are used in XSS attacks, namely <, " and >. Examining the source shows the rendered output encoded as:

```
&lt;&quot;123&quot;&gt;
```

### WARNING

ASP.NET Core MVC provides an `HtmlString` class which isn't automatically encoded upon output. This should never be used in combination with untrusted input as this will expose an XSS vulnerability.

## Javascript Encoding using Razor

There may be times you want to insert a value into JavaScript to process in your view. There are two ways to do this. The safest way to insert values is to place the value in a data attribute of a tag and retrieve it in your JavaScript. For example:

```
@{
    var untrustedInput = "<\\"123\\>";
}

<div
    id="injectedData"
    data-untrustedinput="@untrustedInput" />

<script>
    var injectedData = document.getElementById("injectedData");

    // All clients
    var clientSideUntrustedInputOldStyle =
        injectedData.getAttribute("data-untrustedinput");

    // HTML 5 clients only
    var clientSideUntrustedInputHtml5 =
        injectedData.dataset.untrustedinput;

    document.write(clientSideUntrustedInputOldStyle);
    document.write("<br />")
    document.write(clientSideUntrustedInputHtml5);
</script>
```

This will produce the following HTML

```
<div
    id="injectedData"
    data-untrustedinput="&lt;&quot;123&quot;&gt;" />

<script>
    var injectedData = document.getElementById("injectedData");

    var clientSideUntrustedInputOldStyle =
        injectedData.getAttribute("data-untrustedinput");

    var clientSideUntrustedInputHtml5 =
        injectedData.dataset.untrustedinput;

    document.write(clientSideUntrustedInputOldStyle);
    document.write("<br />")
    document.write(clientSideUntrustedInputHtml5);
</script>
```

Which, when it runs, will render the following;

```
<"123">
<"123">
```

You can also call the JavaScript encoder directly,

```
@using System.Text.Encodings.Web;
@inject JavaScriptEncoder encoder;

@{
    var untrustedInput = "<\\"123\\>";
}

<script>
    document.write("@encoder.Encode(untrustedInput)");
</script>
```

This will render in the browser as follows;

```
<script>
    document.write("\u003C\u0022123\u0022\u003E");
</script>
```

### WARNING

Don't concatenate untrusted input in JavaScript to create DOM elements. You should use `createElement()` and assign property values appropriately such as `node.textContent=`, or use `element.setAttribute() / element[attribute]=` otherwise you expose yourself to DOM-based XSS.

## Accessing encoders in code

The HTML, JavaScript and URL encoders are available to your code in two ways, you can inject them via [dependency injection](#) or you can use the default encoders contained in the `System.Text.Encodings.Web` namespace. If you use the default encoders then any you applied to character ranges to be treated as safe won't take effect - the default encoders use the safest encoding rules possible.

To use the configurable encoders via DI your constructors should take an `HtmlEncoder`, `JavaScriptEncoder` and `UrlEncoder` parameter as appropriate. For example;

```
public class HomeController : Controller
{
    HtmlEncoder _htmlEncoder;
    JavaScriptEncoder _javaScriptEncoder;
    UrlEncoder _urlEncoder;

    public HomeController(HtmlEncoder htmlEncoder,
                          JavaScriptEncoder javascriptEncoder,
                          UrlEncoder urlEncoder)
    {
        _htmlEncoder = htmlEncoder;
        _javaScriptEncoder = javascriptEncoder;
        _urlEncoder = urlEncoder;
    }
}
```

# Encoding URL Parameters

If you want to build a URL query string with untrusted input as a value use the `UrlEncoder` to encode the value.

For example,

```
var example = "\"Quoted Value with spaces and &\"";  
var encodedValue = _urlEncoder.Encode(example);
```

After encoding the `encodedValue` variable will contain `%22quoted%20value%20with%20spaces%20and%20%26%22`. Spaces, quotes, punctuation and other unsafe characters will be percent encoded to their hexadecimal value, for example a space character will become `%20`.

**WARNING**

Don't use untrusted input as part of a URL path. Always pass untrusted input as a query string value.

# Customizing the Encoders

By default encoders use a safe list limited to the Basic Latin Unicode range and encode all characters outside of that range as their character code equivalents. This behavior also affects Razor TagHelper and HtmlHelper rendering as it will use the encoders to output your strings.

The reasoning behind this is to protect against unknown or future browser bugs (previous browser bugs have tripped up parsing based on the processing of non-English characters). If your web site makes heavy use of non-Latin characters, such as Chinese, Cyrillic or others this is probably not the behavior you want.

You can customize the encoder safe lists to include Unicode ranges appropriate to your application during startup, in `ConfigureServices()`.

For example, using the default configuration you might use a Razor HtmlHelper like so;

```
<p>This link text is in Chinese: @Html.ActionLink("汉语/漢語", "Index")</p>
```

When you view the source of the web page you will see it has been rendered as follows, with the Chinese text encoded:

<p>This link text is in Chinese: <a href="/">&#xC49;&#x8BED;/&#xF22;&#xA9E;</a></p>

To widen the characters treated as safe by the encoder you would insert the following line into the `ConfigureServices()` method in `startup.cs`:

```
services.AddSingleton<HtmlEncoder>(  
    HtmlEncoder.Create(allowedRanges: new[] { UnicodeRanges.BasicLatin,  
                                            UnicodeRanges.CjkUnifiedIdeographs }));
```

This example widens the safe list to include the Unicode Range CjkUnifiedIdeographs. The rendered output would now become

<p>This link text is in Chinese: <a href="/">汉语/漢語</a></p>

Safe list ranges are specified as Unicode code charts, not languages. The [Unicode standard](#) has a list of [code charts](#) you can use to find the chart containing your characters. Each encoder, Html, JavaScript and Url, must be

configured separately.

**NOTE**

Customization of the safe list only affects encoders sourced via DI. If you directly access an encoder via `System.Text.Encodings.Web.*Encoder.Default` then the default, Basic Latin only safelist will be used.

## Where should encoding take place?

The general accepted practice is that encoding takes place at the point of output and encoded values should never be stored in a database. Encoding at the point of output allows you to change the use of data, for example, from HTML to a query string value. It also enables you to easily search your data without having to encode values before searching and allows you to take advantage of any changes or bug fixes made to encoders.

## Validation as an XSS prevention technique

Validation can be a useful tool in limiting XSS attacks. For example, a numeric string containing only the characters 0-9 won't trigger an XSS attack. Validation becomes more complicated should you wish to accept HTML in user input - parsing HTML input is difficult, if not impossible. MarkDown and other text formats would be a safer option for rich input. You should never rely on validation alone. Always encode untrusted input before output, no matter what validation you have performed.

# Enable Cross-Origin Requests (CORS) in ASP.NET Core

6/21/2018 • 9 minutes to read • [Edit Online](#)

By [Mike Wasson](#), [Shayne Boyer](#), and [Tom Dykstra](#)

Browser security prevents a web page from making AJAX requests to another domain. This restriction is called the *same-origin policy*, and prevents a malicious site from reading sensitive data from another site. However, sometimes you might want to let other sites make cross-origin requests to your web API.

[Cross Origin Resource Sharing](#) (CORS) is a W3C standard that allows a server to relax the same-origin policy. Using CORS, a server can explicitly allow some cross-origin requests while rejecting others. CORS is safer and more flexible than earlier techniques such as [JSONP](#). This topic shows how to enable CORS in an ASP.NET Core application.

## What is "same origin"?

Two URLs have the same origin if they have identical schemes, hosts, and ports. ([RFC 6454](#))

These two URLs have the same origin:

- `http://example.com/foo.html`
- `http://example.com/bar.html`

These URLs have different origins than the previous two:

- `http://example.net` - Different domain
- `http://www.example.com/foo.html` - Different subdomain
- `https://example.com/foo.html` - Different scheme
- `http://example.com:9000/foo.html` - Different port

### NOTE

Internet Explorer doesn't consider the port when comparing origins.

## Setting up CORS

To set up CORS for your application add the `Microsoft.AspNetCore.Cors` package to your project.

Add the CORS services in `Startup.cs`:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddCors();
}
```

## Enabling CORS with middleware

To enable CORS for your entire application add the CORS middleware to your request pipeline using the `UseCors` extension method. Note that the CORS middleware must precede any defined endpoints in your app that you want to support cross-origin requests (ex. before any call to `UseMvc`).

You can specify a cross-origin policy when adding the CORS middleware using the `CorsPolicyBuilder` class. There are two ways to do this. The first is to call `UseCors` with a lambda:

```
public void Configure(IApplicationBuilder app, IHostingEnvironment env, ILoggerFactory loggerFactory)
{
    loggerFactory.AddConsole();

    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
    }

    // Shows UseCors with CorsPolicyBuilder.
    app.UseCors(builder =>
        builder.WithOrigins("http://example.com"));

    app.Run(async (context) =>
    {
        await context.Response.WriteAsync("Hello World!");
    });
}
```

**Note:** The URL must be specified without a trailing slash (`/`). If the URL terminates with `/`, the comparison will return `false` and no header will be returned.

The lambda takes a `CorsPolicyBuilder` object. You'll find a list of the [configuration options](#) later in this topic. In this example, the policy allows cross-origin requests from `http://example.com` and no other origins.

Note that `CorsPolicyBuilder` has a fluent API, so you can chain method calls:

```
app.UseCors(builder =>
    builder.WithOrigins("http://example.com")
        .AllowAnyHeader()
    );
```

The second approach is to define one or more named CORS policies, and then select the policy by name at run time.

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddCors(options =>
    {
        options.AddPolicy("AllowSpecificOrigin",
            builder => builder.WithOrigins("http://example.com"));
    });
}

public void Configure(IApplicationBuilder app, IHostingEnvironment env, ILoggerFactory loggerFactory)
{
    loggerFactory.AddConsole();

    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
    }

    // Shows UseCors with named policy.
    app.UseCors("AllowSpecificOrigin");
    app.Run(async (context) =>
    {
        await context.Response.WriteAsync("Hello World!");
    });
}

```

This example adds a CORS policy named "AllowSpecificOrigin". To select the policy, pass the name to `UseCors`.

## Enabling CORS in MVC

You can alternatively use MVC to apply specific CORS per action, per controller, or globally for all controllers. When using MVC to enable CORS the same CORS services are used, but the CORS middleware isn't.

### Per action

To specify a CORS policy for a specific action add the `[EnableCors]` attribute to the action. Specify the policy name.

```

[HttpGet]
[EnableCors("AllowSpecificOrigin")]
public IEnumerable<string> Get()
{
    return new string[] { "value1", "value2" };
}

```

### Per controller

To specify the CORS policy for a specific controller add the `[EnableCors]` attribute to the controller class. Specify the policy name.

```

[Route("api/[controller]")]
[EnableCors("AllowSpecificOrigin")]
public class ValuesController : Controller

```

### Globally

You can enable CORS globally for all controllers by adding the `CorsAuthorizationFilterFactory` filter to the global filter collection:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc();
    services.Configure<MvcOptions>(options =>
    {
        options.Filters.Add(new CorsAuthorizationFilterFactory("AllowSpecificOrigin"));
    });
}
```

The precedence order is: Action, controller, global. Action-level policies take precedence over controller-level policies, and controller-level policies take precedence over global policies.

## Disable CORS

To disable CORS for a controller or action, use the `[DisableCors]` attribute.

```
[HttpGet("{id}")]
[DisableCors]
public string Get(int id)
{
    return "value";
}
```

## CORS policy options

This section describes the various options that you can set in a CORS policy.

- [Set the allowed origins](#)
- [Set the allowed HTTP methods](#)
- [Set the allowed request headers](#)
- [Set the exposed response headers](#)
- [Credentials in cross-origin requests](#)
- [Set the preflight expiration time](#)

For some options it may be helpful to read [How CORS works](#) first.

### Set the allowed origins

To allow one or more specific origins:

```
options.AddPolicy("AllowSpecificOrigins",
builder =>
{
    builder.WithOrigins("http://example.com", "http://www.contoso.com");
});
```

To allow all origins:

```
using System;
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.AspNetCore.Http;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;

namespace CorsExample4
```

```
{  
    public class Startup  
    {  
        // This method gets called by the runtime. Use this method to add services to the container.  
        // For more information on how to configure your application, visit http://go.microsoft.com/fwlink/?  
LinkID=398940  
        public void ConfigureServices(IServiceCollection services)  
        {  
            services.AddCors(options =>  
            {  
                // BEGIN01  
                options.AddPolicy("AllowSpecificOrigins",  
                    builder =>  
                {  
                    builder.WithOrigins("http://example.com", "http://www.contoso.com");  
                });  
                // END01  
  
                // BEGIN02  
                options.AddPolicy("AllowAllOrigins",  
                    builder =>  
                {  
                    builder.AllowAnyOrigin();  
                });  
                // END02  
  
                // BEGIN03  
                options.AddPolicy("AllowSpecificMethods",  
                    builder =>  
                {  
                    builder.WithOrigins("http://example.com")  
                        .WithMethods("GET", "POST", "HEAD");  
                });  
                // END03  
  
                // BEGIN04  
                options.AddPolicy("AllowAllMethods",  
                    builder =>  
                {  
                    builder.WithOrigins("http://example.com")  
                        .AllowAnyMethod();  
                });  
                // END04  
  
                // BEGIN05  
                options.AddPolicy("AllowHeaders",  
                    builder =>  
                {  
                    builder.WithOrigins("http://example.com")  
                        .WithHeaders("accept", "content-type", "origin", "x-custom-header");  
                });  
                // END05  
  
                // BEGIN06  
                options.AddPolicy("AllowAllHeaders",  
                    builder =>  
                {  
                    builder.WithOrigins("http://example.com")  
                        .AllowAnyHeader();  
                });  
                // END06  
  
                // BEGIN07  
                options.AddPolicy("ExposeResponseHeaders",  
                    builder =>  
                {  
                    builder.WithOrigins("http://example.com")  
                        .WithExposedHeaders("x-custom-header");  
                });  
            };  
        }  
    }  
}
```

```

        // END07

        // BEGIN08
        options.AddPolicy("AllowCredentials",
            builder =>
        {
            builder.WithOrigins("http://example.com")
                .AllowCredentials();
        });
        // END08

        // BEGIN09
        options.AddPolicy("SetPreflightExpiration",
            builder =>
        {
            builder.WithOrigins("http://example.com")
                .SetPreflightMaxAge(TimeSpan.FromSeconds(2520));
        });
        // END09
    });
}

// This method gets called by the runtime. Use this method to configure the HTTP request pipeline.
public void Configure(IApplicationBuilder app, IHostingEnvironment env, ILoggerFactory
loggerFactory)
{
    loggerFactory.AddConsole();

    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
    }

    app.UseCors("AllowSpecificOrigins");
    app.Run(async (context) =>
    {
        await context.Response.WriteAsync("Hello World!");
    });
}
}
}

```

Consider carefully before allowing requests from any origin. It means that literally any website can make AJAX calls to your API.

## Set the allowed HTTP methods

To allow all HTTP methods:

```

options.AddPolicy("AllowAllMethods",
    builder =>
{
    builder.WithOrigins("http://example.com")
        .AllowAnyMethod();
});

```

This affects pre-flight requests and Access-Control-Allow-Methods header.

## Set the allowed request headers

A CORS preflight request might include an Access-Control-Request-Headers header, listing the HTTP headers set by the application (the so-called "author request headers").

To whitelist specific headers:

```
options.AddPolicy("AllowHeaders",
    builder =>
{
    builder.WithOrigins("http://example.com")
        .WithHeaders("accept", "content-type", "origin", "x-custom-header");
});
```

To allow all author request headers:

```
options.AddPolicy("AllowAllHeaders",
    builder =>
{
    builder.WithOrigins("http://example.com")
        .AllowAnyHeader();
});
```

Browsers are not entirely consistent in how they set Access-Control-Request-Headers. If you set headers to anything other than "\*", you should include at least "accept", "content-type", and "origin", plus any custom headers that you want to support.

### Set the exposed response headers

By default, the browser doesn't expose all of the response headers to the application. (See <http://www.w3.org/TR/cors/#simple-response-header>.) The response headers that are available by default are:

- Cache-Control
- Content-Language
- Content-Type
- Expires
- Last-Modified
- Pragma

The CORS spec calls these *simple response headers*. To make other headers available to the application:

```
options.AddPolicy("ExposeResponseHeaders",
    builder =>
{
    builder.WithOrigins("http://example.com")
        .WithExposedHeaders("x-custom-header");
});
```

### Credentials in cross-origin requests

Credentials require special handling in a CORS request. By default, the browser doesn't send any credentials with a cross-origin request. Credentials include cookies as well as HTTP authentication schemes. To send credentials with a cross-origin request, the client must set XMLHttpRequest.withCredentials to true.

Using XMLHttpRequest directly:

```
var xhr = new XMLHttpRequest();
xhr.open('get', 'http://www.example.com/api/test');
xhr.withCredentials = true;
```

In jQuery:

```
$.ajax({
  type: 'get',
  url: 'http://www.example.com/home',
  xhrFields: {
    withCredentials: true
})
```

In addition, the server must allow the credentials. To allow cross-origin credentials:

```
options.AddPolicy("AllowCredentials",
  builder =>
{
  builder.WithOrigins("http://example.com")
    .AllowCredentials();
});
```

Now the HTTP response will include an Access-Control-Allow-Credentials header, which tells the browser that the server allows credentials for a cross-origin request.

If the browser sends credentials, but the response doesn't include a valid Access-Control-Allow-Credentials header, the browser won't expose the response to the application, and the AJAX request fails.

Be careful when allowing cross-origin credentials. A website at another domain can send a logged-in user's credentials to the app on the user's behalf without the user's knowledge. The CORS specification also states that setting origins to "\*" (all origins) is invalid if the `Access-Control-Allow-Credentials` header is present.

### Set the preflight expiration time

The Access-Control-Max-Age header specifies how long the response to the preflight request can be cached. To set this header:

```
options.AddPolicy("SetPreflightExpiration",
  builder =>
{
  builder.WithOrigins("http://example.com")
    .SetPreflightMaxAge(TimeSpan.FromSeconds(2520));
});
```

## How CORS works

This section describes what happens in a CORS request at the level of the HTTP messages. It's important to understand how CORS works so that the CORS policy can be configured correctly and troubleshooted when unexpected behaviors occur.

The CORS specification introduces several new HTTP headers that enable cross-origin requests. If a browser supports CORS, it sets these headers automatically for cross-origin requests. Custom JavaScript code isn't required to enable CORS.

Here is an example of a cross-origin request. The `Origin` header provides the domain of the site that's making the request:

```
GET http://myservice.azurewebsites.net/api/test HTTP/1.1
Referer: http://myclient.azurewebsites.net/
Accept: /*
Accept-Language: en-US
Origin: http://myclient.azurewebsites.net
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/5.0 (compatible; MSIE 10.0; Windows NT 6.2; WOW64; Trident/6.0)
Host: myservice.azurewebsites.net
```

If the server allows the request, it sets the Access-Control-Allow-Origin header in the response. The value of this header either matches the Origin header from the request, or is the wildcard value "\*", meaning that any origin is allowed:

```
HTTP/1.1 200 OK
Cache-Control: no-cache
Pragma: no-cache
Content-Type: text/plain; charset=utf-8
Access-Control-Allow-Origin: http://myclient.azurewebsites.net
Date: Wed, 20 May 2015 06:27:30 GMT
Content-Length: 12

Test message
```

If the response doesn't include the Access-Control-Allow-Origin header, the AJAX request fails. Specifically, the browser disallows the request. Even if the server returns a successful response, the browser doesn't make the response available to the client application.

## Preflight Requests

For some CORS requests, the browser sends an additional request, called a "preflight request", before it sends the actual request for the resource. The browser can skip the preflight request if the following conditions are true:

- The request method is GET, HEAD, or POST, and
- The application doesn't set any request headers other than Accept, Accept-Language, Content-Language, Content-Type, or Last-Event-ID, and
- The Content-Type header (if set) is one of the following:
  - application/x-www-form-urlencoded
  - multipart/form-data
  - text/plain

The rule about request headers applies to headers that the application sets by calling setRequestHeader on the XMLHttpRequest object. (The CORS specification calls these "author request headers".) The rule doesn't apply to headers the browser can set, such as User-Agent, Host, or Content-Length.

Here is an example of a preflight request:

```
OPTIONS http://myservice.azurewebsites.net/api/test HTTP/1.1
Accept: /*
Origin: http://myclient.azurewebsites.net
Access-Control-Request-Method: PUT
Access-Control-Request-Headers: accept, x-my-custom-header
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/5.0 (compatible; MSIE 10.0; Windows NT 6.2; WOW64; Trident/6.0)
Host: myservice.azurewebsites.net
Content-Length: 0
```

The pre-flight request uses the HTTP OPTIONS method. It includes two special headers:

- Access-Control-Request-Method: The HTTP method that will be used for the actual request.
- Access-Control-Request-Headers: A list of request headers that the application set on the actual request.  
(Again, this doesn't include headers that the browser sets.)

Here is an example response, assuming that the server allows the request:

```
HTTP/1.1 200 OK
Cache-Control: no-cache
Pragma: no-cache
Content-Length: 0
Access-Control-Allow-Origin: http://myclient.azurewebsites.net
Access-Control-Allow-Headers: x-my-custom-header
Access-Control-Allow-Methods: PUT
Date: Wed, 20 May 2015 06:33:22 GMT
```

The response includes an Access-Control-Allow-Methods header that lists the allowed methods, and optionally an Access-Control-Allow-Headers header, which lists the allowed headers. If the preflight request succeeds, the browser sends the actual request, as described earlier.

# Share cookies among apps with ASP.NET and ASP.NET Core

6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Rick Anderson](#) and [Luke Latham](#)

Websites often consist of individual web apps working together. To provide a single sign-on (SSO) experience, web apps within a site must share authentication cookies. To support this scenario, the data protection stack allows sharing Katana cookie authentication and ASP.NET Core cookie authentication tickets.

[View or download sample code \(how to download\)](#)

The sample illustrates cookie sharing across three apps that use cookie authentication:

- ASP.NET Core 2.0 Razor Pages app without using [ASP.NET Core Identity](#)
- ASP.NET Core 2.0 MVC app with ASP.NET Core Identity
- ASP.NET Framework 4.6.1 MVC app with ASP.NET Identity

In the examples that follow:

- The authentication cookie name is set to a common value of `.AspNet.SharedCookie`.
- The `AuthenticationType` is set to `Identity.Application` either explicitly or by default.
- A common app name is used to enable the data protection system to share data protection keys (`SharedCookieApp`).
- `Identity.Application` is used as the authentication scheme. Whatever scheme is used, it must be used consistently *within and across* the shared cookie apps either as the default scheme or by explicitly setting it. The scheme is used when encrypting and decrypting cookies, so a consistent scheme must be used across apps.
- A common [data protection key](#) storage location is used. The sample app uses a folder named *KeyRing* at the root of the solution to hold the data protection keys.
- In the ASP.NET Core apps, `PersistKeysToFileSystem` is used to set the key storage location. `SetApplicationName` is used to configure a common shared app name.
- In the .NET Framework app, the cookie authentication middleware uses an implementation of `DataProtectionProvider`. `DataProtectionProvider` provides data protection services for the encryption and decryption of authentication cookie payload data. The `DataProtectionProvider` instance is isolated from the data protection system used by other parts of the app.
  - `DataProtectionProvider.Create(System.IO.DirectoryInfo, Action<IDataProtectionBuilder>)` accepts a `DirectoryInfo` to specify the location for data protection key storage. The sample app provides the path of the *KeyRing* folder to  `DirectoryInfo`. `DataProtectionBuilderExtensions.SetApplicationName` sets the common app name.
  - `DataProtectionProvider` requires the [Microsoft.AspNetCore.DataProtection.Extensions](#) NuGet package. To obtain this package for ASP.NET Core 2.1 and later apps, reference the [Microsoft.AspNetCore.App metapackage](#). When targeting the .NET Framework, add a package reference to `Microsoft.AspNetCore.DataProtection.Extensions`.

## Share authentication cookies among ASP.NET Core apps

When using ASP.NET Core Identity:

- [ASP.NET Core 2.x](#)

- [ASP.NET Core 1.x](#)

In the `ConfigureServices` method, use the `ConfigureApplicationCookie` extension method to set up the data protection service for cookies.

```
services.AddDataProtection()
    .PersistKeysToFileSystem(GetKeyRingDirInfo())
    .SetApplicationName("SharedCookieApp");

services.ConfigureApplicationCookie(options => {
    options.Cookie.Name = ".AspNet.SharedCookie";
});
```

Data protection keys and the app name must be shared among apps. In the sample apps, `GetKeyRingDirInfo` returns the common key storage location to the `PersistKeysToFileSystem` method. Use `SetApplicationName` to configure a common shared app name (`SharedCookieApp` in the sample). For more information, see [Configuring Data Protection](#).

See the `CookieAuthWithIdentity.Core` project in the [sample code \(how to download\)](#).

When using cookies directly:

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
services.AddDataProtection()
    .PersistKeysToFileSystem(GetKeyRingDirInfo())
    .SetApplicationName("SharedCookieApp");

services.AddAuthentication("Identity.Application")
    .AddCookie("Identity.Application", options =>
{
    options.Cookie.Name = ".AspNet.SharedCookie";
});
```

Data protection keys and the app name must be shared among apps. In the sample apps, `GetKeyRingDirInfo` returns the common key storage location to the `PersistKeysToFileSystem` method. Use `SetApplicationName` to configure a common shared app name (`SharedCookieApp` in the sample). For more information, see [Configuring Data Protection](#).

See the `CookieAuth.Core` project in the [sample code \(how to download\)](#).

## Encrypting data protection keys at rest

For production deployments, configure the `DataProtectionProvider` to encrypt keys at rest with DPAPI or an X509Certificate. See [Key Encryption At Rest](#) for more information.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
services.AddDataProtection()
    .ProtectKeysWithCertificate("thumbprint");
```

## Sharing authentication cookies between ASP.NET 4.x and ASP.NET Core apps

ASP.NET 4.x apps which use Katana cookie authentication middleware can be configured to generate authentication cookies that are compatible with the ASP.NET Core cookie authentication middleware. This allows upgrading a large site's individual apps piecemeal while providing a smooth SSO experience across the site.

When an app uses Katana cookie authentication middleware, it calls `UseCookieAuthentication` in the project's `Startup.Auth.cs` file. ASP.NET 4.x web app projects created with Visual Studio 2013 and later use the Katana cookie authentication middleware by default. Although `UseCookieAuthentication` is obsolete and unsupported for ASP.NET Core apps, calling `UseCookieAuthentication` in an ASP.NET 4.x app that uses Katana cookie authentication middleware is valid.

An ASP.NET 4.x app must target .NET Framework 4.5.1 or higher. Otherwise, the necessary NuGet packages fail to install.

To share authentication cookies between an ASP.NET 4.x app and an ASP.NET Core app, configure the ASP.NET Core app as stated above, then configure the ASP.NET 4.x app by following these steps:

1. Install the package [Microsoft.Owin.Security.Interop](#) into each ASP.NET 4.x app.
2. In `Startup.Auth.cs`, locate the call to `UseCookieAuthentication` and modify it as follows. Change the cookie name to match the name used by the ASP.NET Core cookie authentication middleware. Provide an instance of a `DataProtectionProvider` initialized to the common data protection key storage location. Make sure that the app name is set to the common app name used by all apps that share cookies, `SharedCookieApp` in the sample app.

```
app.UseCookieAuthentication(new CookieAuthenticationOptions
{
    AuthenticationType = "Identity.Application",
    CookieName = ".AspNet.SharedCookie",
    LoginPath = new PathString("/Account/Login"),
    Provider = new CookieAuthenticationProvider
    {
        OnValidateIdentity =
            SecurityStampValidator
                .OnValidateIdentity<ApplicationUserManager, ApplicationUser>(
                    validateInterval: TimeSpan.FromMinutes(30),
                    regenerateIdentity: (manager, user) =>
                        user.GenerateUserIdentityAsync(manager))
    },
    TicketDataFormat = new AspNetTicketDataFormat(
        new DataProtectorShim(
            DataProtectionProvider.Create.GetKeyRingDirInfo(),
            (builder) => { builder.SetApplicationName("SharedCookieApp"); })
        .CreateProtector(
            "Microsoft.AspNetCore.Authentication.Cookies.CookieAuthenticationMiddleware",
            "Identity.Application",
            "v2")),
    CookieManager = new ChunkingCookieManager()
});
// If not setting http://schemas.xmlsoap.org/ws/2005/05/identity/claims/nameidentifier and
// http://schemas.microsoft.com/accesscontrolservice/2010/07/claims/identityprovider,
// then set UniqueClaimTypeIdentifier to a claim that distinguishes unique users.
System.Web.Helpers.AntiForgeryToken.UniqueClaimTypeIdentifier =
    "http://schemas.xmlsoap.org/ws/2005/05/identity/claims/name";
```

See the `CookieAuthWithIdentity.NETFramework` project in the [sample code \(how to download\)](#).

When generating a user identity, the authentication type must match the type defined in `AuthenticationType` set with `UseCookieAuthentication`.

`Models/IdentityModels.cs`:

```
public async Task<ClaimsIdentity> GenerateUserIdentityAsync(UserManager<ApplicationUser> manager)
{
    // Note the authenticationType must match the one defined in
    CookieAuthenticationOptions.AuthenticationType
    var userIdentity = await manager.CreateIdentityAsync(this, "Identity.Application");
    // Add custom user claims here
    return userIdentity;
}
```

## Use a common user database

Confirm that the identity system for each app is pointed at the same user database. Otherwise, the identity system produces failures at runtime when it attempts to match the information in the authentication cookie against the information in its database.

# Performance in ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

- [Cache responses](#)
  - [Cache in-memory](#)
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# Cache responses in ASP.NET Core

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# Cache in-memory in ASP.NET Core

6/28/2018 • 5 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [John Luo](#), and [Steve Smith](#)

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## Caching basics

Caching can significantly improve the performance and scalability of an app by reducing the work required to generate content. Caching works best with data that changes infrequently. Caching makes a copy of data that can be returned much faster than from the original source. You should write and test your app to never depend on cached data.

ASP.NET Core supports several different caches. The simplest cache is based on the [IMemoryCache](#), which represents a cache stored in the memory of the web server. Apps which run on a server farm of multiple servers should ensure that sessions are sticky when using the in-memory cache. Sticky sessions ensure that subsequent requests from a client all go to the same server. For example, Azure Web apps use [Application Request Routing \(ARR\)](#) to route all subsequent requests to the same server.

Non-sticky sessions in a web farm require a [distributed cache](#) to avoid cache consistency problems. For some apps, a distributed cache can support higher scale out than an in-memory cache. Using a distributed cache offloads the cache memory to an external process.

The `IMemoryCache` cache will evict cache entries under memory pressure unless the `cache priority` is set to `CacheItemPriority.NeverRemove`. You can set the `CacheItemPriority` to adjust the priority with which the cache evicts items under memory pressure.

The in-memory cache can store any object; the distributed cache interface is limited to `byte[]`.

## Using [IMemoryCache](#)

In-memory caching is a *service* that's referenced from your app using [Dependency Injection](#). Call `AddMemoryCache` in `ConfigureServices`:

```
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Mvc;
using Microsoft.Extensions.DependencyInjection;

public class Startup
{
    public void ConfigureServices(IServiceCollection services)
    {
        services.AddMemoryCache();
        services.AddMvc().SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
    }

    public void Configure(IApplicationBuilder app)
    {
        app.UseMvcWithDefaultRoute();
    }
}
```

Request the `IMemoryCache` instance in the constructor:

```

public class HomeController : Controller
{
    private IMemoryCache _cache;

    public HomeController(IMemoryCache memoryCache)
    {
        _cache = memoryCache;
    }
}

```

`IMemoryCache` requires NuGet package [Microsoft.Extensions.Caching.Memory](#).

`IMemoryCache` requires NuGet package [Microsoft.Extensions.Caching.Memory](#), which is available in the [Microsoft.AspNetCore.All metapackage](#).

`IMemoryCache` requires NuGet package [Microsoft.Extensions.Caching.Memory](#), which is available in the [Microsoft.AspNetCore.App metapackage](#).

The following code uses [TryGetValue](#) to check if a time is in the cache. If a time isn't cached, a new entry is created and added to the cache with [Set](#).

```

public IActionResult CacheTryGetValueSet()
{
    DateTime cacheEntry;

    // Look for cache key.
    if (!_cache.TryGetValue(CacheKeys.Entry, out cacheEntry))
    {
        // Key not in cache, so get data.
        cacheEntry = DateTime.Now;

        // Set cache options.
        var cacheEntryOptions = new MemoryCacheEntryOptions()
            // Keep in cache for this time, reset time if accessed.
            .SetSlidingExpiration(TimeSpan.FromSeconds(3));

        // Save data in cache.
        _cache.Set(CacheKeys.Entry, cacheEntry, cacheEntryOptions);
    }

    return View("Cache", cacheEntry);
}

```

The current time and the cached time are displayed:

```

@model DateTime?

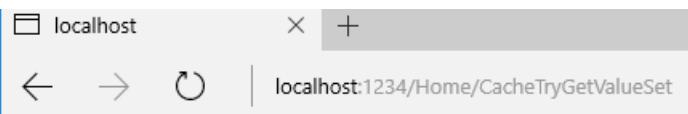
<div>
    <h2>Actions</h2>
    <ul>
        <li><a href="#" asp-controller="Home" asp-action="CacheTryGetValueSet">TryGetValue and Set</a></li>
        <li><a href="#" asp-controller="Home" asp-action="CacheGet">Get</a></li>
        <li><a href="#" asp-controller="Home" asp-action="CacheGetOrCreate">GetOrCreate</a></li>
        <li><a href="#" asp-controller="Home" asp-action="CacheGetOrCreateAsync">GetOrCreateAsync</a></li>
        <li><a href="#" asp-controller="Home" asp-action="CacheRemove">Remove</a></li>
    </ul>
</div>

<h3>Current Time: @DateTime.Now.ToString()</h3>
<h3>Cached Time: @(Model == null ? "No cached entry found" : Model.Value.ToString())</h3>

```

The cached `DateTime` value remains in the cache while there are requests within the timeout period (and no

eviction due to memory pressure). The following image shows the current time and an older time retrieved from the cache:



## Scenarios

- [Basic cache operations](#)
- [Cache entry with eviction callback](#)
- [Dependent cache entries](#)

## Actions

- [TryGetValue and Set](#)
- [Get](#)
- [GetOrCreate](#)
- [GetOrCreateAsync](#)
- [Remove](#)

**Current Time: 17:04:01.1913080**

**Cached Time: 17:03:39.9454218**

The following code uses [GetOrCreate](#) and [GetOrCreateAsync](#) to cache data.

```
public IActionResult CacheGetOrCreate()
{
    var cacheEntry = _cache.GetOrCreate(CacheKeys.Entry, entry =>
    {
        entry SlidingExpiration = TimeSpan.FromSeconds(3);
        return DateTime.Now;
    });

    return View("Cache", cacheEntry);
}

public async Task<IActionResult> CacheGetOrCreateAsync()
{
    var cacheEntry = await
        _cache.GetOrCreateAsync(CacheKeys.Entry, entry =>
    {
        entry SlidingExpiration = TimeSpan.FromSeconds(3);
        return Task.FromResult(DateTime.Now);
    });

    return View("Cache", cacheEntry);
}
```

The following code calls [Get](#) to fetch the cached time:

```
public IActionResult CacheGet()
{
    var cacheEntry = _cache.Get<DateTime?>(CacheKeys.Entry);
    return View("Cache", cacheEntry);
}
```

See [IMemoryCache methods](#) and [CacheExtensions methods](#) for a description of the cache methods.

# Using MemoryCacheEntryOptions

The following sample:

- Sets the absolute expiration time. This is the maximum time the entry can be cached and prevents the item from becoming too stale when the sliding expiration is continuously renewed.
- Sets a sliding expiration time. Requests that access this cached item will reset the sliding expiration clock.
- Sets the cache priority to `CacheItemPriority.NeverRemove`.
- Sets a `PostEvictionDelegate` that will be called after the entry is evicted from the cache. The callback is run on a different thread from the code that removes the item from the cache.

```
public IActionResult CreateCallbackEntry()
{
    var cacheEntryOptions = new MemoryCacheEntryOptions()
        // Pin to cache.
        .SetPriority(CacheItemPriority.NeverRemove)
        // Add eviction callback
        .RegisterPostEvictionCallback(callback: EvictionCallback, state: this);

    _cache.Set(CacheKeys.CallbackEntry, DateTime.Now, cacheEntryOptions);

    return RedirectToAction("GetCallbackEntry");
}

public IActionResult GetCallbackEntry()
{
    return View("Callback", new CallbackViewModel
    {
        CachedTime = _cache.Get<DateTime?>(CacheKeys.CallbackEntry),
        Message = _cache.Get<string>(CacheKeys.CallbackMessage)
    });
}

public IActionResult RemoveCallbackEntry()
{
    _cache.Remove(CacheKeys.CallbackEntry);
    return RedirectToAction("GetCallbackEntry");
}

private static void EvictionCallback(object key, object value,
    EvictionReason reason, object state)
{
    var message = $"Entry was evicted. Reason: {reason}.";
    ((HomeController)state)._cache.Set(CacheKeys.CallbackMessage, message);
}
```

## Cache dependencies

The following sample shows how to expire a cache entry if a dependent entry expires. A `CancellationChangeToken` is added to the cached item. When `Cancel` is called on the `CancellationTokenSource`, both cache entries are evicted.

```

public IActionResult CreateDependentEntries()
{
    var cts = new CancellationTokenSource();
    _cache.Set(CacheKeys.DependentCTS, cts);

    using (var entry = _cache.CreateEntry(CacheKeys.Parent))
    {
        // expire this entry if the dependant entry expires.
        entry.Value = DateTime.Now;
        entry.RegisterPostEvictionCallback(DependentEvictionCallback, this);

        _cache.Set(CacheKeys.Child,
            DateTime.Now,
            new CancellationTokenChangeToken(cts.Token));
    }

    return RedirectToAction("GetDependentEntries");
}

public IActionResult GetDependentEntries()
{
    return View("Dependent", new DependentViewModel
    {
        ParentCachedTime = _cache.Get<DateTime?>(CacheKeys.Parent),
        ChildCachedTime = _cache.Get<DateTime?>(CacheKeys.Child),
        Message = _cache.Get<string>(CacheKeys.DependentMessage)
    });
}

public IActionResult RemoveChildEntry()
{
    _cache.Get<CancellationTokenSource>(CacheKeys.DependentCTS).Cancel();
    return RedirectToAction("GetDependentEntries");
}

private static void DependentEvictionCallback(object key, object value,
    EvictionReason reason, object state)
{
    var message = $"Parent entry was evicted. Reason: {reason}." ;
    ((HomeController)state)._cache.Set(CacheKeys.DependentMessage, message);
}

```

Using a `CancellationTokenSource` allows multiple cache entries to be evicted as a group. With the `using` pattern in the code above, cache entries created inside the `using` block will inherit triggers and expiration settings.

## Additional notes

- When using a callback to repopulate a cache item:
  - Multiple requests can find the cached key value empty because the callback hasn't completed.
  - This can result in several threads repopulating the cached item.
- When one cache entry is used to create another, the child copies the parent entry's expiration tokens and time-based expiration settings. The child isn't expired by manual removal or updating of the parent entry.

## Additional resources

- [Work with a distributed cache](#)
- [Detect changes with change tokens](#)
- [Response caching](#)
- [Response Caching Middleware](#)
- [Cache Tag Helper](#)

- [Distributed Cache Tag Helper](#)

# Work with a distributed cache in ASP.NET Core

6/28/2018 • 5 minutes to read • [Edit Online](#)

By [Steve Smith](#)

Distributed caches can improve the performance and scalability of ASP.NET Core apps, especially when hosted in a cloud or server farm environment. This article explains how to work with ASP.NET Core's built-in distributed cache abstractions and implementations.

[View or download sample code \(how to download\)](#)

## What is a distributed cache

A distributed cache is shared by multiple app servers (see [Cache Basics](#)). The information in the cache isn't stored in the memory of individual web servers, and the cached data is available to all of the app's servers. This provides several advantages:

1. Cached data is coherent on all web servers. Users don't see different results depending on which web server handles their request
2. Cached data survives web server restarts and deployments. Individual web servers can be removed or added without impacting the cache.
3. The source data store has fewer requests made to it (than with multiple in-memory caches or no cache at all).

### NOTE

If using a SQL Server Distributed Cache, some of these advantages are only true if a separate database instance is used for the cache than for the app's source data.

Like any cache, a distributed cache can dramatically improve an app's responsiveness, since typically data can be retrieved from the cache much faster than from a relational database (or web service).

Cache configuration is implementation specific. This article describes how to configure both Redis and SQL Server distributed caches. Regardless of which implementation is selected, the app interacts with the cache using a common `IDistributedCache` interface.

## The `IDistributedCache` Interface

The `IDistributedCache` interface includes synchronous and asynchronous methods. The interface allows items to be added, retrieved, and removed from the distributed cache implementation. The `IDistributedCache` interface includes the following methods:

### **Get, GetAsync**

Takes a string key and retrieves a cached item as a `byte[]` if found in the cache.

### **Set, SetAsync**

Adds an item (as `byte[]`) to the cache using a string key.

### **Refresh, RefreshAsync**

Refreshes an item in the cache based on its key, resetting its sliding expiration timeout (if any).

## Remove, RemoveAsync

Removes a cache entry based on its key.

To use the `IDistributedCache` interface:

1. Add the required NuGet packages to your project file.
2. Configure the specific implementation of `IDistributedCache` in your `Startup` class's `ConfigureServices` method, and add it to the container there.
3. From the app's [Middleware](#) or MVC controller classes, request an instance of `IDistributedCache` from the constructor. The instance will be provided by [Dependency Injection](#) (DI).

### NOTE

There's no need to use a Singleton or Scoped lifetime for `IDistributedCache` instances (at least for the built-in implementations). You can also create an instance wherever you might need one (instead of using [Dependency Injection](#)), but this can make your code harder to test, and violates the [Explicit Dependencies Principle](#).

The following example shows how to use an instance of `IDistributedCache` in a simple middleware component:

```

using System.Linq;
using System.Text;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Http;
using Microsoft.Extensions.Caching.Distributed;

namespace DistCacheSample
{
    public class StartTimeHeader
    {
        private readonly RequestDelegate _next;
        private readonly IDistributedCache _cache;

        public StartTimeHeader(RequestDelegate next,
            IDistributedCache cache)
        {
            _next = next;
            _cache = cache;
        }

        public async Task Invoke(HttpContext httpContext)
        {
            string startTimeString = "Not found.";
            var value = await _cache.GetAsync("lastServerStartTime");
            if (value != null)
            {
                startTimeString = Encoding.UTF8.GetString(value);
            }

            httpContext.Response.Headers.Append(
                "Last-Server-Start-Time", startTimeString);

            await _next.Invoke(httpContext);
        }
    }

    // Add the middleware to the HTTP request pipeline.
    public static class StartTimeHeaderExtensions
    {
        public static IApplicationBuilder UseStartTimeHeader(
            this IApplicationBuilder builder)
        {
            return builder.UseMiddleware<StartTimeHeader>();
        }
    }
}

```

In the code above, the cached value is read, but never written. In this sample, the value is only set when a server starts up, and doesn't change. In a multi-server scenario, the most recent server to start will overwrite any previous values that were set by other servers. The `Get` and `Set` methods use the `byte[]` type. Therefore, the string value must be converted using `Encoding.UTF8.GetString` (for `Get`) and `Encoding.UTF8.GetBytes` (for `Set`).

The following code from `Startup.cs` shows the value being set:

```
public void Configure(IApplicationBuilder app,
    IDistributedCache cache)
{
    var serverStartTimeString = DateTime.Now.ToString();
    byte[] val = Encoding.UTF8.GetBytes(serverStartTimeString);
    var cacheEntryOptions = new DistributedCacheEntryOptions()
        .SetSlidingExpiration(TimeSpan.FromSeconds(30));
    cache.Set("lastServerStartTime", val, cacheEntryOptions);
```

#### NOTE

Since `IDistributedCache` is configured in the `ConfigureServices` method, it's available to the `Configure` method as a parameter. Adding it as a parameter will allow the configured instance to be provided through DI.

## Using a Redis distributed cache

Redis is an open source in-memory data store, which is often used as a distributed cache. You can use it locally, and you can configure an [Azure Redis Cache](#) for your Azure-hosted ASP.NET Core apps. Your ASP.NET Core app configures the cache implementation using a `RedisDistributedCache` instance.

You configure the Redis implementation in `ConfigureServices` and access it in your app code by requesting an instance of `IDistributedCache` (see the code above).

In the sample code, a `RedisCache` implementation is used when the server is configured for a `Staging` environment. Thus the `ConfigureStagingServices` method configures the `RedisCache`:

```
public void ConfigureStagingServices(IServiceCollection services)
{
    services.AddDistributedRedisCache(options =>
    {
        options.Configuration = "localhost";
        options.InstanceName = "SampleInstance";
    });
}
```

#### NOTE

To install Redis on your local machine, install the chocolatey package <https://chocolatey.org/packages/redis-64/> and run `redis-server` from a command prompt.

## Using a SQL Server distributed cache

The `SqlServerCache` implementation allows the distributed cache to use a SQL Server database as its backing store. To create SQL Server table you can use `sql-cache` tool, the tool creates a table with the name and schema you specify.

Add `SqlConfig.Tools` to the `<ItemGroup>` element of the project file and run `dotnet restore`.

```
<ItemGroup>
<DotNetCliToolReference Include="Microsoft.Extensions.Caching.SqlConfig.Tools"
Version="2.0.2" />
</ItemGroup>
```

Test `SqlConfig.Tools` by running the following command:

```
dotnet sql-cache create --help
```

SqlConfig.Tools displays usage, options, and command help.

Create a table in SQL Server by running the `sql-cache create` command:

```
dotnet sql-cache create "Data Source=(localdb)\v11.0;Initial Catalog=DistCache;Integrated Security=True;"  
dbo TestCache  
info: Microsoft.Extensions.Caching.SqlConfig.Tools.Program[0]  
Table and index were created successfully.
```

The created table has the following schema:

Column Name	Data Type	Allow Nulls
<code>Id</code>	<code>nvarchar(900)</code>	<input type="checkbox"/>
<code>Value</code>	<code>varbinary(MAX)</code>	<input type="checkbox"/>
<code>ExpiresAtTime</code>	<code>datetimeoffset(7)</code>	<input type="checkbox"/>
<code>SlidingExpirationInSecond...</code>	<code>bigint</code>	<input checked="" type="checkbox"/>
<code>AbsoluteExpiration</code>	<code>datetimeoffset(7)</code>	<input checked="" type="checkbox"/>
		<input type="checkbox"/>

Like all cache implementations, your app should get and set cache values using an instance of `IDistributedCache`, not a `SqlServerCache`. The sample implements `SqlServerCache` in the Production environment (so it's configured in `ConfigureProductionServices`).

```
public void ConfigureProductionServices(IServiceCollection services)  
{  
    services.AddDistributedSqlServerCache(options =>  
    {  
        options.ConnectionString =  
            @"Data Source=(localdb)\v11.0;Initial Catalog=DistCache;" +  
            @"Integrated Security=True;"  
        options.SchemaName = "dbo";  
        options.TableName = "TestCache";  
    });  
}
```

#### NOTE

The `ConnectionString` (and optionally, `SchemaName` and `TableName`) should typically be stored outside of source control (such as UserSecrets), as they may contain credentials.

## Recommendations

When deciding which implementation of `IDistributedCache` is right for your app, choose between Redis and SQL Server based on your existing infrastructure and environment, your performance requirements, and your team's experience. If your team is more comfortable working with Redis, it's an excellent choice. If your team prefers SQL Server, you can be confident in that implementation as well. Note that a traditional caching solution stores data in-memory which allows for fast retrieval of data. You should store commonly used data in a cache and store the entire data in a backend persistent store such as SQL Server or Azure Storage. Redis Cache is a caching solution which gives you high throughput and low latency as compared to SQL Cache.

## Additional resources

- [Redis Cache on Azure](#)
- [SQL Database on Azure](#)
- [Cache in-memory](#)
- [Detect changes with change tokens](#)
- [Response caching](#)
- [Response Caching Middleware](#)
- [Cache Tag Helper](#)
- [Distributed Cache Tag Helper](#)

# Response caching in ASP.NET Core

6/28/2018 • 8 minutes to read • [Edit Online](#)

By [John Luo](#), [Rick Anderson](#), [Steve Smith](#), and [Luke Latham](#)

## NOTE

Response caching in Razor Pages is available in ASP.NET Core 2.1 or later.

[View or download sample code \(how to download\)](#)

Response caching reduces the number of requests a client or proxy makes to a web server. Response caching also reduces the amount of work the web server performs to generate a response. Response caching is controlled by headers that specify how you want client, proxy, and middleware to cache responses.

The web server can cache responses when you add [Response Caching Middleware](#).

## HTTP-based response caching

The [HTTP 1.1 Caching specification](#) describes how Internet caches should behave. The primary HTTP header used for caching is [Cache-Control](#), which is used to specify cache *directives*. The directives control caching behavior as requests make their way from clients to servers and as responses make their way from servers back to clients. Requests and responses move through proxy servers, and proxy servers must also conform to the HTTP 1.1 Caching specification.

Common `Cache-Control` directives are shown in the following table.

DIRECTIVE	ACTION
<code>public</code>	A cache may store the response.
<code>private</code>	The response must not be stored by a shared cache. A private cache may store and reuse the response.
<code>max-age</code>	The client won't accept a response whose age is greater than the specified number of seconds. Examples: <code>max-age=60</code> (60 seconds), <code>max-age=2592000</code> (1 month)
<code>no-cache</code>	<b>On requests:</b> A cache must not use a stored response to satisfy the request. Note: The origin server re-generates the response for the client, and the middleware updates the stored response in its cache.  <b>On responses:</b> The response must not be used for a subsequent request without validation on the origin server.
<code>no-store</code>	<b>On requests:</b> A cache must not store the request.  <b>On responses:</b> A cache must not store any part of the response.

Other cache headers that play a role in caching are shown in the following table.

HEADER	FUNCTION
Age	An estimate of the amount of time in seconds since the response was generated or successfully validated at the origin server.
Expires	The date/time after which the response is considered stale.
Pragma	Exists for backwards compatibility with HTTP/1.0 caches for setting <code>no-cache</code> behavior. If the <code>Cache-Control</code> header is present, the <code>Pragma</code> header is ignored.
Vary	Specifies that a cached response must not be sent unless all of the <code>Vary</code> header fields match in both the cached response's original request and the new request.

## HTTP-based caching respects request Cache-Control directives

The [HTTP 1.1 Caching specification for the Cache-Control header](#) requires a cache to honor a valid `Cache-Control` header sent by the client. A client can make requests with a `no-cache` header value and force the server to generate a new response for every request.

Always honoring client `Cache-Control` request headers makes sense if you consider the goal of HTTP caching. Under the official specification, caching is meant to reduce the latency and network overhead of satisfying requests across a network of clients, proxies, and servers. It isn't necessarily a way to control the load on an origin server.

There's no current developer control over this caching behavior when using the [Response Caching Middleware](#) because the middleware adheres to the official caching specification. [Future enhancements to the middleware](#) will permit configuring the middleware to ignore a request's `Cache-Control` header when deciding to serve a cached response. This will offer you an opportunity to better control the load on your server when you use the middleware.

## Other caching technology in ASP.NET Core

### In-memory caching

In-memory caching uses server memory to store cached data. This type of caching is suitable for a single server or multiple servers using *sticky sessions*. Sticky sessions means that the requests from a client are always routed to the same server for processing.

For more information, see [Cache in-memory](#).

### Distributed Cache

Use a distributed cache to store data in memory when the app is hosted in a cloud or server farm. The cache is shared across the servers that process requests. A client can submit a request that's handled by any server in the group if cached data for the client is available. ASP.NET Core offers SQL Server and Redis distributed caches.

For more information, see [Work with a distributed cache](#).

### Cache Tag Helper

You can cache the content from an MVC view or Razor Page with the Cache Tag Helper. The Cache Tag Helper uses in-memory caching to store data.

For more information, see [Cache Tag Helper in ASP.NET Core MVC](#).

## Distributed Cache Tag Helper

You can cache the content from an MVC view or Razor Page in distributed cloud or web farm scenarios with the Distributed Cache Tag Helper. The Distributed Cache Tag Helper uses SQL Server or Redis to store data.

For more information, see [Distributed Cache Tag Helper](#).

## ResponseCache attribute

The [ResponseCacheAttribute](#) specifies the parameters necessary for setting appropriate headers in response caching.

### WARNING

Disable caching for content that contains information for authenticated clients. Caching should only be enabled for content that doesn't change based on a user's identity or whether a user is signed in.

[VaryByQueryKeys](#) varies the stored response by the values of the given list of query keys. When a single value of `*` is provided, the middleware varies responses by all request query string parameters. [VaryByQueryKeys](#) requires ASP.NET Core 1.1 or later.

The Response Caching Middleware must be enabled to set the `VaryByQueryKeys` property; otherwise, a runtime exception is thrown. There isn't a corresponding HTTP header for the `VaryByQueryKeys` property. The property is an HTTP feature handled by the Response Caching Middleware. For the middleware to serve a cached response, the query string and query string value must match a previous request. For example, consider the sequence of requests and results shown in the following table.

REQUEST	RESULT
<code>http://example.com?key1=value1</code>	Returned from server
<code>http://example.com?key1=value1</code>	Returned from middleware
<code>http://example.com?key1=value2</code>	Returned from server

The first request is returned by the server and cached in middleware. The second request is returned by middleware because the query string matches the previous request. The third request isn't in the middleware cache because the query string value doesn't match a previous request.

The `ResponseCacheAttribute` is used to configure and create (via `IFilterFactory`) a `ResponseCacheFilter`. The `ResponseCacheFilter` performs the work of updating the appropriate HTTP headers and features of the response. The filter:

- Removes any existing headers for `Vary`, `Cache-Control`, and `Pragma`.
- Writes out the appropriate headers based on the properties set in the `ResponseCacheAttribute`.
- Updates the response caching HTTP feature if `VaryByQueryKeys` is set.

### Vary

This header is only written when the `VaryByHeader` property is set. It's set to the `Vary` property's value. The following sample uses the `VaryByHeader` property:

```
[ResponseCache(VaryByHeader = "User-Agent", Duration = 30)]
public IActionResult About2()
{
```

```
[ResponseCache(VaryByHeader = "User-Agent", Duration = 30)]
public IActionResult About2()
{
```

You can view the response headers with your browser's network tools. The following image shows the Edge F12 output on the **Network** tab when the `About2` action method is refreshed:

The screenshot shows the Microsoft Edge F12 developer tools Network tab. The Headers tab is selected. The Request URL is `http://localhost/Home/About2`. The Request Method is GET. The Status Code is 200 / OK. The Request Headers section lists: Accept: `text/html, application/xhtml+xml, image/jxr, */*`, Accept-Encoding: `gzip, deflate`, Accept-Language: `en-US, en; q=0.8, zh-Hans-CN; q=0.5, zh-Hans; q=0.3`, Connection: `Keep-Alive`, Host: `localhost`, and User-Agent: `Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36...`. The Response Headers section lists: Cache-Control: `public, max-age=30`, Content-Type: `text/html; charset=utf-8`, Date: `Fri, 18 Nov 2016 21:45:14 GMT`, Server: `Kestrel`, Transfer-Encoding: `chunked`, and Vary: `User-Agent`.

## NoStore and Location.None

`NoStore` overrides most of the other properties. When this property is set to `true`, the `Cache-Control` header is set to `no-store`. If `Location` is set to `None`:

- `Cache-Control` is set to `no-store,no-cache`.
- `Pragma` is set to `no-cache`.

If `NoStore` is `false` and `Location` is `None`, `Cache-Control` and `Pragma` are set to `no-cache`.

You typically set `NoStore` to `true` on error pages. For example:

```
[ResponseCache(Location = ResponseCacheLocation.None, NoStore = true)]
public IActionResult Error()
{
    return View();
}
```

```
[ResponseCache(Location = ResponseCacheLocation.None, NoStore = true)]
public IActionResult Error()
{
    return View();
}
```

This results in the following headers:

```
Cache-Control: no-store,no-cache  
Pragma: no-cache
```

## Location and Duration

To enable caching, `Duration` must be set to a positive value and `Location` must be either `Any` (the default) or `Client`. In this case, the `Cache-Control` header is set to the location value followed by the `max-age` of the response.

### NOTE

`Location`'s options of `Any` and `Client` translate into `Cache-Control` header values of `public` and `private`, respectively. As noted previously, setting `Location` to `None` sets both `Cache-Control` and `Pragma` headers to `no-cache`.

Below is an example showing the headers produced by setting `Duration` and leaving the default `Location` value:

```
[ResponseCache(Duration = 60)]  
public IActionResult Contact()  
{  
    ViewData["Message"] = "Your contact page.";  
  
    return View();  
}
```

```
[ResponseCache(Duration = 60)]  
public IActionResult Contact()  
{  
    ViewData["Message"] = "Your contact page.";  
  
    return View();  
}
```

This produces the following header:

```
Cache-Control: public,max-age=60
```

## Cache profiles

Instead of duplicating `ResponseCache` settings on many controller action attributes, cache profiles can be configured as options when setting up MVC in the `ConfigureServices` method in `Startup`. Values found in a referenced cache profile are used as the defaults by the `ResponseCache` attribute and are overridden by any properties specified on the attribute.

Setting up a cache profile:

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc(options =>
    {
        options.CacheProfiles.Add("Default",
            new CacheProfile()
            {
                Duration = 60
            });
        options.CacheProfiles.Add("Never",
            new CacheProfile()
            {
                Location = ResponseCacheLocation.None,
                NoStore = true
            });
    }).SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
}

```

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc(options =>
    {
        options.CacheProfiles.Add("Default",
            new CacheProfile()
            {
                Duration = 60
            });
        options.CacheProfiles.Add("Never",
            new CacheProfile()
            {
                Location = ResponseCacheLocation.None,
                NoStore = true
            });
    });
}

```

Referencing a cache profile:

```

[ResponseCache(Duration = 30)]
public class HomeController : Controller
{
    [ResponseCache(CacheProfileName = "Default")]
    public IActionResult Index()
    {
        return View();
    }
}

```

```

[ResponseCache(Duration = 30)]
public class HomeController : Controller
{
    [ResponseCache(CacheProfileName = "Default")]
    public IActionResult Index()
    {
        return View();
    }
}

```

The `[ResponseCache]` attribute can be applied both to actions (methods) and controllers (classes). Method-level attributes override the settings specified in class-level attributes.

In the above example, a class-level attribute specifies a duration of 30 seconds, while a method-level attribute

references a cache profile with a duration set to 60 seconds.

The resulting header:

```
Cache-Control: public,max-age=60
```

## Additional resources

- [Storing Responses in Caches](#)
- [Cache-Control](#)
- [Cache in-memory](#)
- [Work with a distributed cache](#)
- [Detect changes with change tokens](#)
- [Response Caching Middleware](#)
- [Cache Tag Helper](#)
- [Distributed Cache Tag Helper](#)

# Response Caching Middleware in ASP.NET Core

6/28/2018 • 6 minutes to read • [Edit Online](#)

By [Luke Latham](#) and [John Luo](#)

[View or download ASP.NET Core 2.1 sample code \(how to download\)](#)

This article explains how to configure Response Caching Middleware in an ASP.NET Core app. The middleware determines when responses are cacheable, stores responses, and serves responses from cache. For an introduction to HTTP caching and the `ResponseCache` attribute, see [Response Caching](#).

## Package

To include the middleware in your project, add a reference to the [Microsoft.AspNetCore.ResponseCaching](#) package or use the [Microsoft.AspNetCore.App metapackage](#), which is available for use in ASP.NET Core 2.1 or later.

## Configuration

In `ConfigureServices`, add the middleware to the service collection.

```
public void ConfigureServices(IServiceCollection services)
{
    services.Configure<CookiePolicyOptions>(options =>
    {
        options.CheckConsentNeeded = context => true;
        options.MinimumSameSitePolicy = SameSiteMode.None;
    });

    services.AddResponseCaching();
    services.AddMvc()
        .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
}
```

Configure the app to use the middleware with the `UseResponseCaching` extension method, which adds the middleware to the request processing pipeline. The sample app adds a `Cache-Control` header to the response that caches cacheable responses for up to 10 seconds. The sample sends a `Vary` header to configure the middleware to serve a cached response only if the `Accept-Encoding` header of subsequent requests matches that of the original request. In the code example that follows, `CacheControlHeaderValue` and `HeaderNames` require a `using` statement for the [Microsoft.Net.Http.Headers](#) namespace.

```

public void Configure(IApplicationBuilder app, IHostingEnvironment env)
{
    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
    }
    else
    {
        app.UseExceptionHandler("/Error");
        app.UseHsts();
    }

    app.UseHttpsRedirection();
    app.UseStaticFiles();
    app.UseCookiePolicy();

    app.UseResponseCaching();

    app.Use(async (context, next) =>
    {
        context.Response.GetTypedHeaders().CacheControl =
            new Microsoft.Net.Http.Headers.CacheControlHeaderValue()
        {
            Public = true,
            MaxAge = TimeSpan.FromSeconds(10)
        };
        context.Response.Headers[Microsoft.Net.Http.Headers.HeaderNames.Vary] =
            new string[] { "Accept-Encoding" };

        await next();
    });
}

app.UseMvc();
}

```

Response Caching Middleware only caches server responses that result in a 200 (OK) status code. Any other responses, including [error pages](#), are ignored by the middleware.

#### **WARNING**

Responses containing content for authenticated clients must be marked as not cacheable to prevent the middleware from storing and serving those responses. See [Conditions for caching](#) for details on how the middleware determines if a response is cacheable.

## Options

The middleware offers three options for controlling response caching.

OPTION	DESCRIPTION
UseCaseSensitivePaths	Determines if responses are cached on case-sensitive paths. The default value is <code>false</code> .
MaximumBodySize	The largest cacheable size for the response body in bytes. The default value is <code>64 * 1024 * 1024</code> (64 MB).
SizeLimit	The size limit for the response cache middleware in bytes. The default value is <code>100 * 1024 * 1024</code> (100 MB).

The following example configures the middleware to:

- Cache responses smaller than or equal to 1,024 bytes.
- Store the responses by case-sensitive paths (for example, `/page1` and `/Page1` are stored separately).

```
services.AddResponseCaching(options =>
{
    options.UseCaseSensitivePaths = true;
    options.MaximumBodySize = 1024;
});
```

## VaryByQueryKeys

When using MVC/Web API controllers or Razor Pages page models, the `ResponseCache` attribute specifies the parameters necessary for setting the appropriate headers for response caching. The only parameter of the `ResponseCache` attribute that strictly requires the middleware is `VaryByQueryKeys`, which doesn't correspond to an actual HTTP header. For more information, see [ResponseCache Attribute](#).

When not using the `ResponseCache` attribute, response caching can be varied with the `VaryByQueryKeys` feature. Use the `ResponseCachingFeature` directly from the `IFeatureCollection` of the `HttpContext`:

```
var responseCachingFeature = context.HttpContext.Features.Get<IResponseCachingFeature>();
if (responseCachingFeature != null)
{
    responseCachingFeature.VaryByQueryKeys = new[] { "MyKey" };
}
```

Using a single value equal to `*` in `VaryByQueryKeys` varies the cache by all request query parameters.

## HTTP headers used by Response Caching Middleware

Response caching by the middleware is configured using HTTP headers.

HEADER	DETAILS
Authorization	The response isn't cached if the header exists.

HEADER	DETAILS
Cache-Control	<p>The middleware only considers caching responses marked with the <code>public</code> cache directive. Control caching with the following parameters:</p> <ul style="list-style-type: none"> <li>• <code>max-age</code></li> <li>• <code>max-stale</code></li> <li>• <code>min-fresh</code></li> <li>• <code>must-revalidate</code></li> <li>• <code>no-cache</code></li> <li>• <code>no-store</code></li> <li>• <code>only-if-cached</code></li> <li>• <code>private</code></li> <li>• <code>public</code></li> <li>• <code>s-maxage</code></li> <li>• <code>proxy-revalidate</code><sup>#</sup></li> </ul> <p><sup>†</sup>If no limit is specified to <code>max-stale</code>, the middleware takes no action.</p> <p><sup>#</sup> <code>proxy-revalidate</code> has the same effect as <code>must-revalidate</code>.</p> <p>For more information, see <a href="#">RFC 7231: Request Cache-Control Directives</a>.</p>
Pragma	A <code>Pragma: no-cache</code> header in the request produces the same effect as <code>Cache-Control: no-cache</code> . This header is overridden by the relevant directives in the <code>Cache-Control</code> header, if present. Considered for backward compatibility with HTTP/1.0.
Set-Cookie	The response isn't cached if the header exists. Any middleware in the request processing pipeline that sets one or more cookies prevents the Response Caching Middleware from caching the response (for example, the <a href="#">cookie-based TempData provider</a> ).
Vary	The <code>Vary</code> header is used to vary the cached response by another header. For example, cache responses by encoding by including the <code>Vary: Accept-Encoding</code> header, which caches responses for requests with headers <code>Accept-Encoding: gzip</code> and <code>Accept-Encoding: text/plain</code> separately. A response with a header value of <code>*</code> is never stored.
Expires	A response deemed stale by this header isn't stored or retrieved unless overridden by other <code>Cache-Control</code> headers.
If-None-Match	The full response is served from cache if the value isn't <code>*</code> and the <code>ETag</code> of the response doesn't match any of the values provided. Otherwise, a 304 (Not Modified) response is served.
If-Modified-Since	If the <code>If-None-Match</code> header isn't present, a full response is served from cache if the cached response date is newer than the value provided. Otherwise, a 304 (Not Modified) response is served.

HEADER	DETAILS
Date	When serving from cache, the <code>Date</code> header is set by the middleware if it wasn't provided on the original response.
Content-Length	When serving from cache, the <code>Content-Length</code> header is set by the middleware if it wasn't provided on the original response.
Age	The <code>Age</code> header sent in the original response is ignored. The middleware computes a new value when serving a cached response.

## Caching respects request Cache-Control directives

The middleware respects the rules of the [HTTP 1.1 Caching specification](#). The rules require a cache to honor a valid `Cache-Control` header sent by the client. Under the specification, a client can make requests with a `no-cache` header value and force the server to generate a new response for every request. Currently, there's no developer control over this caching behavior when using the middleware because the middleware adheres to the official caching specification.

For more control over caching behavior, explore other caching features of ASP.NET Core. See the following topics:

- [Cache in-memory](#)
- [Work with a distributed cache](#)
- [Cache Tag Helper in ASP.NET Core MVC](#)
- [Distributed Cache Tag Helper](#)

## Troubleshooting

If caching behavior isn't as expected, confirm that responses are cacheable and capable of being served from the cache. Examine the request's incoming headers and the response's outgoing headers. Enable [logging](#) to help with debugging.

When testing and troubleshooting caching behavior, a browser may set request headers that affect caching in undesirable ways. For example, a browser may set the `Cache-Control` header to `no-cache` or `max-age=0` when refreshing a page. The following tools can explicitly set request headers and are preferred for testing caching:

- [Fiddler](#)
- [Postman](#)

### Conditions for caching

- The request must result in a server response with a 200 (OK) status code.
- The request method must be GET or HEAD.
- Terminal middleware, such as [Static File Middleware](#), must not process the response prior to the Response Caching Middleware.
- The `Authorization` header must not be present.
- `Cache-Control` header parameters must be valid, and the response must be marked `public` and not marked `private`.
- The `Pragma: no-cache` header must not be present if the `Cache-Control` header isn't present, as the `Cache-Control` header overrides the `Pragma` header when present.
- The `Set-Cookie` header must not be present.

- `Vary` header parameters must be valid and not equal to `*`.
- The `Content-Length` header value (if set) must match the size of the response body.
- The `IHttpSendFileFeature` isn't used.
- The response must not be stale as specified by the `Expires` header and the `max-age` and `s-maxage` cache directives.
- Response buffering must be successful, and the size of the response must be smaller than the configured or default `SizeLimit`.
- The response must be cacheable according to the [RFC 7234](#) specifications. For example, the `no-store` directive must not exist in request or response header fields. See *Section 3: Storing Responses in Caches of RFC 7234* for details.

#### NOTE

The Antiforgery system for generating secure tokens to prevent Cross-Site Request Forgery (CSRF) attacks sets the `Cache-Control` and `Pragma` headers to `no-cache` so that responses aren't cached. For information on how to disable antiforgery tokens for HTML form elements, see [ASP.NET Core antiforgery configuration](#).

## Additional resources

- [Application Startup](#)
- [Middleware](#)
- [Cache in-memory](#)
- [Work with a distributed cache](#)
- [Detect changes with change tokens](#)
- [Response caching](#)
- [Cache Tag Helper](#)
- [Distributed Cache Tag Helper](#)

# Response Compression Middleware for ASP.NET Core

6/21/2018 • 9 minutes to read • [Edit Online](#)

By [Luke Latham](#)

[View or download sample code](#) ([how to download](#))

Network bandwidth is a limited resource. Reducing the size of the response usually increases the responsiveness of an app, often dramatically. One way to reduce payload sizes is to compress an app's responses.

## When to use Response Compression Middleware

Use server-based response compression technologies in IIS, Apache, or Nginx. The performance of the middleware probably won't match that of the server modules. [HTTP.sys server](#) and [Kestrel](#) don't currently offer built-in compression support.

Use Response Compression Middleware when you're:

- Unable to use the following server-based compression technologies:
  - [IIS Dynamic Compression module](#)
  - [Apache mod\\_deflate module](#)
  - [Nginx Compression and Decompression](#)
- Hosting directly on:
  - [HTTP.sys server](#) (formerly called [WebListener](#))
  - [Kestrel](#)

## Response compression

Usually, any response not natively compressed can benefit from response compression. Responses not natively compressed typically include: CSS, JavaScript, HTML, XML, and JSON. You shouldn't compress natively compressed assets, such as PNG files. If you attempt to further compress a natively compressed response, any small additional reduction in size and transmission time will likely be overshadowed by the time it took to process the compression. Don't compress files smaller than about 150-1000 bytes (depending on the file's content and the efficiency of compression). The overhead of compressing small files may produce a compressed file larger than the uncompressed file.

When a client can process compressed content, the client must inform the server of its capabilities by sending the `Accept-Encoding` header with the request. When a server sends compressed content, it must include information in the `Content-Encoding` header on how the compressed response is encoded. Content encoding designations supported by the middleware are shown in the following table.

ACCEPT-ENCODING HEADER VALUES	MIDDLEWARE SUPPORTED	DESCRIPTION
<code>br</code>	No	Brotli Compressed Data Format
<code>compress</code>	No	UNIX "compress" data format

ACCEPT-ENCODING HEADER VALUES	MIDDLEWARE SUPPORTED	DESCRIPTION
deflate	No	"deflate" compressed data inside the "zlib" data format
exi	No	W3C Efficient XML Interchange
gzip	Yes (default)	gzip file format
identity	Yes	"No encoding" identifier: The response must not be encoded.
pack200-gzip	No	Network Transfer Format for Java Archives
*	Yes	Any available content encoding not explicitly requested

For more information, see the [IANA Official Content Coding List](#).

The middleware allows you to add additional compression providers for custom `Accept-Encoding` header values. For more information, see [Custom Providers](#) below.

The middleware is capable of reacting to quality value (qvalue, `q`) weighting when sent by the client to prioritize compression schemes. For more information, see [RFC 7231: Accept-Encoding](#).

Compression algorithms are subject to a tradeoff between compression speed and the effectiveness of the compression. *Effectiveness* in this context refers to the size of the output after compression. The smallest size is achieved by the most *optimal* compression.

The headers involved in requesting, sending, caching, and receiving compressed content are described in the table below.

HEADER	ROLE
Accept-Encoding	Sent from the client to the server to indicate the content encoding schemes acceptable to the client.
Content-Encoding	Sent from the server to the client to indicate the encoding of the content in the payload.
Content-Length	When compression occurs, the <code>Content-Length</code> header is removed, since the body content changes when the response is compressed.
Content-MD5	When compression occurs, the <code>Content-MD5</code> header is removed, since the body content has changed and the hash is no longer valid.
Content-Type	Specifies the MIME type of the content. Every response should specify its <code>Content-Type</code> . The middleware checks this value to determine if the response should be compressed. The middleware specifies a set of <a href="#">default MIME types</a> that it can encode, but you can replace or add MIME types.

HEADER	ROLE
Vary	When sent by the server with a value of <code>Accept-Encoding</code> to clients and proxies, the <code>Vary</code> header indicates to the client or proxy that it should cache (vary) responses based on the value of the <code>Accept-Encoding</code> header of the request. The result of returning content with the <code>Vary: Accept-Encoding</code> header is that both compressed and uncompressed responses are cached separately.

You can explore the features of the Response Compression Middleware with the [sample app](#). The sample illustrates:

- The compression of app responses using gzip and custom compression providers.
- How to add a MIME type to the default list of MIME types for compression.

## Package

To include the middleware in your project, add a reference to the [Microsoft.AspNetCore.ResponseCompression](#) package. This feature is available for apps that target ASP.NET Core 1.1 or later.

To include the middleware in your project, add a reference to the [Microsoft.AspNetCore.ResponseCompression](#) package or use the [Microsoft.AspNetCore.App metapackage](#) (ASP.NET Core 2.1 or later).

## Configuration

The following code shows how to enable the Response Compression Middleware with the default gzip compression and for default MIME types.

```
public class Startup
{
    public void ConfigureServices(IServiceCollection services)
    {
        services.AddResponseCompression();
    }

    public void Configure(IApplicationBuilder app, IHostingEnvironment env)
    {
        app.UseResponseCompression();
    }
}
```

### NOTE

Use a tool like [Fiddler](#), [Firebug](#), or [Postman](#) to set the `Accept-Encoding` request header and study the response headers, size, and body.

Submit a request to the sample app without the `Accept-Encoding` header and observe that the response is uncompressed. The `Content-Encoding` and `Vary` headers aren't present on the response.

Headers TextView WebForms HexView Auth Cookies Raw JSON XML

**Request Headers**

GET / HTTP/1.1

**Client**  
User-Agent: Fiddler

**Transport**  
Host: localhost:5000

Get SyntaxView Transformer Headers TextView ImageView HexView WebView Auth Caching Cookies Raw

```
HTTP/1.1 200 OK
Date: Wed, 11 Jan 2017 18:30:11 GMT
Content-Type: text/plain
Server: Kestrel
Content-Length: 2032

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```

Submit a request to the sample app with the `Accept-Encoding: gzip` header and observe that the response is compressed. The `Content-Encoding` and `Vary` headers are present on the response.

Headers TextView WebForms HexView Auth Cookies Raw JSON XML

**Request Headers**

GET / HTTP/1.1

**Client**  
`Accept-Encoding: gzip`  
User-Agent: Fiddler

**Transport**  
Host: localhost:5000

Get SyntaxView Transformer Headers TextView ImageView HexView WebView Auth Caching Cookies Raw

Response body is encoded. Click to decode.

```
HTTP/1.1 200 OK
Date: Wed, 11 Jan 2017 18:24:08 GMT
Content-Type: text/plain
Server: Kestrel
Transfer-Encoding: chunked
Content-Encoding: gzip
Vary: Accept-Encoding

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0
```

## Providers

### GzipCompressionProvider

Use the [GzipCompressionProvider](#) to compress responses with gzip. This is the default compression provider if none are specified. You can set the compression level with the [GzipCompressionProviderOptions](#).

The gzip compression provider defaults to the fastest compression level ([CompressionLevel.Fastest](#)), which might not produce the most efficient compression. If the most efficient compression is desired, you can configure the middleware for optimal compression.

COMPRESSION LEVEL	DESCRIPTION
CompressionLevel.Fastest	Compression should complete as quickly as possible, even if the resulting output isn't optimally compressed.
CompressionLevel.NoCompression	No compression should be performed.
CompressionLevel.Optimal	Responses should be optimally compressed, even if the compression takes more time to complete.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddResponseCompression(options =>
    {
        options.Providers.Add<GzipCompressionProvider>();
        options.Providers.Add<CustomCompressionProvider>();
        options.MimeTypes =
            ResponseCompressionDefaults.MimeTypes.Concat(
                new[] { "image/svg+xml" });
    });

    services.Configure<GzipCompressionProviderOptions>(options =>
    {
        options.Level = CompressionLevel.Fastest;
    });
}
```

## MIME types

The middleware specifies a default set of MIME types for compression:

- `text/plain`
- `text/css`
- `application/javascript`
- `text/html`
- `application/xml`
- `text/xml`
- `application/json`
- `text/json`

You can replace or append MIME types with the Response Compression Middleware options. Note that wildcard MIME types, such as `text/*` aren't supported. The sample app adds a MIME type for `image/svg+xml` and compresses and serves the ASP.NET Core banner image (`bannersvg`).

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddResponseCompression(options =>
    {
        options.Providers.Add<GzipCompressionProvider>();
        options.Providers.Add<CustomCompressionProvider>();
        options.MimeTypes =
            ResponseCompressionDefaults.MimeTypes.Concat(
                new[] { "image/svg+xml" });
    });

    services.Configure<GzipCompressionProviderOptions>(options =>
    {
        options.Level = CompressionLevel.Fastest;
    });
}

```

## Custom providers

You can create custom compression implementations with [ICompressionProvider](#). The [EncodingName](#) represents the content encoding that this [ICompressionProvider](#) produces. The middleware uses this information to choose the provider based on the list specified in the [Accept-Encoding](#) header of the request.

Using the sample app, the client submits a request with the [Accept-Encoding: mycustomcompression](#) header. The middleware uses the custom compression implementation and returns the response with a [Content-Encoding: mycustomcompression](#) header. The client must be able to decompress the custom encoding in order for a custom compression implementation to work.

- [ASP.NET Core 2.x](#)
- [ASP.NET Core 1.x](#)

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddResponseCompression(options =>
    {
        options.Providers.Add<GzipCompressionProvider>();
        options.Providers.Add<CustomCompressionProvider>();
        options.MimeTypes =
            ResponseCompressionDefaults.MimeTypes.Concat(
                new[] { "image/svg+xml" });
    });

    services.Configure<GzipCompressionProviderOptions>(options =>
    {
        options.Level = CompressionLevel.Fastest;
    });
}

```

```

public class CustomCompressionProvider : ICompressionProvider
{
    public string EncodingName => "mycustomcompression";
    public bool SupportsFlush => true;

    public Stream CreateStream(Stream outputStream)
    {
        // Create a custom compression stream wrapper here
        return outputStream;
    }
}

```

Submit a request to the sample app with the [Accept-Encoding: mycustomcompression](#) header and observe the

response headers. The `Vary` and `Content-Encoding` headers are present on the response. The response body (not shown) isn't compressed by the sample. There isn't a compression implementation in the `CustomCompressionProvider` class of the sample. However, the sample shows where you would implement such a compression algorithm.

The screenshot shows the Fiddler interface with two main sections: Request Headers and Response Headers.

**Request Headers:**

- Method: GET / HTTP/1.1
- Client:
  - Accept-Encoding: mycustomcompression
  - User-Agent: Fiddler
- Transport:
  - Host: localhost:5000

**Response Headers:**

- HTTP/1.1 200 OK
- Cache:
  - Date: Thu, 19 Jan 2017 22:06:50 GMT
  - Vary: Accept-Encoding
- Entity:
  - Content-Encoding: mycustomcompression
  - Content-Type: text/plain
- Miscellaneous:
  - Server: Kestrel
- Transport:
  - Transfer-Encoding: chunked

## Compression with secure protocol

Compressed responses over secure connections can be controlled with the `EnableForHttps` option, which is disabled by default. Using compression with dynamically generated pages can lead to security problems such as the [CRIME](#) and [BREACH](#) attacks.

## Adding the Vary header

When compressing responses based on the `Accept-Encoding` header, there are potentially multiple compressed versions of the response and an uncompressed version. In order to instruct client and proxy caches that multiple versions exist and should be stored, the `Vary` header is added with an `Accept-Encoding` value. In ASP.NET Core 2.0 or later, the middleware adds the `Vary` header automatically when the response is compressed.

When compressing responses based on the `Accept-Encoding` header, there are potentially multiple compressed versions of the response and an uncompressed version. In order to instruct client and proxy caches that multiple versions exist and should be stored, the `Vary` header is added with an `Accept-Encoding` value. In ASP.NET Core 1.x, adding the `Vary` header to the response is accomplished manually:

```
// ONLY REQUIRED FOR ASP.NET CORE 1.x APPS
private void ManageVaryHeader(HttpContext context)
{
    // If the Accept-Encoding header is present, add the Vary header
    var accept = context.Request.Headers[HeaderNames.AcceptEncoding];
    if (!StringValues.IsNullOrEmpty(accept))
    {
        context.Response.Headers.Append(HeaderNames.Vary, HeaderNames.AcceptEncoding);
    }
}
```

## Middleware issue when behind an Nginx reverse proxy

When a request is proxied by Nginx, the `Accept-Encoding` header is removed. This prevents the middleware from compressing the response. For more information, see [NGINX: Compression and Decompression](#). This issue is

tracked by [Figure out pass-through compression for Nginx \(BasicMiddleware #123\)](#).

## Working with IIS dynamic compression

If you have an active IIS Dynamic Compression Module configured at the server level that you would like to disable for an app, you can do so with an addition to your `web.config` file. For more information, see [Disabling IIS modules](#).

## Troubleshooting

Use a tool like [Fiddler](#), [Firebug](#), or [Postman](#), which allow you to set the `Accept-Encoding` request header and study the response headers, size, and body. The Response Compression Middleware compresses responses that meet the following conditions:

- The `Accept-Encoding` header is present with a value of `gzip`, `*`, or custom encoding that matches a custom compression provider that you've established. The value must not be `identity` or have a quality value (`qvalue`, `q`) setting of 0 (zero).
- The MIME type (`Content-Type`) must be set and must match a MIME type configured on the [ResponseCompressionOptions](#).
- The request must not include the `Content-Range` header.
- The request must use insecure protocol (http), unless secure protocol (https) is configured in the Response Compression Middleware options. *Note the danger described above when enabling secure content compression.*

## Additional resources

- [Application Startup](#)
- [Middleware](#)
- [Mozilla Developer Network: Accept-Encoding](#)
- [RFC 7231 Section 3.1.2.1: Content Codings](#)
- [RFC 7230 Section 4.2.3: Gzip Coding](#)
- [GZIP file format specification version 4.3](#)

# Migration to ASP.NET Core

7/10/2018 • 2 minutes to read • [Edit Online](#)

## ASP.NET to ASP.NET Core

- [Migrate from ASP.NET to ASP.NET Core](#)
- [Migrate from ASP.NET MVC to ASP.NET Core MVC](#)
- [Migrate from ASP.NET Web API to ASP.NET Core Web API](#)
- [Migrate configuration](#)
- [Migrate authentication and Identity](#)
- [Migrate ClaimsPrincipal.Current usage](#)
- [Migrate ASP.NET Membership to ASP.NET Core Identity](#)
- [Migrate HTTP modules to middleware](#)

## ASP.NET Core 1.x to 2.0

- [Migrate from ASP.NET Core 1.x to 2.0](#)
- [Migrate authentication and Identity](#)

## ASP.NET Core 2.0 to 2.1

- [Migrate from ASP.NET Core 2.0 to 2.1](#)

# Migrate from ASP.NET Core 2.0 to 2.1

7/11/2018 • 7 minutes to read • [Edit Online](#)

By [Rick Anderson](#)

See [What's new in ASP.NET Core 2.1](#) for an overview of the new features in ASP.NET Core 2.1.

This article:

- Covers the basics of migrating an ASP.NET Core 2.0 app to 2.1.
- Provides an overview of the changes to the ASP.NET Core web application templates.

A quick way to get an overview of the changes in 2.1 is to:

- Create an ASP.NET Core 2.0 web app named WebApp1.
- Commit the WebApp1 in a source control system.
- Delete WebApp1 and create an ASP.NET Core 2.1 web app named WebApp1 in the same place.
- Review the changes in the 2.1 version.

This article provides an overview on migration to ASP.NET Core 2.1. It doesn't contain a complete list of all changes needed to migrate to version 2.1. Some projects might require more steps depending on the options selected when the project was created and modifications made to the project.

## Update the project file to use 2.1 versions

Update the project file:

- Change the target framework to .NET Core 2.1 by updating the project file to  
`<TargetFramework>netcoreapp2.1</TargetFramework>`.
- Replace the package reference for `Microsoft.AspNetCore.All` with a package reference for `Microsoft.AspNetCore.App`. You may need to add dependencies that were removed from `Microsoft.AspNetCore.All`. For more information, see [Microsoft.AspNetCore.All metapackage for ASP.NET Core 2.0 and later](#) and [Microsoft.AspNetCore.App metapackage for ASP.NET Core 2.1 and later](#). For apps that target the .NET Framework:
  - Add individual package references instead of a metapackage reference.
  - Update each package reference to 2.1.
- Remove references to `<DotNetCliToolReference>` elements for the following packages. These tools are bundled by default in the .NET Core CLI and don't need to be installed separately.
  - `Microsoft.DotNet.Watcher.Tools` (`dotnet watch`)
  - `Microsoft.EntityFrameworkCore.Tools.DotNet` (`dotnet ef`)
  - `Microsoft.Extensions.Caching.SqlConfig.Tools` (`dotnet sql-cache`)
  - `Microsoft.Extensions.SecretManager.Tools` (`dotnet user-secrets`)
- Optional: you can remove the `<DotNetCliToolReference>` element for `Microsoft.VisualStudio.Web.CodeGeneration.Tools`. You can replace this tool with a globally installed version by running `dotnet tool install -g dotnet-aspnet-codegenerator`.

The following markup shows the template-generated 2.0 project file:

```

<Project Sdk="Microsoft.NET.Sdk.Web">
  <PropertyGroup>
    <TargetFramework>netcoreapp2.0</TargetFramework>
    <UserSecretsId>aspnet-{Project Name}-{GUID}</UserSecretsId>
  </PropertyGroup>
  <ItemGroup>
    <PackageReference Include="Microsoft.AspNetCore.All" Version="2.0.8" />
    <PackageReference Include="Microsoft.EntityFrameworkCore.Tools" Version="2.0.3" PrivateAssets="All" />
    <PackageReference Include="Microsoft.VisualStudio.Web.CodeGeneration.Design" Version="2.0.4" PrivateAssets="All" />
  </ItemGroup>
  <ItemGroup>
    <DotNetCliToolReference Include="Microsoft.EntityFrameworkCore.Tools.DotNet" Version="2.0.3" />
    <DotNetCliToolReference Include="Microsoft.Extensions.SecretManager.Tools" Version="2.0.2" />
    <DotNetCliToolReference Include="Microsoft.VisualStudio.Web.CodeGeneration.Tools" Version="2.0.4" />
  </ItemGroup>
</Project>

```

The following markup shows the template-generated 2.1 project file:

```

<Project Sdk="Microsoft.NET.Sdk.Web">

  <PropertyGroup>
    <TargetFramework>netcoreapp2.1</TargetFramework>
    <UserSecretsId>aspnet-{Project Name}-{GUID}</UserSecretsId>
  </PropertyGroup>

  <ItemGroup>
    <PackageReference Include="Microsoft.AspNetCore.App" Version="2.1.1" />
    <PackageReference Include="Microsoft.VisualStudio.Web.CodeGeneration.Design" Version="2.1.1" PrivateAssets="All" />
  </ItemGroup>

</Project>

```

## Rules for projects targeting the shared runtime

ASP.NET Core includes the following shared runtimes:

- [Microsoft.AspNetCore.App](#)
- [Microsoft.AspNetCore.All](#)

The version specified by the package reference is the *minimum required* version. For example, a project referencing the 2.1.1 versions of these packages won't run on a machine with only the 2.1.0 runtime installed.

Known issues for projects targeting the shared runtime:

- Using `Microsoft.AspNetCore.App` 2.1.0 with Entity Framework Core 2.1.1 causes NuGet restore failures due to package conflicts. The recommended solution is to upgrade `Microsoft.AspNetCore.App` to 2.1.1. For more information, see [Packages that share dependencies with Microsoft.AspNetCore.App cannot reference patch versions](#).
- All projects that must use `Microsoft.AspNetCore.All` or `Microsoft.AspNetCore.App` should add a package reference for the package in the project file, even if they contain a project reference to another project using `Microsoft.AspNetCore.All` or `Microsoft.AspNetCore.App`.

Example:

- `MyApp` has a package reference to `Microsoft.AspNetCore.App`.
- `MyApp.Tests` has a project reference to `MyApp.csproj`.

Add a package reference for `Microsoft.AspNetCore.App` to `MyApp.Tests`. For more information, see [Integration testing is hard to set up and may break on shared framework servicing.](#)

## Changes to take advantage of the new code-based idioms that are recommended in ASP.NET Core 2.1

### Changes to Main

The following images show the changes made to the templated generated `Program.cs` file.

```
namespace WebApp1
{
    public class Program
    {
        public static void Main(string[] args)
        {
            BuildWebHost(args).Run();
        }

        public static IWebHost BuildWebHost(string[] args) =>
           WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>()
                .Build();
    }
}
```

The preceding image shows the 2.0 version with the deletions in red.

The following image shows the 2.1 code. The code in green replaced the 2.0 version:

```
namespace WebApp1
{
    public class Program
    {
        public static void Main(string[] args)
        {
            CreateWebHostBuilder(args).Build().Run();
        }

        public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>();
    }
}
```

The following code shows the 2.1 version of `Program.cs`:

```
namespace WebApp1
{
    public class Program
    {
        public static void Main(string[] args)
        {
            CreateWebHostBuilder(args).Build().Run();
        }

        public static IWebHostBuilder CreateWebHostBuilder(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>();
    }
}
```

The new `Main` replaces the call to `BuildWebHost` with `CreateWebHostBuilder`. `IWebHostBuilder` was added to support a new [integration test infrastructure](#).

## Changes to Startup

The following code shows the changes to 2.1 template generated code. All changes are newly added code, except that `UseBrowserLink` has been removed:

```
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.AspNetCore.Http;
using Microsoft.AspNetCore.Mvc;
using Microsoft.Extensions.Configuration;
using Microsoft.Extensions.DependencyInjection;

namespace WebApp1
{
    public class Startup
    {
        public Startup(IConfiguration configuration)
        {
            Configuration = configuration;
        }

        public IConfiguration Configuration { get; }

        public void ConfigureServices(IServiceCollection services)
        {
            services.Configure<CookiePolicyOptions>(options =>
            {
                // This lambda determines whether user consent for non-essential cookies is needed for a given
request.
                options.CheckConsentNeeded = context => true;
                options.MinimumSameSitePolicy = SameSiteMode.None;
            });

            services.AddMvc()
                .SetCompatibilityVersion(CompatibilityVersion.Version_2_1);
        }

        public void Configure(IApplicationBuilder app, IHostingEnvironment env)
        {
            if (env.IsDevelopment())
            {
                app.UseDeveloperExceptionPage();
            }
            else
            {
                app.UseExceptionHandler("/Error");
                app.UseHsts();
            }

            app.UseHttpsRedirection();
            app.UseStaticFiles();
            app.UseCookiePolicy();

            app.UseMvc();
        }
    }
}
```

The preceding code changes are detailed in:

- [GDPR support in ASP.NET Core](#) for `CookiePolicyOptions` and `UseCookiePolicy`.
- [HTTP Strict Transport Security Protocol \(HSTS\)](#) for `UseHsts`.
- [Require HTTPS](#) for `UseHttpsRedirection`.
- [SetCompatibilityVersion](#) for `SetCompatibilityVersion(CompatibilityVersion.Version_2_1)`.

# Changes to authentication code

ASP.NET Core 2.1 provides [ASP.NET Core Identity](#) as a [Razor Class Library](#) (RCL).

The default 2.1 Identity UI doesn't currently provide significant new features over the 2.0 version. Replacing Identity with the RCL package is optional. The advantages to replacing the template generated Identity code with the RCL version include:

- Many files are moved out of your source tree.
- Any bug fixes or new features to Identity are included in the [Microsoft.AspNetCore.App metapackage](#). You automatically get the updated Identity when `Microsoft.AspNetCore.App` is updated.

If you've made non-trivial changes to the template generated Identity code:

- The preceding advantages probably do **not** justify converting to the the RCL version.
- You can keep your ASP.NET Core 2.0 Identity code, it's fully supported.

Identity 2.1 exposes endpoints with the `/Identity` area. For example, the follow table shows examples of Identity endpoints that change from 2.0 to 2.1:

2.0 URL	2.1 URL
<code>/Account/Login</code>	<code>/Identity/Account/Login</code>
<code>/Account/Logout</code>	<code>/Identity/Account/Logout</code>
<code>/Account/Manage</code>	<code>/Identity/Account/Manage</code>

Applications that have code using Identity and replace 2.0 Identity UI with the 2.1 Identity Library need to take into account Identity URLs have `/Identity` segement prepended to the URIs. One way to handle the new Identity endpoints is to set up redirects, for example from `/Account/Login` to `/Identity/Account/Login`.

## Update Identity to version 2.1

The following options are available to update Identity to 2.1.

- Use the Identity UI 2.0 code with no changes. Using Identity UI 2.0 code is fully supported. This is a good approach when significant changes have been made to the generated Identity code.
- Delete your existing Identity 2.0 code and [Scaffold Identity](#) into your project. Your project will use the [ASP.NET Core Identity Razor Class Library](#). You can generate code and UI for any of the Identity UI code that you modified. Apply your code changes to the newly scaffolded UI code.
- Delete your existing Identity 2.0 code and [Scaffold Identity](#) into your project with the option to **Override all files**.

## Replace Identity 2.0 UI with the Identity 2.1 Razor Class Library

This section outlines the steps to replace the ASP.NET Core 2.0 template generated Identity code with the [ASP.NET Core Identity Razor Class Library](#). The following steps are for a Razor Pages project, but the approach for an MVC project is similar.

- Verify the [project file is updated to use 2.1 versions](#)
- Delete the following folders and all the files in them:
  - *Controllers*
  - *Pages/Account/*
  - *Extensions*
- Build the project.

- **Scaffold Identity** into your project:
  - Select the projects exiting `_Layout.cshtml` file.
  - Select the `+` icon on the right side of the **Data context class**. Accept the default name.
  - Select **Add** to create a new Data context class. Creating a new data context is required for to scaffold. You remove the new data context in the next section.

### Update after scaffolding Identity

- Delete the Identity scaffolder generated `IdentityDbContext` derrived class in the `Areas/Identity/Data/` folder.
- Delete `Areas/Identity/IdentityHostingStartup.cs`
- Update the `_LoginPartial.cshtml` file:
  - Move `Pages/_LoginPartial.cshtml` to `Pages/Shared/_LoginPartial.cshtml`
  - Add `asp-area="Identity"` to the form and anchor links.
  - Update the `<form />` element to
 

```
<form asp-area="Identity" asp-page="/Account/Logout" asp-route-returnUrl="@Url.Page("/Index", new { area = "" })" method="post" id="logoutForm" class="navbar-right">
```

The following code shows the updated `_LoginPartial.cshtml` file:

```
@using Microsoft.AspNetCore.Identity

@inject SignInManager<ApplicationUser> SignInManager
@inject UserManager<ApplicationUser> UserManager

@if (SignInManager.IsSignedIn(User))
{
    <form asp-area="Identity" asp-page="/Account/Logout" asp-route-returnUrl="@Url.Page("/Index", new { area = "" })" method="post" id="logoutForm" class="navbar-right">
        <ul class="nav navbar-nav navbar-right">
            <li>
                <a asp-area="Identity" asp-page="/Account/Manage/Index" title="Manage">Hello
                    @UserManager.GetUserName(User) !</a>
            </li>
            <li>
                <button type="submit" class="btn btn-link navbar-btn navbar-link">Log out</button>
            </li>
        </ul>
    </form>
}
else
{
    <ul class="nav navbar-nav navbar-right">
        <li><a asp-area="Identity" asp-page="/Account/Register">Register</a></li>
        <li><a asp-area="Identity" asp-page="/Account/Login">Log in</a></li>
    </ul>
}
```

Update `ConfigureServices` with the following code:

```

public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<ApplicationContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("DefaultConnection")));

    services.AddDefaultIdentity<ApplicationUser>()
        .AddEntityFrameworkStores<ApplicationContext>()
        .AddDefaultTokenProviders();

    services.AddMvc();

    // Register no-op EmailSender used by account confirmation and password reset
    // during development
    services.AddSingleton<IEmailSender, EmailSender>();
}

```

## Changes to Razor Pages projects Razor files

### The layout file

- Move *Pages/\_Layout.cshtml* to *Pages/Shared/\_Layout.cshtml*
- The *Layout.cshtml* file has the following changes:
  - `<partial name="_CookieConsentPartial" />` is added. For more information, see [GDPR support in ASP.NET Core](#).
  - jQuery changes from 2.2.0 to 3.3.1

### \_ValidationScriptsPartial.cshtml

- *Pages/\_ValidationScriptsPartial.cshtml* moves to *Pages/Shared/\_ValidationScriptsPartial.cshtml*
- *jquery.validate/1.14.0* changes to *jquery.validate/1.17.0*

### New files

The following files are added:

- *Privacy.cshtml*
- *Privacy.cshtml.cs*

See [GDPR support in ASP.NET Core](#) for information on the preceding files.

## Changes to MVC projects Razor files

### The layout file

The *Layout.cshtml* file has the following changes:

- `<partial name="_CookieConsentPartial" />` is added.
- jQuery changes from 2.2.0 to 3.3.1

### \_ValidationScriptsPartial.cshtml

*jquery.validate/1.14.0* changes to *jquery.validate/1.17.0*

### New files and action methods

The following are added:

- *Views/Home/Privacy.cshtml*
- The `Privacy` action method is added to the Home controller.

See [GDPR support in ASP.NET Core](#) for information on the preceding files.

## Additional changes

- [SetCompatibilityVersion](#)
- [Transport configuration](#)

# Migrate from ASP.NET to ASP.NET Core

6/21/2018 • 7 minutes to read • [Edit Online](#)

By [Isaac Levin](#)

This article serves as a reference guide for migrating ASP.NET apps to ASP.NET Core.

## Prerequisites

[.NET Core SDK 2.0 or later](#)

## Target frameworks

ASP.NET Core projects offer developers the flexibility of targeting .NET Core, .NET Framework, or both. See [Choosing between .NET Core and .NET Framework for server apps](#) to determine which target framework is most appropriate.

When targeting .NET Framework, projects need to reference individual NuGet packages.

Targeting .NET Core allows you to eliminate numerous explicit package references, thanks to the ASP.NET Core [metapackage](#). Install the `Microsoft.AspNetCore.All` metapackage in your project:

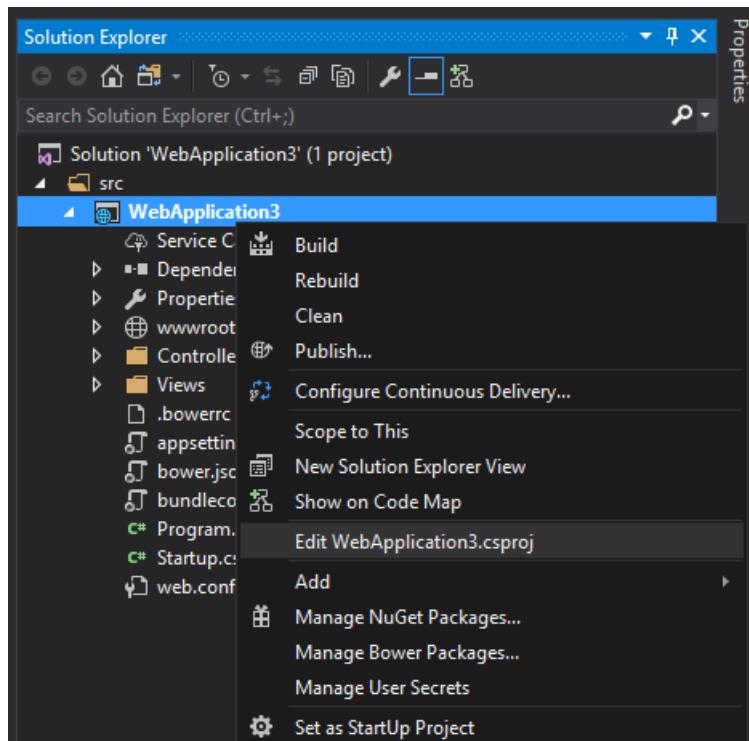
```
<ItemGroup>
  <PackageReference Include="Microsoft.AspNetCore.All" Version="2.0.0" />
</ItemGroup>
```

When the metapackage is used, no packages referenced in the metapackage are deployed with the app. The .NET Core Runtime Store includes these assets, and they're precompiled to improve performance. See [Microsoft.AspNetCore.All metapackage for ASP.NET Core 2.x](#) for more detail.

## Project structure differences

The `.csproj` file format has been simplified in ASP.NET Core. Some notable changes include:

- Explicit inclusion of files isn't necessary for them to be considered part of the project. This reduces the risk of XML merge conflicts when working on large teams.
- There are no GUID-based references to other projects, which improves file readability.
- The file can be edited without unloading it in Visual Studio:



## Global.asax file replacement

ASP.NET Core introduced a new mechanism for bootstrapping an app. The entry point for ASP.NET applications is the *Global.asax* file. Tasks such as route configuration and filter and area registrations are handled in the *Global.asax* file.

```
public class MvcApplication : System.Web.HttpApplication
{
    protected void Application_Start()
    {
        AreaRegistration.RegisterAllAreas();
        FilterConfig.RegisterGlobalFilters(GlobalFilters.Filters);
        RouteConfig.RegisterRoutes(RouteTable.Routes);
        BundleConfig.RegisterBundles(BundleTable.Bundles);
    }
}
```

This approach couples the application and the server to which it's deployed in a way that interferes with the implementation. In an effort to decouple, **OWIN** was introduced to provide a cleaner way to use multiple frameworks together. OWIN provides a pipeline to add only the modules needed. The hosting environment takes a **Startup** function to configure services and the app's request pipeline. **Startup** registers a set of middleware with the application. For each request, the application calls each of the middleware components with the head pointer of a linked list to an existing set of handlers. Each middleware component can add one or more handlers to the request handling pipeline. This is accomplished by returning a reference to the handler that's the new head of the list. Each handler is responsible for remembering and invoking the next handler in the list. With ASP.NET Core, the entry point to an application is **Startup**, and you no longer have a dependency on *Global.asax*. When using OWIN with .NET Framework, use something like the following as a pipeline:

```

using Owin;
using System.Web.Http;

namespace WebApi
{
    // Note: By default all requests go through this OWIN pipeline. Alternatively you can turn this off by
    // adding an appSetting owin:AutomaticAppStartup with value "false".
    // With this turned off you can still have OWIN apps listening on specific routes by adding routes in
    global.asax file using MapOwinPath or MapOwinRoute extensions on RouteTable.Routes
    public class Startup
    {
        // Invoked once at startup to configure your application.
        public void Configuration(IAppBuilder builder)
        {
            HttpConfiguration config = new HttpConfiguration();
            config.Routes.MapHttpRoute("Default", "{controller}/{customerID}", new { controller = "Customer",
customerID = RouteParameter.Optional });

            config.Formatters.XmlFormatter.UseXmlSerializer = true;
            config.Formatters.Remove(config.Formatters.JsonFormatter);
            // config.Formatters.JsonFormatter.UseDataContractJsonSerializer = true;

            builder.UseWebApi(config);
        }
    }
}

```

This configures your default routes, and defaults to XmlSerialization over Json. Add other Middleware to this pipeline as needed (loading services, configuration settings, static files, etc.).

ASP.NET Core uses a similar approach, but doesn't rely on OWIN to handle the entry. Instead, that's done through the `Program.cs` `Main` method (similar to console applications) and `Startup` is loaded through there.

```

using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;

namespace WebApplication2
{
    public class Program
    {
        public static void Main(string[] args)
        {
            BuildWebHost(args).Run();
        }

        public static IWebHost BuildWebHost(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>()
                .Build();
    }
}

```

`Startup` must include a `Configure` method. In `Configure`, add the necessary middleware to the pipeline. In the following example (from the default web site template), several extension methods are used to configure the pipeline with support for:

- [BrowserLink](#)
- Error pages
- Static files
- ASP.NET Core MVC
- Identity

```

public void Configure(IApplicationBuilder app, IHostingEnvironment env, ILoggerFactory loggerFactory)
{
    loggerFactory.AddConsole(Configuration.GetSection("Logging"));
    loggerFactory.AddDebug();

    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
        app.UseDatabaseErrorPage();
        app.UseBrowserLink();
    }
    else
    {
        app.UseExceptionHandler("/Home/Error");
    }

    app.UseStaticFiles();

    app.UseIdentity();

    app.UseMvc(routes =>
    {
        routes.MapRoute(
            name: "default",
            template: "{controller=Home}/{action=Index}/{id?}");
    });
}

```

The host and application have been decoupled, which provides the flexibility of moving to a different platform in the future.

#### **NOTE**

For a more in-depth reference to ASP.NET Core Startup and Middleware, see [Startup in ASP.NET Core](#)

## Store configurations

ASP.NET supports storing settings. These setting are used, for example, to support the environment to which the applications were deployed. A common practice was to store all custom key-value pairs in the `<appSettings>` section of the `Web.config` file:

```

<appSettings>
    <add key="UserName" value="User" />
    <add key="Password" value="Password" />
</appSettings>

```

Applications read these settings using the `ConfigurationManager.AppSettings` collection in the `System.Configuration` namespace:

```

string userName = System.Web.Configuration.ConfigurationManager.AppSettings["UserName"];
string password = System.Web.Configuration.ConfigurationManager.AppSettings["Password"];

```

ASP.NET Core can store configuration data for the application in any file and load them as part of middleware bootstrapping. The default file used in the project templates is `appsettings.json`:

```
{
    "Logging": {
        "IncludeScopes": false,
        "LogLevel": {
            "Default": "Debug",
            "System": "Information",
            "Microsoft": "Information"
        }
    },
    // Here is where you can supply custom configuration settings, Since it is JSON, everything is
    represented as key: value pairs
    // Name of section is your choice
    "AppConfiguration": {
        "UserName": "UserName",
        "Password": "Password"
    }
}
```

Loading this file into an instance of `IConfiguration` inside your application is done in *Startup.cs*:

```
public Startup(IConfiguration configuration)
{
    Configuration = configuration;
}

public IConfiguration Configuration { get; }
```

The app reads from `Configuration` to get the settings:

```
string userName = Configuration.GetSection("AppConfiguration")["UserName"];
string password = Configuration.GetSection("AppConfiguration")["Password"];
```

There are extensions to this approach to make the process more robust, such as using [Dependency Injection \(DI\)](#) to load a service with these values. The DI approach provides a strongly-typed set of configuration objects.

```
// Assume AppConfiguration is a class representing a strongly-typed version of AppConfiguration section
services.Configure<AppConfiguration>(Configuration.GetSection("AppConfiguration"));
```

#### NOTE

For a more in-depth reference to ASP.NET Core configuration, see [Configuration in ASP.NET Core](#).

## Native dependency injection

An important goal when building large, scalable applications is the loose coupling of components and services.

[Dependency Injection](#) is a popular technique for achieving this, and it's a native component of ASP.NET Core.

In ASP.NET apps, developers rely on a third-party library to implement Dependency Injection. One such library is [Unity](#), provided by Microsoft Patterns & Practices.

An example of setting up Dependency Injection with Unity is implementing `IDependencyResolver` that wraps a `UnityContainer`:

```

using Microsoft.Practices.Unity;
using System;
using System.Collections.Generic;
using System.Web.Http.Dependencies;

public class UnityResolver : IDependencyResolver
{
    protected IUnityContainer container;

    public UnityResolver(IUnityContainer container)
    {
        if (container == null)
        {
            throw new ArgumentNullException("container");
        }
        this.container = container;
    }

    public object GetService(Type serviceType)
    {
        try
        {
            return container.Resolve(serviceType);
        }
        catch (ResolutionFailedException)
        {
            return null;
        }
    }

    public IEnumerable<object> GetServices(Type serviceType)
    {
        try
        {
            return container.ResolveAll(serviceType);
        }
        catch (ResolutionFailedException)
        {
            return new List<object>();
        }
    }

    public IDependencyScope BeginScope()
    {
        var child = container.CreateChildContainer();
        return new UnityResolver(child);
    }

    public void Dispose()
    {
        Dispose(true);
    }

    protected virtual void Dispose(bool disposing)
    {
        container.Dispose();
    }
}

```

Create an instance of your `UnityContainer`, register your service, and set the dependency resolver of `HttpConfiguration` to the new instance of `UnityResolver` for your container:

```

public static void Register(HttpConfiguration config)
{
    var container = new UnityContainer();
    container.RegisterType<IProductRepository, ProductRepository>(new HierarchicalLifetimeManager());
    config.DependencyResolver = new UnityResolver(container);

    // Other Web API configuration not shown.
}

```

Inject `IProductRepository` where needed:

```

public class ProductsController : ApiController
{
    private IProductRepository _repository;

    public ProductsController(IProductRepository repository)
    {
        _repository = repository;
    }

    // Other controller methods not shown.
}

```

Because Dependency Injection is part of ASP.NET Core, you can add your service in the `ConfigureServices` method of `Startup.cs`:

```

public void ConfigureServices(IServiceCollection services)
{
    // Add application services.
    services.AddTransient<IProductRepository, ProductRepository>();
}

```

The repository can be injected anywhere, as was true with Unity.

#### **NOTE**

For an in-depth reference to dependency injection in ASP.NET Core, see [Dependency Injection in ASP.NET Core](#)

## Serve static files

An important part of web development is the ability to serve static, client-side assets. The most common examples of static files are HTML, CSS, Javascript, and images. These files need to be saved in the published location of the app (or CDN) and referenced so they can be loaded by a request. This process has changed in ASP.NET Core.

In ASP.NET, static files are stored in various directories and referenced in the views.

In ASP.NET Core, static files are stored in the "web root" (`<content root>/wwwroot`), unless configured otherwise. The files are loaded into the request pipeline by invoking the `UseStaticFiles` extension method from `Startup.Configure`:

```

public void Configure(IApplicationBuilder app)
{
    app.UseStaticFiles();
}

```

**NOTE**

If targeting .NET Framework, install the NuGet package `Microsoft.AspNetCore.StaticFiles`.

For example, an image asset in the `wwwroot/images` folder is accessible to the browser at a location such as

`http://<app>/images/<imageFileName>`.

**NOTE**

For a more in-depth reference to serving static files in ASP.NET Core, see [Static files](#).

## Additional resources

- [Porting Libraries to .NET Core](#)

# Migrate from ASP.NET MVC to ASP.NET Core MVC

6/21/2018 • 7 minutes to read • [Edit Online](#)

By [Rick Anderson](#), [Daniel Roth](#), [Steve Smith](#), and [Scott Addie](#)

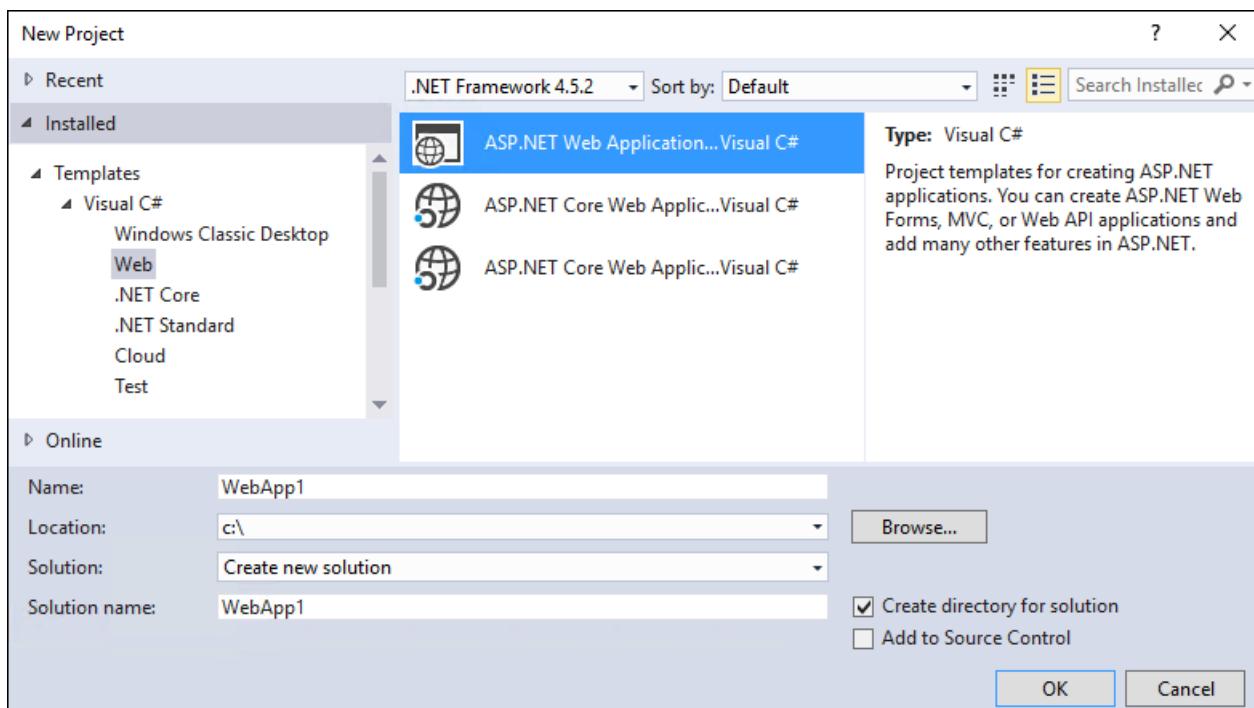
This article shows how to get started migrating an ASP.NET MVC project to [ASP.NET Core MVC](#). In the process, it highlights many of the things that have changed from ASP.NET MVC. Migrating from ASP.NET MVC is a multiple step process and this article covers the initial setup, basic controllers and views, static content, and client-side dependencies. Additional articles cover migrating configuration and identity code found in many ASP.NET MVC projects.

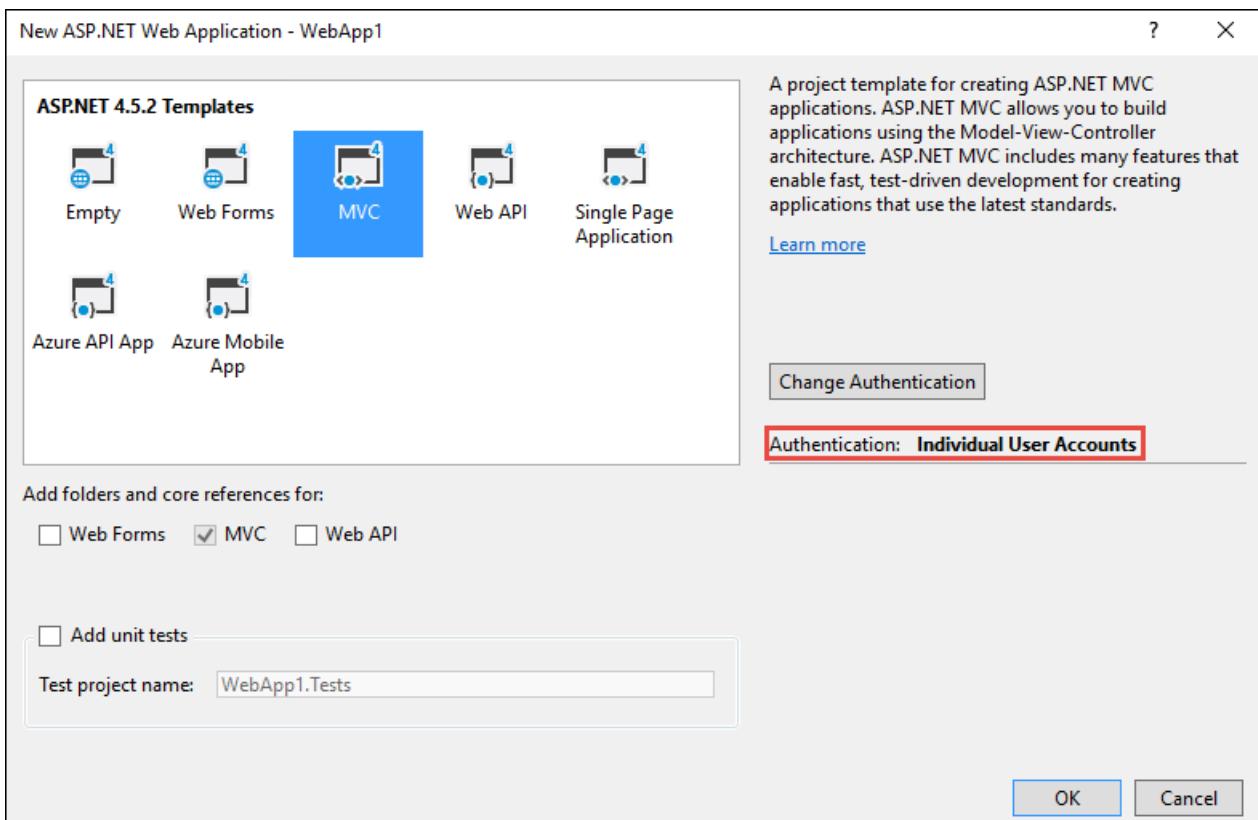
## NOTE

The version numbers in the samples might not be current. You may need to update your projects accordingly.

## Create the starter ASP.NET MVC project

To demonstrate the upgrade, we'll start by creating a ASP.NET MVC app. Create it with the name *WebApp1* so the namespace matches the ASP.NET Core project we create in the next step.

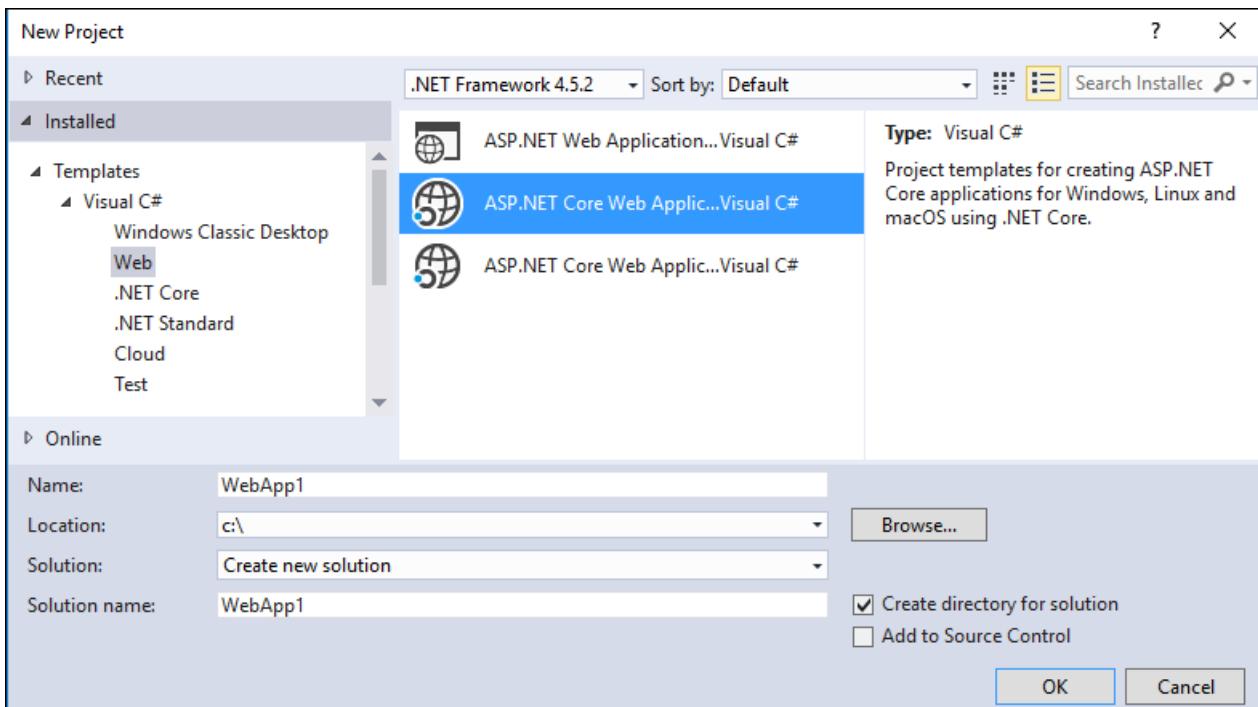


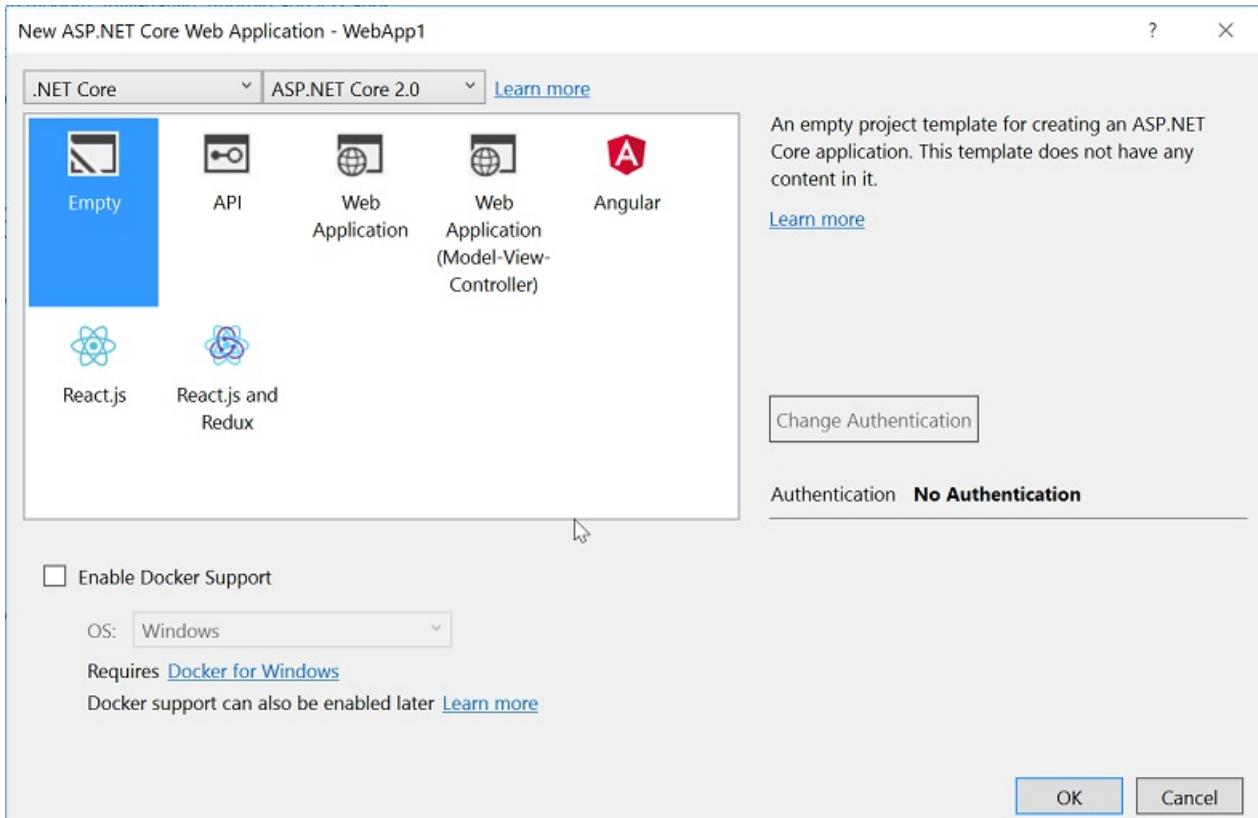


*Optional:* Change the name of the Solution from *WebApp1* to *Mvc5*. Visual Studio displays the new solution name (*Mvc5*), which makes it easier to tell this project from the next project.

## Create the ASP.NET Core project

Create a new *empty* ASP.NET Core web app with the same name as the previous project (*WebApp1*) so the namespaces in the two projects match. Having the same namespace makes it easier to copy code between the two projects. You'll have to create this project in a different directory than the previous project to use the same name.





- *Optional:* Create a new ASP.NET Core app using the *Web Application* project template. Name the project *WebApp1*, and select an authentication option of **Individual User Accounts**. Rename this app to *FullAspNetCore*. Creating this project saves you time in the conversion. You can look at the template-generated code to see the end result or to copy code to the conversion project. It's also helpful when you get stuck on a conversion step to compare with the template-generated project.

## Configure the site to use MVC

- When targeting .NET Core, the ASP.NET Core metapackage is added to the project, called `Microsoft.AspNetCore.All` by default. This package contains packages like `Microsoft.AspNetCore.Mvc` and `Microsoft.AspNetCore.StaticFiles`. If targeting .NET Framework, package references need to be listed individually in the \*.csproj file.

`Microsoft.AspNetCore.Mvc` is the ASP.NET Core MVC framework. `Microsoft.AspNetCore.StaticFiles` is the static file handler. The ASP.NET Core runtime is modular, and you must explicitly opt in to serve static files (see [Static files](#)).

- Open the *Startup.cs* file and change the code to match the following:

```

using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.DependencyInjection;

namespace WebApp1
{
    public class Startup
    {
        // This method gets called by the runtime. Use this method to add services to the container.
        // For more information on how to configure your application, visit
        https://go.microsoft.com/fwlink/?LinkID=398940
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddMvc();
        }

        // This method gets called by the runtime. Use this method to configure the HTTP request
        pipeline.
        public void Configure(IApplicationBuilder app, IHostingEnvironment env)
        {
            if (env.IsDevelopment())
            {
                app.UseDeveloperExceptionPage();
            }

            app.UseStaticFiles();

            app.UseMvc(routes =>
            {
                routes.MapRoute(
                    name: "default",
                    template: "{controller=Home}/{action=Index}/{id?}");
            });
        }
    }
}

```

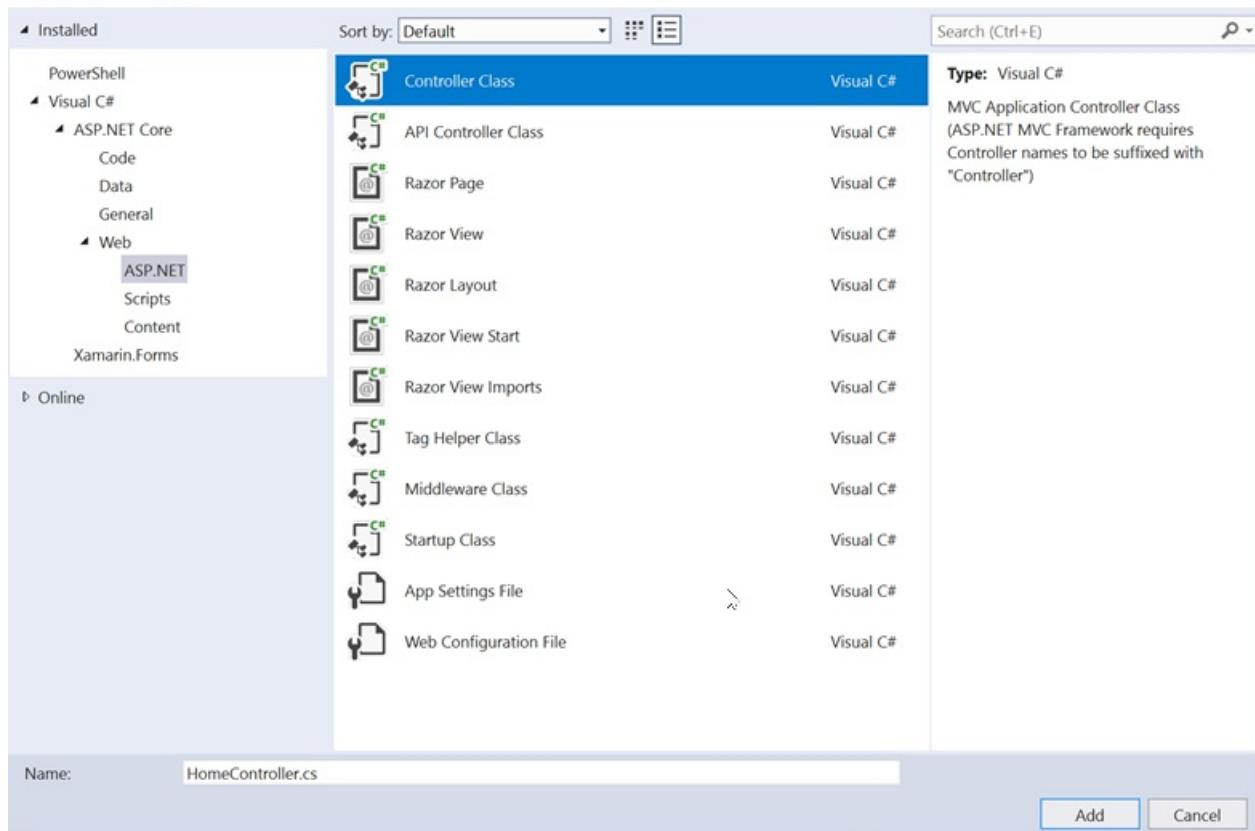
The `UseStaticFiles` extension method adds the static file handler. As mentioned previously, the ASP.NET runtime is modular, and you must explicitly opt in to serve static files. The `UseMvc` extension method adds routing. For more information, see [Application Startup](#) and [Routing](#).

## Add a controller and view

In this section, you'll add a minimal controller and view to serve as placeholders for the ASP.NET MVC controller and views you'll migrate in the next section.

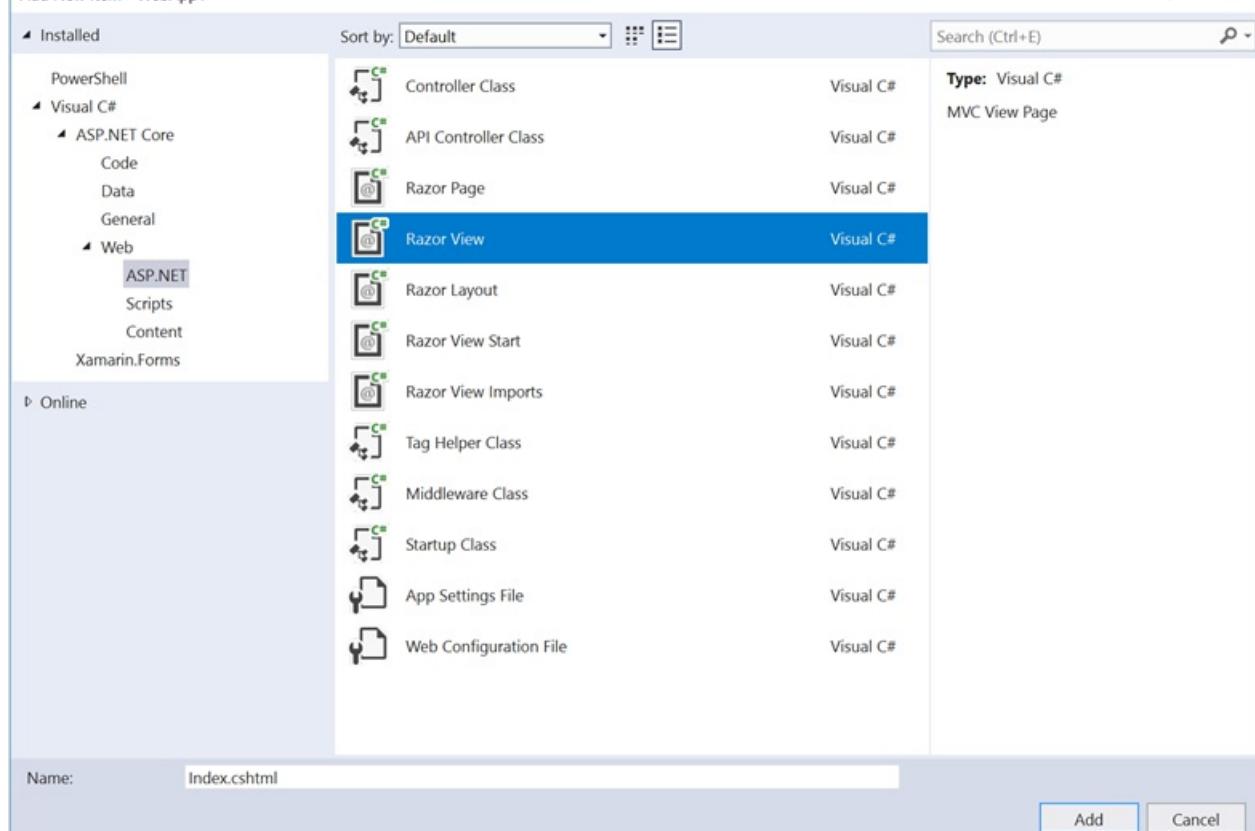
- Add a *Controllers* folder.
- Add a **Controller Class** named *HomeController.cs* to the *Controllers* folder.

## Add New Item - WebApp1

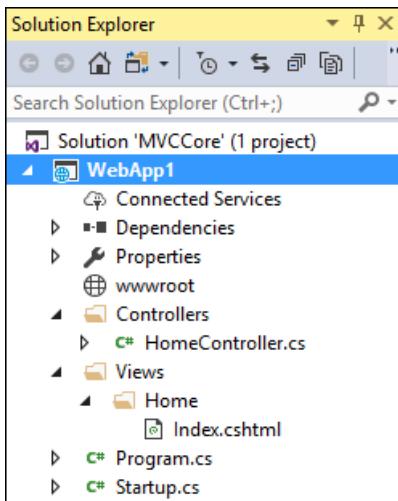


- Add a *Views* folder.
- Add a *Views/Home* folder.
- Add a **Razor View** named *Index.cshtml* to the *Views/Home* folder.

## Add New Item - WebApp1



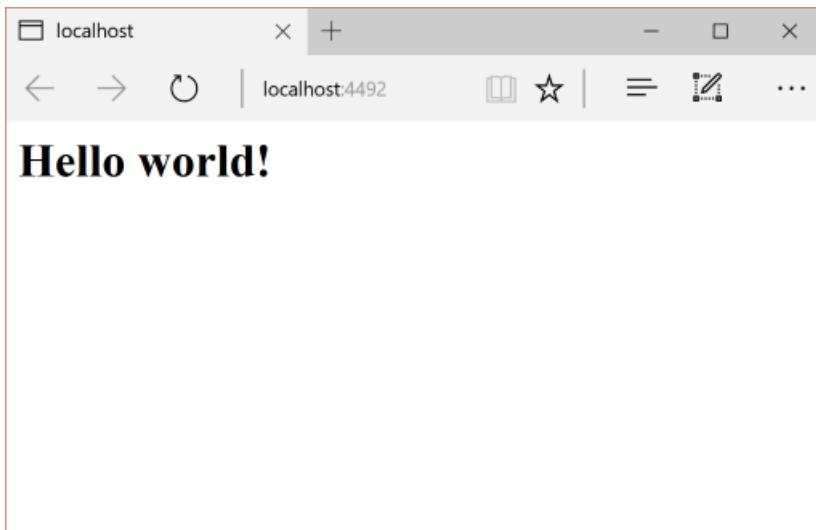
The project structure is shown below:



Replace the contents of the `Views/Home/Index.cshtml` file with the following:

```
<h1>Hello world!</h1>
```

Run the app.



See [Controllers](#) and [Views](#) for more information.

Now that we have a minimal working ASP.NET Core project, we can start migrating functionality from the ASP.NET MVC project. We need to move the following:

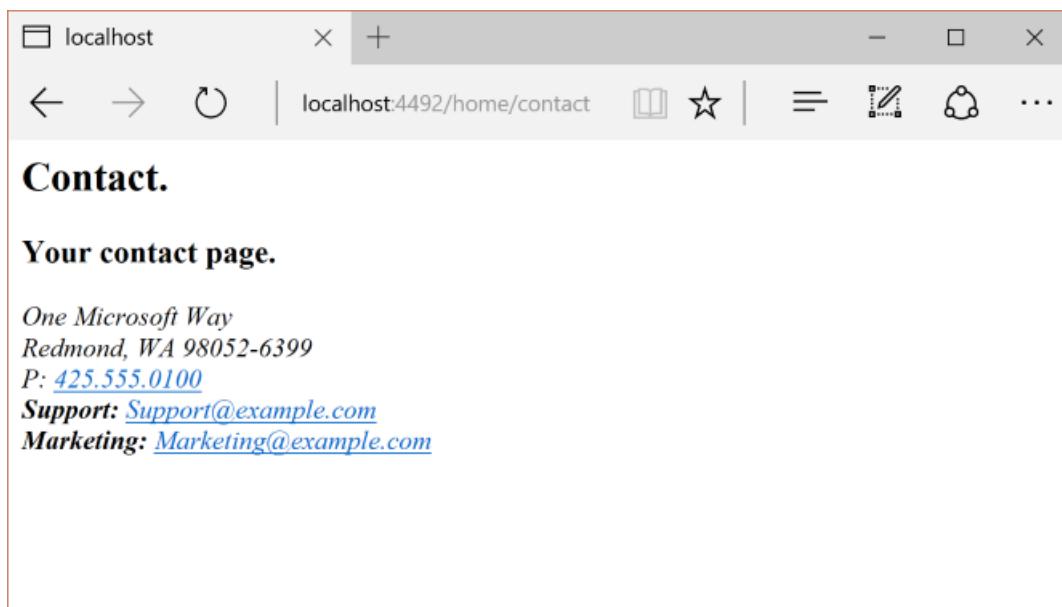
- client-side content (CSS, fonts, and scripts)
- controllers
- views
- models
- bundling
- filters
- Log in/out, Identity (This is done in the next tutorial.)

## Controllers and views

- Copy each of the methods from the ASP.NET MVC `HomeController` to the new `HomeController`. Note that

in ASP.NET MVC, the built-in template's controller action method return type is `ActionResult`; in ASP.NET Core MVC, the action methods return `IActionResult` instead. `ActionResult` implements `IActionResult`, so there's no need to change the return type of your action methods.

- Copy the `About.cshtml`, `Contact.cshtml`, and `Index.cshtml` Razor view files from the ASP.NET MVC project to the ASP.NET Core project.
- Run the ASP.NET Core app and test each method. We haven't migrated the layout file or styles yet, so the rendered views only contain the content in the view files. You won't have the layout file generated links for the `About` and `Contact` views, so you'll have to invoke them from the browser (replace **4492** with the port number used in your project).
  - `http://localhost:4492/home/about`
  - `http://localhost:4492/home/contact`



Note the lack of styling and menu items. We'll fix that in the next section.

## Static content

In previous versions of ASP.NET MVC, static content was hosted from the root of the web project and was intermixed with server-side files. In ASP.NET Core, static content is hosted in the `wwwroot` folder. You'll want to copy the static content from your old ASP.NET MVC app to the `wwwroot` folder in your ASP.NET Core project. In this sample conversion:

- Copy the `favicon.ico` file from the old MVC project to the `wwwroot` folder in the ASP.NET Core project.

The old ASP.NET MVC project uses `Bootstrap` for its styling and stores the Bootstrap files in the `Content` and `Scripts` folders. The template, which generated the old ASP.NET MVC project, references Bootstrap in the layout file (`Views/Shared/_Layout.cshtml`). You could copy the `bootstrap.js` and `bootstrap.css` files from the ASP.NET MVC project to the `wwwroot` folder in the new project. Instead, we'll add support for Bootstrap (and other client-side libraries) using CDNs in the next section.

## Migrate the layout file

- Copy the `_ViewStart.cshtml` file from the old ASP.NET MVC project's `Views` folder into the ASP.NET Core project's `Views` folder. The `_ViewStart.cshtml` file has not changed in ASP.NET Core MVC.
- Create a `Views/Shared` folder.

- *Optional:* Copy `_ViewImports.cshtml` from the `FullAspNetCore` MVC project's `Views` folder into the ASP.NET Core project's `Views` folder. Remove any namespace declaration in the `_ViewImports.cshtml` file. The `_ViewImports.cshtml` file provides namespaces for all the view files and brings in [Tag Helpers](#). Tag Helpers are used in the new layout file. The `_ViewImports.cshtml` file is new for ASP.NET Core.
- Copy the `_Layout.cshtml` file from the old ASP.NET MVC project's `Views/Shared` folder into the ASP.NET Core project's `Views/Shared` folder.

Open `_Layout.cshtml` file and make the following changes (the completed code is shown below):

- Replace `@Styles.Render("~/Content/css")` with a `<link>` element to load `bootstrap.css` (see below).
- Remove `@Scripts.Render("~/bundles/modernizr")`.
- Comment out the `@Html.Partial("_LoginPartial")` line (surround the line with `@*...*@`). We'll return to it in a future tutorial.
- Replace `@Scripts.Render("~/bundles/jquery")` with a `<script>` element (see below).
- Replace `@Scripts.Render("~/bundles/bootstrap")` with a `<script>` element (see below).

The replacement markup for Bootstrap CSS inclusion:

```
<link rel="stylesheet"
      href="https://maxcdn.bootstrapcdn.com/bootstrap/3.3.7/css/bootstrap.min.css"
      integrity="sha384-BVYiiSIFeK1dGmJRAkycuHAHRg32OmUcww7on3RYdg4Va+PmSTsz/K68vbdEjh4u"
      crossorigin="anonymous">
```

The replacement markup for jQuery and Bootstrap JavaScript inclusion:

```
<script src="https://code.jquery.com/jquery-3.3.1.min.js"></script>
<script src="https://maxcdn.bootstrapcdn.com/bootstrap/3.3.7/js/bootstrap.min.js"
      integrity="sha384-Tc5IQib027qvyjSMfHj0maLkfuWVxZxUPnCJA7l2mCWNIpG9mGCD8wGNicPD7Txa"
      crossorigin="anonymous"></script>
```

The updated `_Layout.cshtml` file is shown below:

```

<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>@ViewBag.Title - My ASP.NET Application</title>
    <link rel="stylesheet"
        href="https://maxcdn.bootstrapcdn.com/bootstrap/3.3.7/css/bootstrap.min.css"
        integrity="sha384-BVYiiSIFeK1dGmJRAkycuHAHRg320mUcww7on3RYdg4Va+PmSTsz/K68vbdEjh4u"
        crossorigin="anonymous">
</head>
<body>
    <div class="navbar navbar-inverse navbar-fixed-top">
        <div class="container">
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-collapse">
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                @Html.ActionLink("Application name", "Index", "Home", new { area = "" }, new { @class = "navbar-brand" })
            </div>
            <div class="navbar-collapse collapse">
                <ul class="nav navbar-nav">
                    <li>@Html.ActionLink("Home", "Index", "Home")</li>
                    <li>@Html.ActionLink("About", "About", "Home")</li>
                    <li>@Html.ActionLink("Contact", "Contact", "Home")</li>
                </ul>
                @* @Html.Partial("_LoginPartial") *@
            </div>
        </div>
    </div>
    <div class="container body-content">
        @RenderBody()
        <hr />
        <footer>
            <p>&copy; @DateTime.Now.Year - My ASP.NET Application</p>
        </footer>
    </div>

    <script src="https://code.jquery.com/jquery-3.3.1.min.js"></script>
    <script src="https://maxcdn.bootstrapcdn.com/bootstrap/3.3.7/js/bootstrap.min.js"
        integrity="sha384-Tc5Iqib027qvyyjSMfHj0MaLkfuiWxZxUPnCJA712mCWNIPG9mGCD8wGNICPD7Txu"
        crossorigin="anonymous"></script>
    @RenderSection("scripts", required: false)
</body>
</html>

```

View the site in the browser. It should now load correctly, with the expected styles in place.

- *Optional:* You might want to try using the new layout file. For this project you can copy the layout file from the `FullAspNetCore` project. The new layout file uses [Tag Helpers](#) and has other improvements.

## Configure bundling and minification

For information about how to configure bundling and minification, see [Bundling and Minification](#).

## Solve HTTP 500 errors

There are many problems that can cause a HTTP 500 error message that contain no information on the source of the problem. For example, if the `Views/_ViewImports.cshtml` file contains a namespace that doesn't exist in your

project, you'll get a HTTP 500 error. By default in ASP.NET Core apps, the `UseDeveloperExceptionPage` extension is added to the `IApplicationBuilder` and executed when the configuration is *Development*. This is detailed in the following code:

```
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.DependencyInjection;

namespace WebApp1
{
    public class Startup
    {
        // This method gets called by the runtime. Use this method to add services to the container.
        // For more information on how to configure your application, visit https://go.microsoft.com/fwlink/?LinkID=398940
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddMvc();
        }

        // This method gets called by the runtime. Use this method to configure the HTTP request pipeline.
        public void Configure(IApplicationBuilder app, IHostingEnvironment env)
        {
            if (env.IsDevelopment())
            {
                app.UseDeveloperExceptionPage();
            }

            app.UseStaticFiles();

            app.UseMvc(routes =>
            {
                routes.MapRoute(
                    name: "default",
                    template: "{controller=Home}/{action=Index}/{id?}");
            });
        }
    }
}
```

ASP.NET Core converts unhandled exceptions in a web app into HTTP 500 error responses. Normally, error details aren't included in these responses to prevent disclosure of potentially sensitive information about the server. See [Using the Developer Exception Page](#) in [Handle errors](#) for more information.

## Additional resources

- [Client-side development](#)
- [Tag Helpers](#)

# Migrate from ASP.NET Web API to ASP.NET Core

7/6/2018 • 8 minutes to read • [Edit Online](#)

By [Steve Smith](#) and [Scott Addie](#)

Web APIs are HTTP services that reach a broad range of clients, including browsers and mobile devices. ASP.NET Core MVC includes support for building Web APIs providing a single, consistent way of building web applications. In this article, we demonstrate the steps required to migrate a Web API implementation from ASP.NET Web API to ASP.NET Core MVC.

[View or download sample code \(how to download\)](#)

## Review ASP.NET Web API project

This article uses the sample project, *ProductsApp*, created in the article [Getting Started with ASP.NET Web API 2](#) as its starting point. In that project, a simple ASP.NET Web API project is configured as follows.

In *Global.asax.cs*, a call is made to `WebApiConfig.Register`:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Web;
using System.Web.Http;
using System.Web.Routing;

namespace ProductsApp
{
    public class WebApiApplication : System.Web.HttpApplication
    {
        protected void Application_Start()
        {
            GlobalConfiguration.Configure(WebApiConfig.Register);
        }
    }
}
```

`WebApiConfig` is defined in *App\_Start*, and has just one static `Register` method:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Web.Http;

namespace ProductsApp
{
    public static class WebApiConfig
    {
        public static void Register(HttpConfiguration config)
        {
            // Web API configuration and services

            // Web API routes
            config.MapHttpAttributeRoutes();

            config.Routes.MapHttpRoute(
                name: "DefaultApi",
                routeTemplate: "api/{controller}/{id}",
                defaults: new { id = RouteParameter.Optional }
            );
        }
    }
}
```

This class configures [attribute routing](#), although it's not actually being used in the project. It also configures the routing table, which is used by ASP.NET Web API. In this case, ASP.NET Web API will expect URLs to match the format `/api/{controller}/{id}`, with `{id}` being optional.

The *ProductsApp* project includes just one simple controller, which inherits from `ApiController` and exposes two methods:

```

using ProductsApp.Models;
using System;
using System.Collections.Generic;
using System.Linq;
using System.Net;
using System.Web.Http;

namespace ProductsApp.Controllers
{
    public class ProductsController : ApiController
    {
        Product[] products = new Product[]
        {
            new Product { Id = 1, Name = "Tomato Soup", Category = "Groceries", Price = 1 },
            new Product { Id = 2, Name = "Yo-yo", Category = "Toys", Price = 3.75M },
            new Product { Id = 3, Name = "Hammer", Category = "Hardware", Price = 16.99M }
        };

        public IEnumerable<Product> GetAllProducts()
        {
            return products;
        }

        public IHttpActionResult GetProduct(int id)
        {
            var product = products.FirstOrDefault((p) => p.Id == id);
            if (product == null)
            {
                return NotFound();
            }
            return Ok(product);
        }
    }
}

```

Finally, the model, *Product*, used by the *ProductsApp*, is a simple class:

```

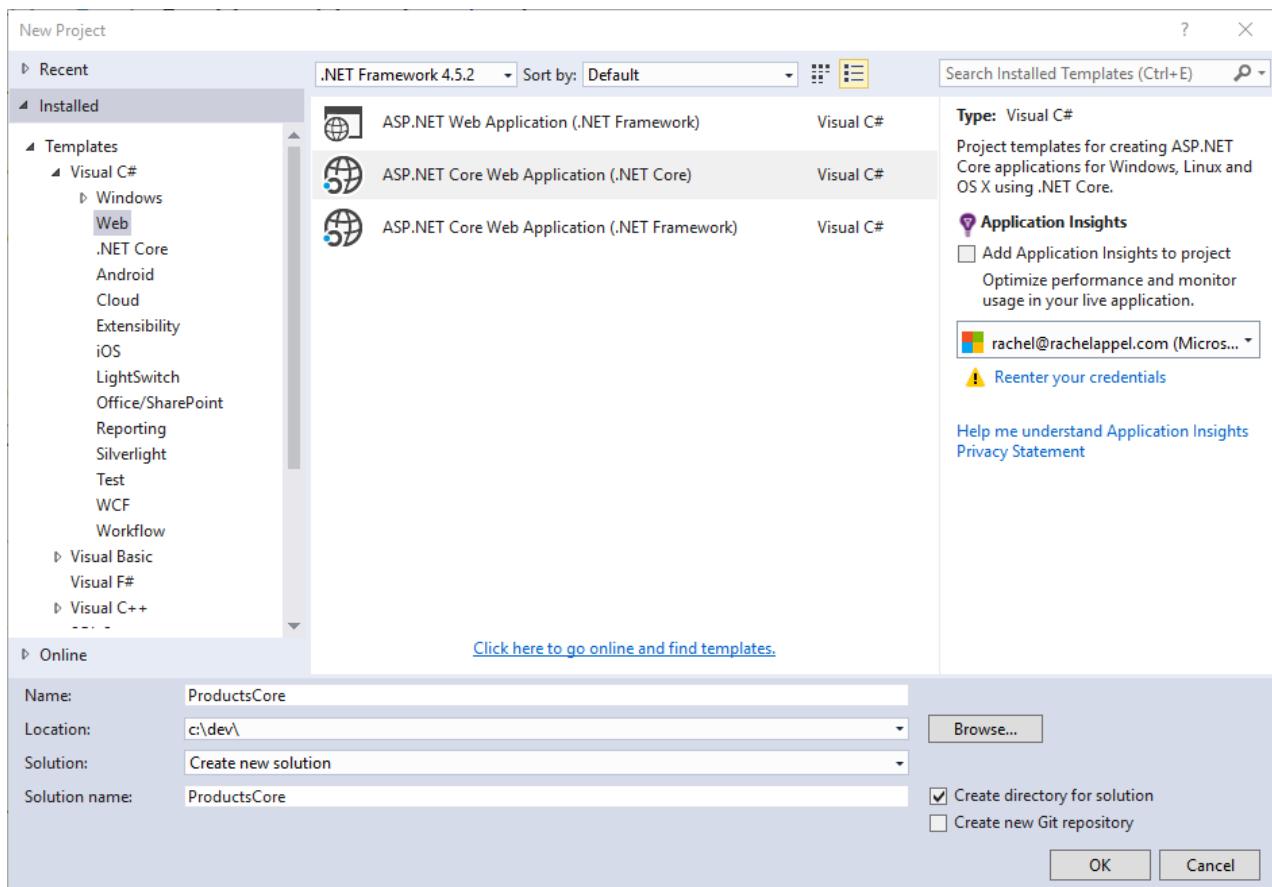
namespace ProductsApp.Models
{
    public class Product
    {
        public int Id { get; set; }
        public string Name { get; set; }
        public string Category { get; set; }
        public decimal Price { get; set; }
    }
}

```

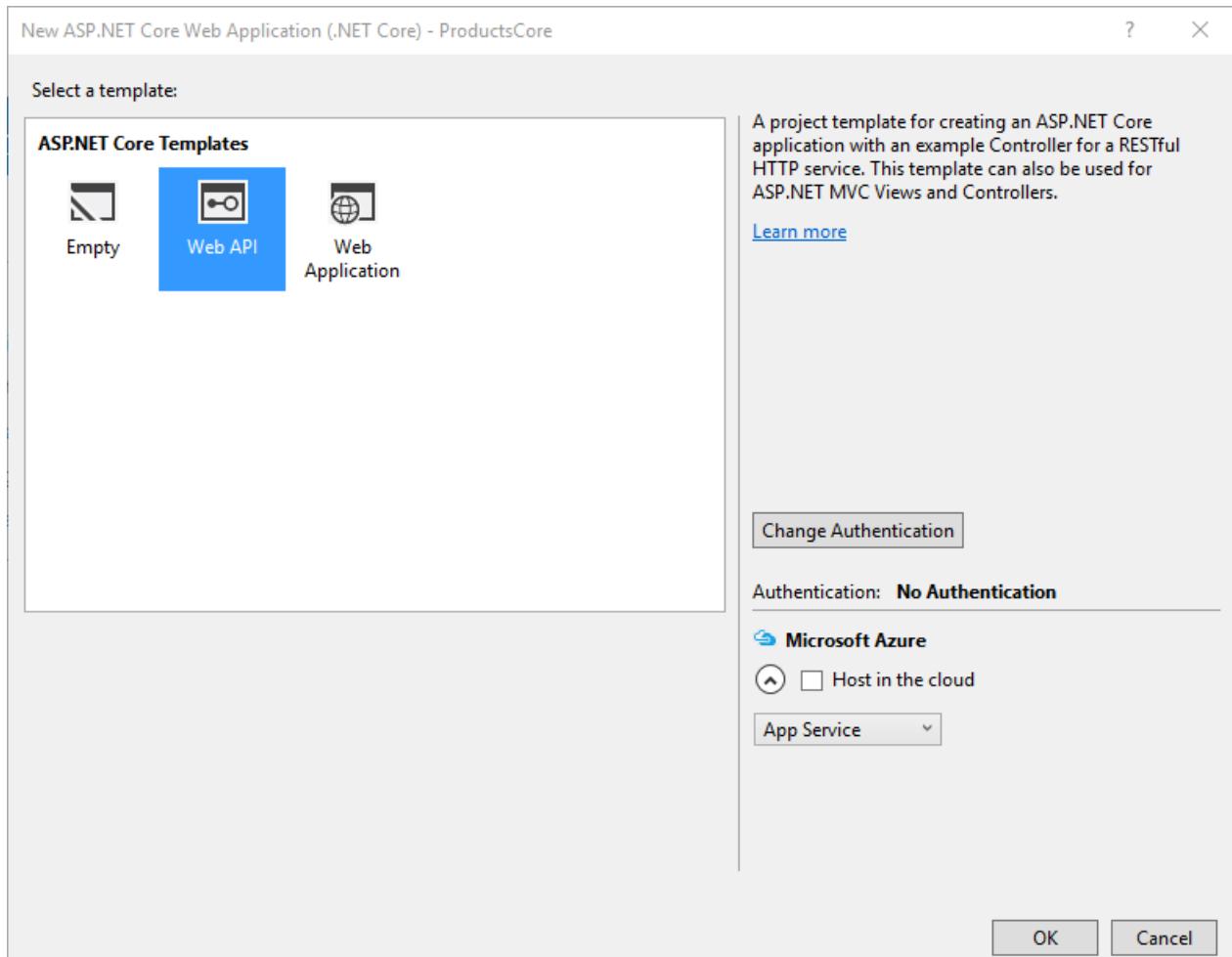
Now that we have a simple project from which to start, we can demonstrate how to migrate this Web API project to ASP.NET Core MVC.

## Create the Destination Project

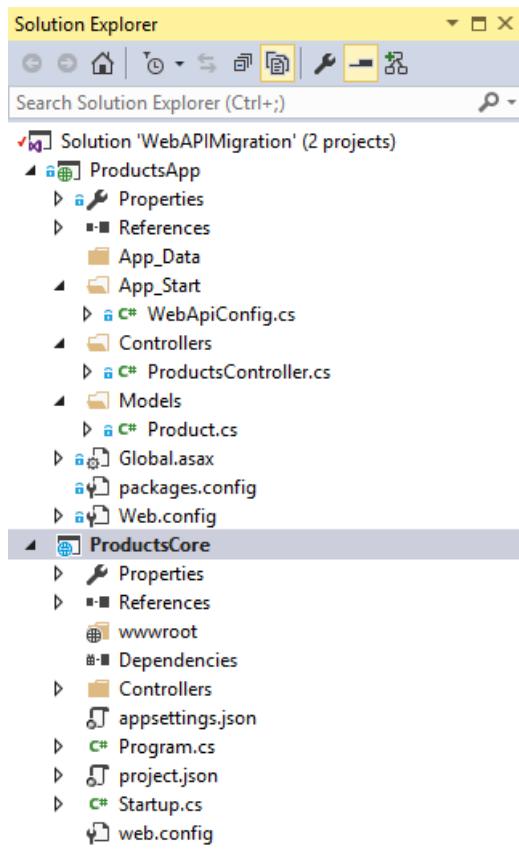
Using Visual Studio, create a new, empty solution, and name it *WebAPIMigration*. Add the existing *ProductsApp* project to it, then, add a new ASP.NET Core Web Application Project to the solution. Name the new project *ProductsCore*.



Next, choose the Web API project template. We will migrate the *ProductsApp* contents to this new project.



Delete the `Project_Readme.html` file from the new project. Your solution should now look like this:



## Migrate Configuration

ASP.NET Core no longer uses `Global.asax`, `web.config`, or `App_Start` folders. Instead, all startup tasks are done in `Startup.cs` in the root of the project (see [Application Startup](#)). In ASP.NET Core MVC, attribute-based routing is now included by default when `UseMvc()` is called; and, this is the recommended approach for configuring Web API routes (and is how the Web API starter project handles routing).

```
using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Hosting;
using Microsoft.Extensions.Configuration;
using Microsoft.Extensions.DependencyInjection;
using Microsoft.Extensions.Logging;

namespace ProductsCore
{
    public class Startup
    {
        public Startup(IConfiguration configuration)
        {
            Configuration = configuration;
        }

        public IConfiguration Configuration { get; }

        // This method gets called by the runtime. Use this method to add services to the container.
        public void ConfigureServices(IServiceCollection services)
        {
            // Add framework services.
            services.AddMvc();
        }

        // This method gets called by the runtime. Use this method to configure the HTTP request pipeline.
        public void Configure(IApplicationBuilder app, IHostingEnvironment env, ILoggerFactory loggerFactory)
        {
            loggerFactory.AddConsole(Configuration.GetSection("Logging"));
            loggerFactory.AddDebug();

            app.UseMvc();
        }
    }
}
```

Assuming you want to use attribute routing in your project going forward, no additional configuration is needed. Simply apply the attributes as needed to your controllers and actions, as is done in the sample `ValuesController` class that's included in the Web API starter project:

```

using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;
using Microsoft.AspNetCore.Mvc;

namespace ProductsCore.Controllers
{
    [Route("api/[controller]")]
    public class ValuesController : Controller
    {
        // GET api/values
        [HttpGet]
        public IEnumerable<string> Get()
        {
            return new string[] { "value1", "value2" };
        }

        // GET api/values/5
        [HttpGet("{id}")]
        public string Get(int id)
        {
            return "value";
        }

        // POST api/values
        [HttpPost]
        public void Post([FromBody]string value)
        {
        }

        // PUT api/values/5
        [HttpPut("{id}")]
        public void Put(int id, [FromBody]string value)
        {
        }

        // DELETE api/values/5
        [HttpDelete("{id}")]
        public void Delete(int id)
        {
        }
    }
}

```

Note the presence of `[controller]` on line 8. Attribute-based routing now supports certain tokens, such as `[controller]` and `[action]`. These tokens are replaced at runtime with the name of the controller or action, respectively, to which the attribute has been applied. This serves to reduce the number of magic strings in the project, and it ensures the routes will be kept synchronized with their corresponding controllers and actions when automatic rename refactorings are applied.

To migrate the Products API controller, we must first copy `ProductsController` to the new project. Then simply include the route attribute on the controller:

```
[Route("api/[controller]")]
```

You also need to add the `[HttpGet]` attribute to the two methods, since they both should be called via HTTP Get. Include the expectation of an "id" parameter in the attribute for `GetProduct()`:

```
// /api/products  
[HttpGet]  
...  
  
// /api/products/1  
[HttpGet("{id}")]
```

At this point, routing is configured correctly; however, we can't yet test it. Additional changes must be made before *ProductsController* will compile.

## Migrate Models and Controllers

The last step in the migration process for this simple Web API project is to copy over the Controllers and any Models they use. In this case, simply copy *Controllers/ProductsController.cs* from the original project to the new one. Then, copy the entire Models folder from the original project to the new one. Adjust the namespaces to match the new project name (*ProductsCore*). At this point, you can build the application, and you will find a number of compilation errors. These should generally fall into the following categories:

- *ApiController* does not exist
- *System.Web.Http* namespace does not exist
- *IHttpActionResult* does not exist

Fortunately, these are all very easy to correct:

- Change *ApiController* to *Controller* (you may need to add *using Microsoft.AspNetCore.Mvc*)
- Delete any using statement referring to *System.Web.Http*
- Change any method returning *IHttpActionResult* to return a *IActionResult*

Once these changes have been made and unused using statements removed, the migrated *ProductsController* class looks like this:

```

using Microsoft.AspNetCore.Mvc;
using ProductsCore.Models;
using System.Collections.Generic;
using System.Linq;

namespace ProductsCore.Controllers
{
    [Route("api/[controller]")]
    public class ProductsController : Controller
    {
        Product[] products = new Product[]
        {
            new Product { Id = 1, Name = "Tomato Soup", Category = "Groceries", Price = 1 },
            new Product { Id = 2, Name = "Yo-yo", Category = "Toys", Price = 3.75M },
            new Product { Id = 3, Name = "Hammer", Category = "Hardware", Price = 16.99M }
        };

        // /api/products
        [HttpGet]
        public IEnumerable<Product> GetAllProducts()
        {
            return products;
        }

        // /api/products/1
        [HttpGet("{id}")]
        public IActionResult GetProduct(int id)
        {
            var product = products.FirstOrDefault((p) => p.Id == id);
            if (product == null)
            {
                return NotFound();
            }
            return Ok(product);
        }
    }
}

```

You should now be able to run the migrated project and browse to `/api/products`; and, you should see the full list of 3 products. Browse to `/api/products/1` and you should see the first product.

## ASP.NET 4.x Web API 2 compatibility shim

A useful tool when migrating ASP.NET Web API projects to ASP.NET Core is the [Microsoft.AspNetCore.Mvc.WebApiCompatShim](#) library. The compatibility shim extends ASP.NET Core to allow a number of different Web API 2 conventions to be used. The sample ported previously in this document is basic enough that the compatibility shim was not necessary. For larger projects, using the compatibility shim can be useful for temporarily bridging the API gap between ASP.NET Core and ASP.NET Web API 2.

The Web API compatibility shim is meant to be used as a temporary measure to facilitate migrating large Web API projects to ASP.NET Core. Over time, projects should be updated to use ASP.NET Core patterns instead of relying on the compatibility shim.

Compatibility features included in [Microsoft.AspNetCore.Mvc.WebApiCompatShim](#) include:

- Adds an `ApiController` type so that controllers' base types don't need to be updated.
- Enables Web API-style model binding. ASP.NET Core MVC model binding functions similarly to MVC 5, by default. The compatibility shim changes model binding to be more similar to Web API 2 model binding conventions. For example, complex types are automatically bound from the request body.
- Extends model binding so that controller actions can take parameters of type `HttpRequestMessage`.
- Adds message formatters allowing actions to return results of type `HttpResponseMessage`.

- Adds additional response methods that Web API 2 actions may have used to serve responses:
  - HttpResponseMessage generators:
    - `CreateResponse<T>`
    - `CreateErrorResponse`
  - Action result methods:
    - `BadRequestErrorMessageResult`
    - `ExceptionResult`
    - `InternalServerErrorResult`
    - `InvalidModelStateResult`
    - `NegotiatedContentResult`
    - `ResponseMessageResult`
- Adds an instance of `IContentNegotiator` to the app's DI container and makes content negotiation-related types from [Microsoft.AspNet.WebApi.Client](#) available. This includes types like `DefaultContentNegotiator`, `MediaTypeFormatter`, etc.

To use the compatibility shim, you need to:

- Install the [Microsoft.AspNetCore.Mvc.WebApiCompatShim](#) NuGet package.
- Register the compatibility shim's services with the app's DI container by calling `services.AddMvc().AddWebApiConventions()` in the app's `Startup.ConfigureServices` method.
- Define Web API-specific routes using `MapWebApiRoute` on the `IRouteBuilder` in the app's `IApplicationBuilder.UseMvc` call.

## Summary

Migrating a simple ASP.NET Web API project to ASP.NET Core MVC is fairly straightforward, thanks to the built-in support for Web APIs in ASP.NET Core MVC. The main pieces every ASP.NET Web API project will need to migrate are routes, controllers, and models, along with updates to the types used by controllers and actions.

# Migrate configuration to ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Steve Smith](#) and [Scott Addie](#)

In the previous article, we began [migrate an ASP.NET MVC project to ASP.NET Core MVC](#). In this article, we migrate configuration.

[View or download sample code \(how to download\)](#)

## Setup configuration

ASP.NET Core no longer uses the *Global.asax* and *web.config* files that previous versions of ASP.NET utilized. In earlier versions of ASP.NET, application startup logic was placed in an `Application_Startup` method within *Global.asax*. Later, in ASP.NET MVC, a *Startup.cs* file was included in the root of the project; and, it was called when the application started. ASP.NET Core has adopted this approach completely by placing all startup logic in the *Startup.cs* file.

The *web.config* file has also been replaced in ASP.NET Core. Configuration itself can now be configured, as part of the application startup procedure described in *Startup.cs*. Configuration can still utilize XML files, but typically ASP.NET Core projects will place configuration values in a JSON-formatted file, such as *appsettings.json*. ASP.NET Core's configuration system can also easily access environment variables, which can provide a [more secure and robust location](#) for environment-specific values. This is especially true for secrets like connection strings and API keys that shouldn't be checked into source control. See [Configuration](#) to learn more about configuration in ASP.NET Core.

For this article, we are starting with the partially migrated ASP.NET Core project from [the previous article](#). To setup configuration, add the following constructor and property to the *Startup.cs* file located in the root of the project:

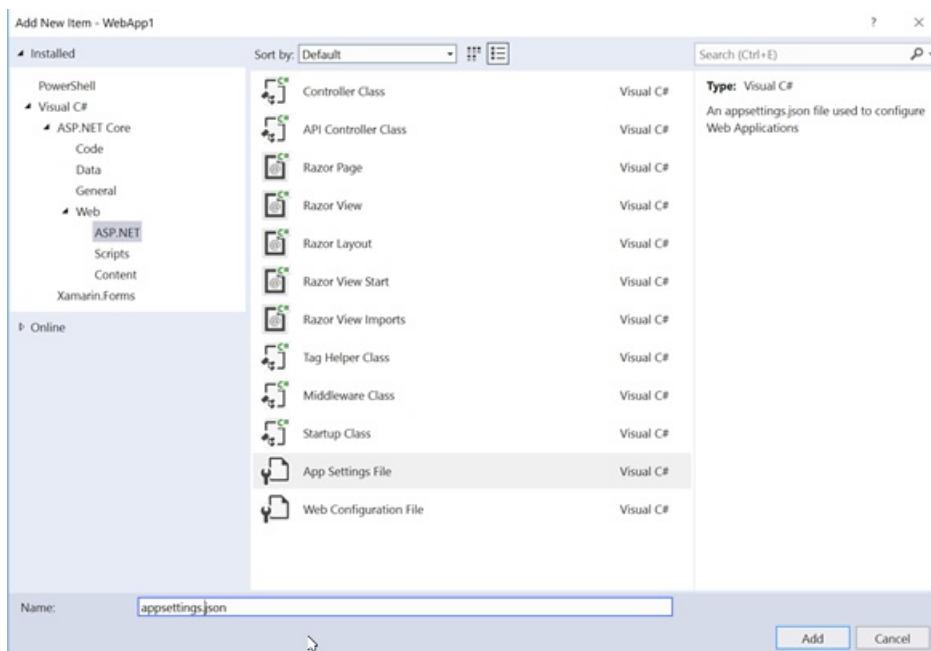
```
public Startup(IConfiguration configuration)
{
    Configuration = configuration;
}

public IConfiguration Configuration { get; }
```

Note that at this point, the *Startup.cs* file won't compile, as we still need to add the following `using` statement:

```
using Microsoft.Extensions.Configuration;
```

Add an *appsettings.json* file to the root of the project using the appropriate item template:



## Migrate configuration settings from web.config

Our ASP.NET MVC project included the required database connection string in *web.config*, in the `<connectionStrings>` element. In our ASP.NET Core project, we are going to store this information in the *appsettings.json* file. Open *appsettings.json*, and note that it already includes the following:

```
{  
  "Data": {  
    "DefaultConnection": {  
      "ConnectionString": "Server=(localdb)\\MSSQLLocalDB;Database=_CHANGE_ME;Trusted_Connection=True;"  
    }  
  }  
}
```

In the highlighted line depicted above, change the name of the database from **\_CHANGE\_ME** to the name of your database.

## Summary

ASP.NET Core places all startup logic for the application in a single file, in which the necessary services and dependencies can be defined and configured. It replaces the *web.config* file with a flexible configuration feature that can leverage a variety of file formats, such as JSON, as well as environment variables.

# Migrate Authentication and Identity to ASP.NET Core

6/21/2018 • 2 minutes to read • [Edit Online](#)

By [Steve Smith](#)

In the previous article, we [migrated configuration from an ASP.NET MVC project to ASP.NET Core MVC](#). In this article, we migrate the registration, login, and user management features.

## Configure Identity and Membership

In ASP.NET MVC, authentication and identity features are configured using ASP.NET Identity in *Startup.Auth.cs* and *IdentityConfig.cs*, located in the *App\_Start* folder. In ASP.NET Core MVC, these features are configured in *Startup.cs*.

Install the `Microsoft.AspNetCore.Identity.EntityFrameworkCore` and `Microsoft.AspNetCore.Authentication.Cookies` NuGet packages.

Then, open *Startup.cs* and update the `Startup.ConfigureServices` method to use Entity Framework and Identity services:

```
public void ConfigureServices(IServiceCollection services)
{
    // Add EF services to the services container.
    services.AddDbContext<ApplicationContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("DefaultConnection")));

    services.AddIdentity<ApplicationUser, IdentityRole>()
        .AddEntityFrameworkStores<ApplicationContext>()
        .AddDefaultTokenProviders();

    services.AddMvc();
}
```

At this point, there are two types referenced in the above code that we haven't yet migrated from the ASP.NET MVC project: `ApplicationContext` and  `ApplicationUser`. Create a new *Models* folder in the ASP.NET Core project, and add two classes to it corresponding to these types. You will find the ASP.NET MVC versions of these classes in */Models/IdentityModels.cs*, but we will use one file per class in the migrated project since that's more clear.

*ApplicationUser.cs*:

```
using Microsoft.AspNetCore.Identity.EntityFrameworkCore;

namespace NewMvcProject.Models
{
    public class ApplicationUser : IdentityUser
    {
    }
}
```

*ApplicationContext.cs*:

```

using Microsoft.AspNetCore.Identity.EntityFrameworkCore;
using Microsoft.Data.Entity;

namespace NewMvcProject.Models
{
    public class ApplicationDbContext : IdentityDbContext<ApplicationUser>
    {
        public ApplicationDbContext(DbContextOptions<ApplicationDbContext> options)
            : base(options)
        {

        }

        protected override void OnModelCreating(ModelBuilder builder)
        {
            base.OnModelCreating(builder);
            // Customize the ASP.NET Identity model and override the defaults if needed.
            // For example, you can rename the ASP.NET Identity table names and more.
            // Add your customizations after calling base.OnModelCreating(builder);
        }
    }
}

```

The ASP.NET Core MVC Starter Web project doesn't include much customization of users, or the `ApplicationDbContext`. When migrating a real app, you also need to migrate all of the custom properties and methods of your app's user and `DbContext` classes, as well as any other Model classes your app utilizes. For example, if your `DbContext` has a `DbSet<Album>`, you need to migrate the `Album` class.

With these files in place, the `Startup.cs` file can be made to compile by updating its `using` statements:

```

using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Identity;
using Microsoft.AspNetCore.Hosting;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.Configuration;
using Microsoft.Extensions.DependencyInjection;

```

Our app is now ready to support authentication and Identity services. It just needs to have these features exposed to users.

## Migrate registration and login logic

With Identity services configured for the app and data access configured using Entity Framework and SQL Server, we're ready to add support for registration and login to the app. Recall that [earlier in the migration process](#) we commented out a reference to `_LoginPartial` in `_Layout.cshtml`. Now it's time to return to that code, uncomment it, and add in the necessary controllers and views to support login functionality.

Uncomment the `@Html.Partial` line in `_Layout.cshtml`:

```

<li>@Html.ActionLink("Contact", "Contact", "Home")</li>
</ul>
@* @Html.Partial("_LoginPartial") *@
</div>
</div>

```

Now, add a new Razor view called `_LoginPartial` to the `Views/Shared` folder:

Update `_LoginPartial.cshtml` with the following code (replace all of its contents):

```
@inject SignInManager< ApplicationUser > SignInManager  
@inject UserManager< ApplicationUser > UserManager  
  
@if (SignInManager.IsSignedIn(User))  
{  
    <form asp-area="" asp-controller="Account" asp-action="Logout" method="post" id="logoutForm"  
    class="navbar-right">  
        <ul class="nav navbar-nav navbar-right">  
            <li>  
                <a asp-area="" asp-controller="Manage" asp-action="Index" title="Manage">Hello  
                @UserManager.GetUserName(User)!</a>  
            </li>  
            <li>  
                <button type="submit" class="btn btn-link navbar-btn navbar-link">Log out</button>  
            </li>  
        </ul>  
    </form>  
}  
else  
{  
    <ul class="nav navbar-nav navbar-right">  
        <li><a asp-area="" asp-controller="Account" asp-action="Register">Register</a></li>  
        <li><a asp-area="" asp-controller="Account" asp-action="Login">Log in</a></li>  
    </ul>  
}
```

At this point, you should be able to refresh the site in your browser.

## Summary

ASP.NET Core introduces changes to the ASP.NET Identity features. In this article, you have seen how to migrate the authentication and user management features of ASP.NET Identity to ASP.NET Core.

# Migrate from ClaimsPrincipal.Current

6/21/2018 • 2 minutes to read • [Edit Online](#)

In ASP.NET projects, it was common to use `ClaimsPrincipal.Current` to retrieve the current authenticated user's identity and claims. In ASP.NET Core, this property is no longer set. Code that was depending on it needs to be updated to get the current authenticated user's identity through a different means.

## Context-specific data instead of static data

When using ASP.NET Core, the values of both `ClaimsPrincipal.Current` and `Thread.CurrentPrincipal` aren't set. These properties both represent static state, which ASP.NET Core generally avoids. Instead, ASP.NET Core's architecture is to retrieve dependencies (like the current user's identity) from context-specific service collections (using its [dependency injection](#) (DI) model). What's more, `Thread.CurrentPrincipal` is thread static, so it may not persist changes in some asynchronous scenarios (and `ClaimsPrincipal.Current` just calls `Thread.CurrentPrincipal` by default).

To understand the sorts of problems thread static members can lead to in asynchronous scenarios, consider the following code snippet:

```
// Create a ClaimsPrincipal and set Thread.CurrentPrincipal
var identity = new ClaimsIdentity();
identity.AddClaim(new Claim(ClaimTypes.Name, "User1"));
Thread.CurrentPrincipal = new ClaimsPrincipal(identity);

// Check the current user
Console.WriteLine($"Current user: {Thread.CurrentPrincipal?.Identity.Name}");

// For the method to complete asynchronously
await Task.Yield();

// Check the current user after
Console.WriteLine($"Current user: {Thread.CurrentPrincipal?.Identity.Name}");
```

The preceding sample code sets `Thread.CurrentPrincipal` and checks its value before and after awaiting an asynchronous call. `Thread.CurrentPrincipal` is specific to the *thread* on which it's set, and the method is likely to resume execution on a different thread after the await. Consequently, `Thread.CurrentPrincipal` is present when it's first checked but is null after the call to `await Task.Yield()`.

Getting the current user's identity from the app's DI service collection is more testable, too, since test identities can be easily injected.

## Retrieve the current user in an ASP.NET Core app

There are several options for retrieving the current authenticated user's `ClaimsPrincipal` in ASP.NET Core in place of `ClaimsPrincipal.Current`:

- **ControllerBase.User.** MVC controllers can access the current authenticated user with their `User` property.
- **HttpContext.User.** Components with access to the current `HttpContext` (middleware, for example) can get the current user's `ClaimsPrincipal` from `HttpContext.User`.
- **Passed in from caller.** Libraries without access to the current `HttpContext` are often called from controllers or middleware components and can have the current user's identity passed as an argument.

- **IHttpContextAccessor**. The ASP.NET project being migrated to ASP.NET Core may be too large to easily pass the current user's identity to all necessary locations. In such cases, `IHttpContextAccessor` can be used as a workaround. `IHttpContextAccessor` is able to access the current `HttpContext` (if one exists). A short-term solution to getting the current user's identity in code that hasn't yet been updated to work with ASP.NET Core's DI-driven architecture would be:

- Make `IHttpContextAccessor` available in the DI container by calling `AddHttpContextAccessor` in `Startup.ConfigureServices`.
- Get an instance of `IHttpContextAccessor` during startup and store it in a static variable. The instance is made available to code that was previously retrieving the current user from a static property.
- Retrieve the current user's `ClaimsPrincipal` using `HttpContextAccessor.HttpContext?.User`. If this code is used outside of the context of an HTTP request, the `HttpContext` is null.

The final option, using `IHttpContextAccessor`, is contrary to ASP.NET Core principles (preferring injected dependencies to static dependencies). Plan to eventually remove the dependency on the static `IHttpContextAccessor` helper. It can be a useful bridge, though, when migrating large existing ASP.NET apps that were previously using `ClaimsPrincipal.Current`.

# Migrate from ASP.NET Membership authentication to ASP.NET Core 2.0 Identity

6/21/2018 • 5 minutes to read • [Edit Online](#)

By [Isaac Levin](#)

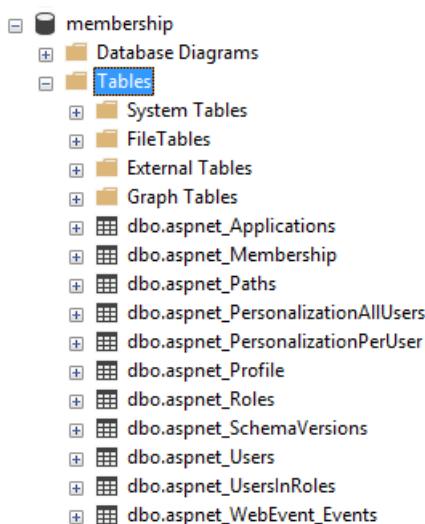
This article demonstrates migrating the database schema for ASP.NET apps using Membership authentication to ASP.NET Core 2.0 Identity.

## NOTE

This document provides the steps needed to migrate the database schema for ASP.NET Membership-based apps to the database schema used for ASP.NET Core Identity. For more information about migrating from ASP.NET Membership-based authentication to ASP.NET Identity, see [Migrate an existing app from SQL Membership to ASP.NET Identity](#). For more information about ASP.NET Core Identity, see [Introduction to Identity on ASP.NET Core](#).

## Review of Membership schema

Prior to ASP.NET 2.0, developers were tasked with creating the entire authentication and authorization process for their apps. With ASP.NET 2.0, Membership was introduced, providing a boilerplate solution to handling security within ASP.NET apps. Developers were now able to bootstrap a schema into a SQL Server database with the `aspnet_regsql.exe` command. After running this command, the following tables were created in the database.



To migrate existing apps to ASP.NET Core 2.0 Identity, the data in these tables needs to be migrated to the tables used by the new Identity schema.

## ASP.NET Core Identity 2.0 schema

ASP.NET Core 2.0 follows the [Identity](#) principle introduced in ASP.NET 4.5. Though the principle is shared, the implementation between the frameworks is different, even between versions of ASP.NET Core (see [Migrate authentication and Identity to ASP.NET Core 2.0](#)).

The fastest way to view the schema for ASP.NET Core 2.0 Identity is to create a new ASP.NET Core 2.0 app. Follow these steps in Visual Studio 2017:

- Select **File > New > Project**.

- Create a new **ASP.NET Core Web Application**, and name the project *CoreIdentitySample*.
- Select **ASP.NET Core 2.0** in the dropdown, and then select **Web Application**. This template produces a [Razor Pages](#) app. Before clicking **OK**, click **Change Authentication**.
- Choose **Individual User Accounts** for the Identity templates. Finally, click **OK**, then **OK**. Visual Studio creates a project using the ASP.NET Core Identity template.

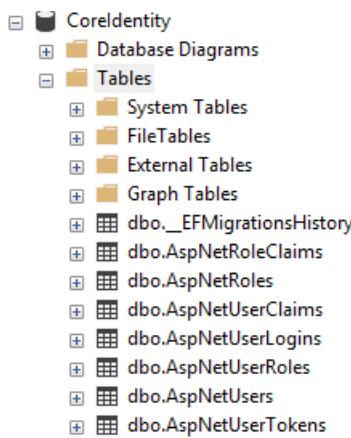
ASP.NET Core 2.0 Identity uses [Entity Framework Core](#) to interact with the database storing the authentication data. In order for the newly created app to work, there needs to be a database to store this data. After creating a new app, the fastest way to inspect the schema in a database environment is to create the database using Entity Framework migrations. This process creates a database, either locally or elsewhere, which mimics that schema. Review the preceding documentation for more information.

To create a database with the ASP.NET Core Identity schema, run the `Update-Database` command in Visual Studio's **Package Manager Console** (PMC) window—it's located at **Tools > NuGet Package Manager > Package Manager Console**. PMC supports running Entity Framework commands.

Entity Framework commands use the connection string for the database specified in *appsettings.json*. The following connection string targets a database on *localhost* named *asp-net-core-identity*. In this setting, Entity Framework is configured to use the `DefaultConnection` connection string.

```
{
  "ConnectionStrings": {
    "DefaultConnection": "Server=localhost;Database=aspnet-core-identity;Trusted_Connection=True;MultipleActiveResultSets=true"
  }
}
```

This command builds the database specified with the schema and any data needed for app initialization. The following image depicts the table structure that's created with the preceding steps.



## Migrate the schema

There are subtle differences in the table structures and fields for both Membership and ASP.NET Core Identity. The pattern has changed substantially for authentication/authorization with ASP.NET and ASP.NET Core apps. The key objects that are still used with Identity are *Users* and *Roles*. Here are mapping tables for *Users*, *Roles*, and *UserRoles*.

### Users

<i>IDENTITY(ASPNETUSERS)</i>		<i>MEMBERSHIP(ASPNET_USERS/A SPNET_MEMBERSHIP)</i>	
Field Name	Type	Field Name	Type

<b>IDENTITY(ASPNETUSERS)</b>		<b>MEMBERSHIP(ASPNET_USERS/A SPNET_MEMBERSHIP)</b>	
<code>Id</code>	string	<code>aspnet_Users.UserId</code>	string
<code>UserName</code>	string	<code>aspnet_Users.UserName</code>	string
<code>Email</code>	string	<code>aspnet_Membership.Email</code>	string
<code>NormalizedUserName</code>	string	<code>aspnet_Users.LoweredUserName</code>	string
<code>NormalizedEmail</code>	string	<code>aspnet_Membership.LoweredEmail</code>	string
<code>PhoneNumber</code>	string	<code>aspnet_Users.MobileAlias</code>	string
<code>LockoutEnabled</code>	bit	<code>aspnet_Membership.IsLockedout</code>	bit

#### NOTE

Not all the field mappings resemble one-to-one relationships from Membership to ASP.NET Core Identity. The preceding table takes the default Membership User schema and maps it to the ASP.NET Core Identity schema. Any other custom fields that were used for Membership need to be mapped manually. In this mapping, there's no map for passwords, as both password criteria and password salts don't migrate between the two. **It's recommended to leave the password as null and to ask users to reset their passwords.** In ASP.NET Core Identity, `LockoutEnd` should be set to some date in the future if the user is locked out. This is shown in the migration script.

## Roles

<b>IDENTITY(ASPNETROLES)</b>		<b>MEMBERSHIP(ASPNET_ROLES)</b>	
<b>Field Name</b>	<b>Type</b>	<b>Field Name</b>	<b>Type</b>
<code>Id</code>	string	<code>RoleId</code>	string
<code>Name</code>	string	<code>RoleName</code>	string
<code>NormalizedRoleName</code>	string	<code>LoweredRoleName</code>	string

## User Roles

<b>IDENTITY(ASPNETUSERROLES)</b>		<b>MEMBERSHIP(ASPNET_USERSIN ROLES)</b>	
<b>Field Name</b>	<b>Type</b>	<b>Field Name</b>	<b>Type</b>
<code>RoleId</code>	string	<code>RoleId</code>	string
<code>UserId</code>	string	<code>UserId</code>	string

Reference the preceding mapping tables when creating a migration script for *Users* and *Roles*. The following example assumes you have two databases on a database server. One database contains the existing ASP.NET Membership schema and data. The other database was created using steps described earlier. Comments are included inline for more details.

```

-- THIS SCRIPT NEEDS TO RUN FROM THE CONTEXT OF THE MEMBERSHIP DB
BEGIN TRANSACTION MigrateUsersAndRoles
use aspnetdb

-- INSERT USERS
INSERT INTO coreidentity.dbo.aspnetusers
    (id,
     username,
     normalizedusername,
     passwordhash,
     securitystamp,
     emailconfirmed,
     phonenumbers,
     phonenumbersconfirmed,
     twofactorenabled,
     lockoutend,
     lockoutenabled,
     accessfailedcount,
     email,
     normalizedemail)
SELECT aspnet_users.userid,
       aspnet_users.username,
       aspnet_users.loweredusername,
       --Creates an empty password since passwords don't map between the two schemas
       '',
       --Security Stamp is a token used to verify the state of an account and is subject to change at any
       time. It should be initialized as a new ID.
       NewID(),
       --EmailConfirmed is set when a new user is created and confirmed via email. Users must have this set
       during migration to ensure they're able to reset passwords.
       1,
       aspnet_users.mobilealias,
       CASE
           WHEN aspnet_Users.MobileAlias is null THEN 0
           ELSE 1
       END,
       --2-factor Auth likely wasn't setup in Membership for users, so setting as false.
       0,
       CASE
           --Setting lockout date to time in the future (1000 years)
           WHEN aspnet_membership.islockedout = 1 THEN Dateadd(year, 1000,
                                                               Sysutcdatetime())
           ELSE NULL
       END,
       aspnet_membership.islockedout,
       --AccessFailedAccount is used to track failed logins. This is stored in membership in multiple columns.
       Setting to 0 arbitrarily.
       0,
       aspnet_membership.email,
       aspnet_membership.loweredemail
FROM aspnet_users
LEFT OUTER JOIN aspnet_membership
    ON aspnet_membership.applicationid =
       aspnet_users.applicationid
       AND aspnet_users.userid = aspnet_membership.userid
LEFT OUTER JOIN coreidentity.dbo.aspnetusers
    ON aspnet_membership.userid = aspnetusers.id
WHERE aspnetusers.id IS NULL

-- INSERT ROLES
INSERT INTO coreIdentity.dbo.aspnetroles(id,name)
SELECT roleId,rolename
FROM aspnet_roles;

-- INSERT USER ROLES
INSERT INTO coreidentity.dbo.aspnetuserroles(userid,roleid)
SELECT userid,roleid

```

```
FROM aspnet_usersinroles;

IF @@ERROR <> 0
BEGIN
    ROLLBACK TRANSACTION MigrateUsersAndRoles
    RETURN
END

COMMIT TRANSACTION MigrateUsersAndRoles
```

After completion of this script, the ASP.NET Core Identity app created earlier is populated with Membership users. Users need to change their passwords before logging in.

#### NOTE

If the Membership system had users with user names that didn't match their email address, changes are required to the app created earlier to accommodate this. The default template expects `UserName` and `Email` to be the same. For situations in which they're different, the login process needs to be modified to use `UserName` instead of `Email`.

In the `PageModel` of the Login Page, located at `Pages\Account\Login.cshtml.cs`, remove the `[EmailAddress]` attribute from the `Email` property. Rename it to `UserName`. This requires a change wherever `EmailAddress` is mentioned, in the `View` and `PageModel`. The result looks like the following:

The screenshot shows a dark-themed login page for 'Coreldentity'. At the top, there's a navigation bar with links for Home, About, and Contact. Below the navigation, the word 'Coreldentity' is displayed. The main content area has a heading 'Log in' and the text 'Use a local account to log in.' followed by a horizontal line. There are two input fields: one labeled 'UserName' and another labeled 'Password', both with placeholder text. Below the password field is a 'Remember me?' checkbox. At the bottom of the form is a 'Log in' button. To the right of the form, there are links for 'Forgot your password?' and 'Register as a new user'.

## Next steps

In this tutorial, you learned how to port users from SQL membership to ASP.NET Core 2.0 Identity. For more information regarding ASP.NET Core Identity, see [Introduction to Identity](#).

# Migrate HTTP handlers and modules to ASP.NET Core middleware

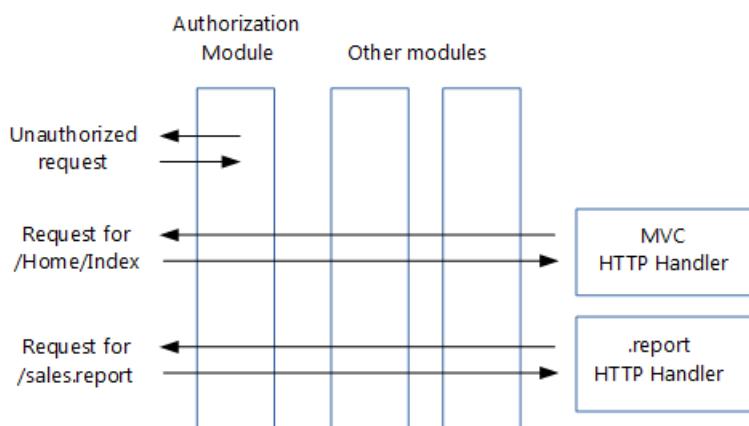
6/21/2018 • 15 minutes to read • [Edit Online](#)

By Matt Perdeck

This article shows how to migrate existing ASP.NET [HTTP modules and handlers from system.webserver](#) to ASP.NET Core [middleware](#).

## Modules and handlers revisited

Before proceeding to ASP.NET Core middleware, let's first recap how HTTP modules and handlers work:



### Handlers are:

- Classes that implement [IHttpHandler](#)
- Used to handle requests with a given file name or extension, such as `.report`
- [Configured](#) in `Web.config`

### Modules are:

- Classes that implement [IHttpModule](#)
- Invoked for every request
- Able to short-circuit (stop further processing of a request)
- Able to add to the HTTP response, or create their own
- [Configured](#) in `Web.config`

### The order in which modules process incoming requests is determined by:

1. The [application life cycle](#), which is a series events fired by ASP.NET: `BeginRequest`, `AuthenticateRequest`, etc. Each module can create a handler for one or more events.
2. For the same event, the order in which they're configured in `Web.config`.

In addition to modules, you can add handlers for the life cycle events to your `Global.asax.cs` file. These handlers run after the handlers in the configured modules.

# From handlers and modules to middleware

## Middleware are simpler than HTTP modules and handlers:

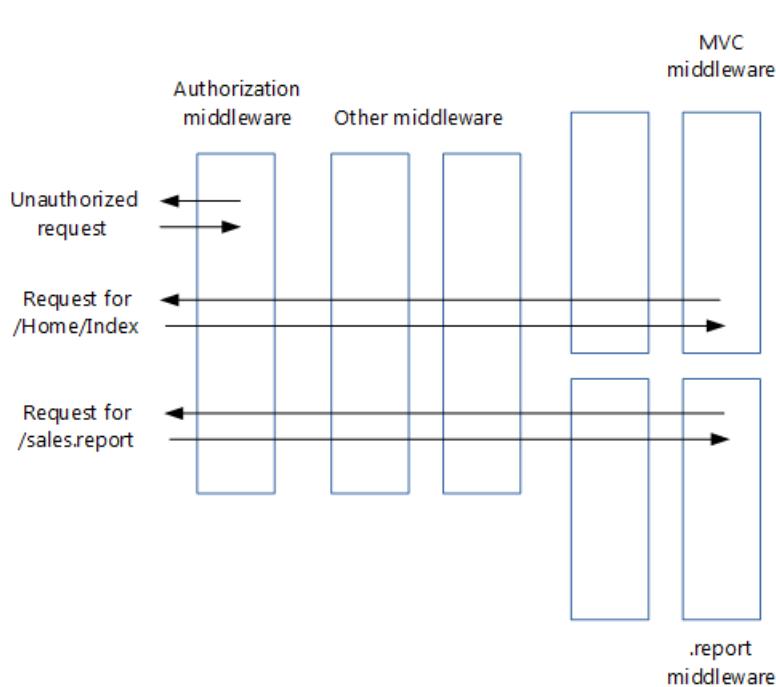
- Modules, handlers, *Global.asax.cs*, *Web.config* (except for IIS configuration) and the application life cycle are gone
- The roles of both modules and handlers have been taken over by middleware
- Middleware are configured using code rather than in *Web.config*
- [Pipeline branching](#) lets you send requests to specific middleware, based on not only the URL but also on request headers, query strings, etc.

## Middleware are very similar to modules:

- Invoked in principle for every request
- Able to short-circuit a request, by [not passing the request to the next middleware](#)
- Able to create their own HTTP response

## Middleware and modules are processed in a different order:

- Order of middleware is based on the order in which they're inserted into the request pipeline, while order of modules is mainly based on [application life cycle](#) events
- Order of middleware for responses is the reverse from that for requests, while order of modules is the same for requests and responses
- See [Create a middleware pipeline with IApplicationBuilder](#)



Note how in the image above, the authentication middleware short-circuited the request.

## Migrating module code to middleware

An existing HTTP module will look similar to this:

```
// ASP.NET 4 module

using System;
using System.Web;

namespace MyApp.Modules
{
    public class MyModule : IHttpModule
    {
        public void Dispose()
        {
        }

        public void Init(HttpApplication application)
        {
            application.BeginRequest += (new EventHandler(this.Application_BeginRequest));
            application.EndRequest += (new EventHandler(this.Application_EndRequest));
        }

        private void Application_BeginRequest(Object source, EventArgs e)
        {
            HttpContext context = ((HttpApplication)source).Context;

            // Do something with context near the beginning of request processing.
        }

        private void Application_EndRequest(Object source, EventArgs e)
        {
            HttpContext context = ((HttpApplication)source).Context;

            // Do something with context near the end of request processing.
        }
    }
}
```

As shown in the [Middleware](#) page, an ASP.NET Core middleware is a class that exposes an `Invoke` method taking an `HttpContext` and returning a `Task`. Your new middleware will look like this:

```
// ASP.NET Core middleware

using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Http;
using System.Threading.Tasks;

namespace MyApp.Middleware
{
    public class MyMiddleware
    {
        private readonly RequestDelegate _next;

        public MyMiddleware(RequestDelegate next)
        {
            _next = next;
        }

        public async Task Invoke(HttpContext context)
        {
            // Do something with context near the beginning of request processing.

            await _next.Invoke(context);

            // Clean up.
        }
    }

    public static class MyMiddlewareExtensions
    {
        public static IApplicationBuilder UseMyMiddleware(this IApplicationBuilder builder)
        {
            return builder.UseMiddleware<MyMiddleware>();
        }
    }
}
```

The preceding middleware template was taken from the section on [writing middleware](#).

The `MyMiddlewareExtensions` helper class makes it easier to configure your middleware in your `Startup` class. The `useMiddleware` method adds your middleware class to the request pipeline. Services required by the middleware get injected in the middleware's constructor.

Your module might terminate a request, for example if the user isn't authorized:

```
// ASP.NET 4 module that may terminate the request

private void Application_BeginRequest(Object source, EventArgs e)
{
    HttpContext context = ((HttpApplication)source).Context;

    // Do something with context near the beginning of request processing.

    if (TerminateRequest())
    {
        context.Response.End();
        return;
    }
}
```

A middleware handles this by not calling `Invoke` on the next middleware in the pipeline. Keep in mind that this doesn't fully terminate the request, because previous middlewares will still be invoked when the response makes its way back through the pipeline.

```
// ASP.NET Core middleware that may terminate the request

public async Task Invoke(HttpContext context)
{
    // Do something with context near the beginning of request processing.

    if (!TerminateRequest())
        await _next.Invoke(context);

    // Clean up.
}
```

When you migrate your module's functionality to your new middleware, you may find that your code doesn't compile because the `HttpContext` class has significantly changed in ASP.NET Core. [Later on](#), you'll see how to migrate to the new ASP.NET Core `HttpContext`.

## Migrating module insertion into the request pipeline

HTTP modules are typically added to the request pipeline using `Web.config`:

```
<?xml version="1.0" encoding="utf-8"?>
<!--ASP.NET 4 web.config-->
<configuration>
    <system.webServer>
        <modules>
            <add name="MyModule" type="MyApp.Modules.MyModule"/>
        </modules>
    </system.webServer>
</configuration>
```

Convert this by [adding your new middleware](#) to the request pipeline in your `Startup` class:

```

public void Configure(IApplicationBuilder app, IHostingEnvironment env, ILoggerFactory loggerFactory)
{
    loggerFactory.AddConsole(Configuration.GetSection("Logging"));
    loggerFactory.AddDebug();

    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
        app.UseBrowserLink();
    }
    else
    {
        app.UseExceptionHandler("/Home/Error");
    }

    app.UseMyMiddleware();

    app.UseMyMiddlewareWithParams();

    var myMiddlewareOptions = Configuration.GetSection("MyMiddlewareOptionsSection").Get<MyMiddlewareOptions>()
();
    var myMiddlewareOptions2 =
Configuration.GetSection("MyMiddlewareOptionsSection2").Get<MyMiddlewareOptions>();
    app.UseMyMiddlewareWithParams(myMiddlewareOptions);
    app.UseMyMiddlewareWithParams(myMiddlewareOptions2);

    app.UseMyTerminatingMiddleware();

    // Create branch to the MyHandlerMiddleware.
    // All requests ending in .report will follow this branch.
    app.MapWhen(
        context => context.Request.Path.ToString().EndsWith(".report"),
        appBranch => {
            // ... optionally add more middleware to this branch
            appBranch.UseMyHandler();
        });
    app.MapWhen(
        context => context.Request.Path.ToString().EndsWith(".context"),
        appBranch => {
            appBranch.UseHttpContextDemoMiddleware();
       });
    app.UseStaticFiles();

    app.UseMvc(routes =>
    {
        routes.MapRoute(
            name: "default",
            template: "{controller=Home}/{action=Index}/{id?}");
    });
}

```

The exact spot in the pipeline where you insert your new middleware depends on the event that it handled as a module (`BeginRequest`, `EndRequest`, etc.) and its order in your list of modules in `Web.config`.

As previously stated, there's no application life cycle in ASP.NET Core and the order in which responses are processed by middleware differs from the order used by modules. This could make your ordering decision more challenging.

If ordering becomes a problem, you could split your module into multiple middleware components that can be ordered independently.

## Migrating handler code to middleware

An HTTP handler looks something like this:

```
// ASP.NET 4 handler

using System.Web;

namespace MyApp.HttpHandlers
{
    public class MyHandler : IHttpHandler
    {
        public bool IsReusable { get { return true; } }

        public void ProcessRequest(HttpContext context)
        {
            string response = GenerateResponse(context);

            context.Response.ContentType = GetContentType();
            context.Response.Output.Write(response);
        }

        // ...

        private string GenerateResponse(HttpContext context)
        {
            string title = context.Request.QueryString["title"];
            return string.Format("Title of the report: {0}", title);
        }

        private string GetContentType()
        {
            return "text/plain";
        }
    }
}
```

In your ASP.NET Core project, you would translate this to a middleware similar to this:

```

// ASP.NET Core middleware migrated from a handler

using Microsoft.AspNetCore.Builder;
using Microsoft.AspNetCore.Http;
using System.Threading.Tasks;

namespace MyApp.Middleware
{
    public class MyHandlerMiddleware
    {

        // Must have constructor with this signature, otherwise exception at run time
        public MyHandlerMiddleware(RequestDelegate next)
        {
            // This is an HTTP Handler, so no need to store next
        }

        public async Task Invoke(HttpContext context)
        {
            string response = GenerateResponse(context);

            context.Response.ContentType = GetContentType();
            await context.Response.WriteAsync(response);
        }

        // ...

        private string GenerateResponse(HttpContext context)
        {
            string title = context.Request.Query["title"];
            return string.Format("Title of the report: {0}", title);
        }

        private string GetContentType()
        {
            return "text/plain";
        }
    }

    public static class MyHandlerExtensions
    {
        public static IApplicationBuilder UseMyHandler(this IApplicationBuilder builder)
        {
            return builder.UseMiddleware<MyHandlerMiddleware>();
        }
    }
}

```

This middleware is very similar to the middleware corresponding to modules. The only real difference is that here there's no call to `_next.Invoke(context)`. That makes sense, because the handler is at the end of the request pipeline, so there will be no next middleware to invoke.

## Migrating handler insertion into the request pipeline

Configuring an HTTP handler is done in *Web.config* and looks something like this:

```
<?xml version="1.0" encoding="utf-8"?>
<!--ASP.NET 4 web.config-->
<configuration>
  <system.webServer>
    <handlers>
      <add name="MyHandler" verb="*" path="*.report" type="MyApp.HttpHandlers.MyHandler"
resourceType="Unspecified" preCondition="integratedMode"/>
    </handlers>
  </system.webServer>
</configuration>
```

You could convert this by adding your new handler middleware to the request pipeline in your `Startup` class, similar to middleware converted from modules. The problem with that approach is that it would send all requests to your new handler middleware. However, you only want requests with a given extension to reach your middleware. That would give you the same functionality you had with your HTTP handler.

One solution is to branch the pipeline for requests with a given extension, using the `MapWhen` extension method. You do this in the same `Configure` method where you add the other middleware:

```

public void Configure(IApplicationBuilder app, IHostingEnvironment env, ILoggerFactory loggerFactory)
{
    loggerFactory.AddConsole(Configuration.GetSection("Logging"));
    loggerFactory.AddDebug();

    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
        app.UseBrowserLink();
    }
    else
    {
        app.UseExceptionHandler("/Home/Error");
    }

    app.UseMyMiddleware();

    app.UseMyMiddlewareWithParams();

    var myMiddlewareOptions = Configuration.GetSection("MyMiddlewareOptionsSection").Get<MyMiddlewareOptions>()
();
    var myMiddlewareOptions2 =
Configuration.GetSection("MyMiddlewareOptionsSection2").Get<MyMiddlewareOptions>();
    app.UseMyMiddlewareWithParams(myMiddlewareOptions);
    app.UseMyMiddlewareWithParams(myMiddlewareOptions2);

    app.UseMyTerminatingMiddleware();

    // Create branch to the MyHandlerMiddleware.
    // All requests ending in .report will follow this branch.
    app.MapWhen(
        context => context.Request.Path.ToString().EndsWith(".report"),
        appBranch => {
            // ... optionally add more middleware to this branch
            appBranch.UseMyHandler();
        });
    app.MapWhen(
        context => context.Request.Path.ToString().EndsWith(".context"),
        appBranch => {
            appBranch.UseHttpContextDemoMiddleware();
       });
    app.UseStaticFiles();

    app.UseMvc(routes =>
    {
        routes.MapRoute(
            name: "default",
            template: "{controller=Home}/{action=Index}/{id?}");
    });
}

```

`MapWhen` takes these parameters:

1. A lambda that takes the `HttpContext` and returns `true` if the request should go down the branch. This means you can branch requests not just based on their extension, but also on request headers, query string parameters, etc.
2. A lambda that takes an `IApplicationBuilder` and adds all the middleware for the branch. This means you can add additional middleware to the branch in front of your handler middleware.

Middleware added to the pipeline before the branch will be invoked on all requests; the branch will have no impact on them.

# Loading middleware options using the options pattern

Some modules and handlers have configuration options that are stored in *Web.config*. However, in ASP.NET Core a new configuration model is used in place of *Web.config*.

The new [configuration system](#) gives you these options to solve this:

- Directly inject the options into the middleware, as shown in the [next section](#).
- Use the [options pattern](#):

1. Create a class to hold your middleware options, for example:

```
public class MyMiddlewareOptions
{
    public string Param1 { get; set; }
    public string Param2 { get; set; }
}
```

2. Store the option values

The configuration system allows you to store option values anywhere you want. However, most sites use *appsettings.json*, so we'll take that approach:

```
{
    "MyMiddlewareOptionsSection": {
        "Param1": "Param1Value",
        "Param2": "Param2Value"
    }
}
```

*MyMiddlewareOptionsSection* here is a section name. It doesn't have to be the same as the name of your options class.

3. Associate the option values with the options class

The options pattern uses ASP.NET Core's dependency injection framework to associate the options type (such as `MyMiddlewareOptions`) with a `MyMiddlewareOptions` object that has the actual options.

Update your `Startup` class:

- If you're using *appsettings.json*, add it to the configuration builder in the `Startup` constructor:

```
public Startup(IHostingEnvironment env)
{
    var builder = new ConfigurationBuilder()
        .SetBasePath(env.ContentRootPath)
        .AddJsonFile("appsettings.json", optional: true, reloadOnChange: true)
        .AddJsonFile($"appsettings.{env.EnvironmentName}.json", optional: true)
        .AddEnvironmentVariables();
    Configuration = builder.Build();
}
```

- Configure the options service:

```

public void ConfigureServices(IServiceCollection services)
{
    // Setup options service
    services.AddOptions();

    // Load options from section "MyMiddlewareOptionsSection"
    services.Configure<MyMiddlewareOptions>(
        Configuration.GetSection("MyMiddlewareOptionsSection"));

    // Add framework services.
    services.AddMvc();
}

```

- c. Associate your options with your options class:

```

public void ConfigureServices(IServiceCollection services)
{
    // Setup options service
    services.AddOptions();

    // Load options from section "MyMiddlewareOptionsSection"
    services.Configure<MyMiddlewareOptions>(
        Configuration.GetSection("MyMiddlewareOptionsSection"));

    // Add framework services.
    services.AddMvc();
}

```

4. Inject the options into your middleware constructor. This is similar to injecting options into a controller.

```

public class MyMiddlewareWithParams
{
    private readonly RequestDelegate _next;
    private readonly MyMiddlewareOptions _myMiddlewareOptions;

    public MyMiddlewareWithParams(RequestDelegate next,
        IOptions<MyMiddlewareOptions> optionsAccessor)
    {
        _next = next;
        _myMiddlewareOptions = optionsAccessor.Value;
    }

    public async Task Invoke(HttpContext context)
    {
        // Do something with context near the beginning of request processing
        // using configuration in _myMiddlewareOptions

        await _next.Invoke(context);

        // Do something with context near the end of request processing
        // using configuration in _myMiddlewareOptions
    }
}

```

The [UseMiddleware](#) extension method that adds your middleware to the `IApplicationBuilder` takes care of dependency injection.

This isn't limited to `IOptions` objects. Any other object that your middleware requires can be injected this way.

## Loading middleware options through direct injection

The options pattern has the advantage that it creates loose coupling between options values and their consumers. Once you've associated an options class with the actual options values, any other class can get access to the options through the dependency injection framework. There's no need to pass around options values.

This breaks down though if you want to use the same middleware twice, with different options. For example an authorization middleware used in different branches allowing different roles. You can't associate two different options objects with the one options class.

The solution is to get the options objects with the actual options values in your `Startup` class and pass those directly to each instance of your middleware.

### 1. Add a second key to `appsettings.json`

To add a second set of options to the `appsettings.json` file, use a new key to uniquely identify it:

```
{
  "MyMiddlewareOptionsSection2": {
    "Param1": "Param1Value2",
    "Param2": "Param2Value2"
  },
  "MyMiddlewareOptionsSection": {
    "Param1": "Param1Value",
    "Param2": "Param2Value"
  }
}
```

### 2. Retrieve options values and pass them to middleware. The `Use...` extension method (which adds your middleware to the pipeline) is a logical place to pass in the option values:

```

public void Configure(IApplicationBuilder app, IHostingEnvironment env, ILoggerFactory loggerFactory)
{
    loggerFactory.AddConsole(Configuration.GetSection("Logging"));
    loggerFactory.AddDebug();

    if (env.IsDevelopment())
    {
        app.UseDeveloperExceptionPage();
        app.UseBrowserLink();
    }
    else
    {
        app.UseExceptionHandler("/Home/Error");
    }

    app.UseMyMiddleware();

    app.UseMyMiddlewareWithParams();

    var myMiddlewareOptions =
Configuration.GetSection("MyMiddlewareOptionsSection").Get<MyMiddlewareOptions>();
    var myMiddlewareOptions2 =
Configuration.GetSection("MyMiddlewareOptionsSection2").Get<MyMiddlewareOptions>();
    app.UseMyMiddlewareWithParams(myMiddlewareOptions);
    app.UseMyMiddlewareWithParams(myMiddlewareOptions2);

    app.UseMyTerminatingMiddleware();

    // Create branch to the MyHandlerMiddleware.
    // All requests ending in .report will follow this branch.
    app.MapWhen(
        context => context.Request.Path.ToString().EndsWith(".report"),
        appBranch => {
            // ... optionally add more middleware to this branch
            appBranch.UseMyHandler();
        });
}

app.MapWhen(
    context => context.Request.Path.ToString().EndsWith(".context"),
    appBranch => {
        appBranch.UseHttpContextDemoMiddleware();
    });

app.UseStaticFiles();

app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});
}

```

3. Enable middleware to take an options parameter. Provide an overload of the `Use...` extension method (that takes the options parameter and passes it to `UseMiddleware`). When `UseMiddleware` is called with parameters, it passes the parameters to your middleware constructor when it instantiates the middleware object.

```

public static class MyMiddlewareWithParamsExtensions
{
    public static IApplicationBuilder UseMyMiddlewareWithParams(
        this IApplicationBuilder builder)
    {
        return builder.UseMiddleware<MyMiddlewareWithParams>();
    }

    public static IApplicationBuilder UseMyMiddlewareWithParams(
        this IApplicationBuilder builder, MyMiddlewareOptions myMiddlewareOptions)
    {
        return builder.UseMiddleware<MyMiddlewareWithParams>(
            new OptionsWrapper<MyMiddlewareOptions>(myMiddlewareOptions));
    }
}

```

Note how this wraps the options object in an `OptionsWrapper` object. This implements `IOptions`, as expected by the middleware constructor.

## Migrating to the new HttpContext

You saw earlier that the `Invoke` method in your middleware takes a parameter of type `HttpContext`:

```
public async Task Invoke(HttpContext context)
```

`HttpContext` has significantly changed in ASP.NET Core. This section shows how to translate the most commonly used properties of `System.Web.HttpContext` to the new `Microsoft.AspNetCore.Http.HttpContext`.

### HttpContext

`HttpContext.Items` translates to:

```
IDictionary<object, object> items = httpContext.Items;
```

### Unique request ID (no `System.Web.HttpContext` counterpart)

Gives you a unique id for each request. Very useful to include in your logs.

```
string requestId = httpContext.TraceIdentifier;
```

### HttpContext.Request

`HttpContext.Request.HttpMethod` translates to:

```
string httpMethod = httpContext.Request.Method;
```

`HttpContext.Request.QueryString` translates to:

```

IQueryCollection queryParameters = httpContext.Request.Query;

// If no query parameter "key" used, values will have 0 items
// If single value used for a key (...?key=v1), values will have 1 item ("v1")
// If key has multiple values (...?key=v1&key=v2), values will have 2 items ("v1" and "v2")
IList<string> values = queryParameters["key"];

// If no query parameter "key" used, value will be ""
// If single value used for a key (...?key=v1), value will be "v1"
// If key has multiple values (...?key=v1&key=v2), value will be "v1,v2"
string value = queryParameters["key"].ToString();

```

**HttpContext.Request.Url** and **HttpContext.Request.RawUrl** translate to:

```

// using Microsoft.AspNetCore.Http.Extensions;
var url = httpContext.Request.GetDisplayUrl();

```

**HttpContext.Request.IsSecureConnection** translates to:

```

var isSecureConnection = httpContext.Request.IsHttps;

```

**HttpContext.Request.UserHostAddress** translates to:

```

var userHostAddress = httpContext.Connection.RemoteIpAddress?.ToString();

```

**HttpContext.Request.Cookies** translates to:

```

 IRequestCookieCollection cookies = httpContext.Request.Cookies;
 string unknownCookieValue = cookies["unknownCookie"]; // will be null (no exception)
 string knownCookieValue = cookies["cookie1name"]; // will be actual value

```

**HttpContext.Request.RequestContext.RouteData** translates to:

```

var routeValue = httpContext.GetRouteValue("key");

```

**HttpContext.Request.Headers** translates to:

```

// using Microsoft.AspNetCore.Http.Headers;
// using Microsoft.Net.Http.Headers;

IHeaderDictionary headersDictionary = httpContext.Request.Headers;

// GetTypedHeaders extension method provides strongly typed access to many headers
var requestHeaders = httpContext.Request.GetTypedHeaders();
CacheControlHeaderValue cacheControlHeaderValue = requestHeaders.CacheControl;

// For unknown header, unknownheaderValues has zero items and unknownHeaderValue is ""
IList<string> unknownheaderValues = headersDictionary["unknownheader"];
string unknownHeaderValue = headersDictionary["unknownheader"].ToString();

// For known header, knownheaderValues has 1 item and knownHeaderValue is the value
IList<string> knownheaderValues = headersDictionary[HeaderNames.AcceptLanguage];
string knownHeaderValue = headersDictionary[HeaderNames.AcceptLanguage].ToString();

```

**HttpContext.Request.UserAgent** translates to:

```
string userAgent = headersDictionary[HeaderNames.UserAgent].ToString();
```

**HttpContext.Request.UrlReferrer** translates to:

```
string urlReferrer = headersDictionary[HeaderNames.Referer].ToString();
```

**HttpContext.Request.ContentType** translates to:

```
// using Microsoft.Net.Http.Headers;

MediaTypeHeaderValue mediaHeaderValue = requestHeaders.ContentType;
string contentType = mediaHeaderValue?.MediaType.ToString(); // ex. application/x-www-form-urlencoded
string contentMainType = mediaHeaderValue?.Type.ToString(); // ex. application
string contentSubType = mediaHeaderValue?.SubType.ToString(); // ex. x-www-form-urlencoded

System.Text.Encoding requestEncoding = mediaHeaderValue?.Encoding;
```

**HttpContext.Request.Form** translates to:

```
if (httpContext.Request.HasFormContentType)
{
    IFormCollection form;

    form = httpContext.Request.Form; // sync
    // Or
    form = await httpContext.Request.ReadFormAsync(); // async

    string firstName = form["firstname"];
    string lastName = form["lastname"];
}
```

#### WARNING

Read form values only if the content sub type is *x-www-form-urlencoded* or *form-data*.

**HttpContext.Request.InputStream** translates to:

```
string inputBody;
using (var reader = new System.IO.StreamReader(
    httpContext.Request.Body, System.Text.Encoding.UTF8))
{
    inputBody = reader.ReadToEnd();
}
```

#### WARNING

Use this code only in a handler type middleware, at the end of a pipeline.

You can read the raw body as shown above only once per request. Middleware trying to read the body after the first read will read an empty body.

This doesn't apply to reading a form as shown earlier, because that's done from a buffer.

**HttpContext.Response**

**HttpContext.Response.Status** and **HttpContext.Response.StatusDescription** translate to:

```
// using Microsoft.AspNetCore.Http;
httpContext.Response.StatusCode = StatusCodes.Status200OK;
```

**HttpContext.Response.ContentEncoding** and **HttpContext.Response.ContentType** translate to:

```
// using Microsoft.Net.Http.Headers;
var mediaType = new MediaTypeHeaderValue("application/json");
mediaType.Encoding = System.Text.Encoding.UTF8;
httpContext.Response.ContentType = mediaType.ToString();
```

**HttpContext.Response.ContentType** on its own also translates to:

```
httpContext.Response.ContentType = "text/html";
```

**HttpContext.Response.Output** translates to:

```
string responseContent = GetResponseContent();
await httpContext.Response.WriteAsync(responseContent);
```

### HttpContext.Response.TransmitFile

Serving up a file is discussed [here](#).

### HttpContext.Response.Headers

Sending response headers is complicated by the fact that if you set them after anything has been written to the response body, they will not be sent.

The solution is to set a callback method that will be called right before writing to the response starts. This is best done at the start of the `Invoke` method in your middleware. It's this callback method that sets your response headers.

The following code sets a callback method called `SetHeaders`:

```
public async Task Invoke(HttpContext httpContext)
{
    // ...
    httpContext.Response.OnStarting(SetHeaders, state: httpContext);
```

The `SetHeaders` callback method would look like this:

```

// using Microsoft.AspNetCore.Http.Headers;
// using Microsoft.Net.Http.Headers;

private Task SetHeaders(object context)
{
    var httpContext = (HttpContext)context;

    // Set header with single value
    httpContext.Response.Headers["ResponseHeaderName"] = "headerValue";

    // Set header with multiple values
    string[] responseHeaderValues = new string[] { "headerValue1", "headerValue1" };
    httpContext.Response.Headers["ResponseHeaderName"] = responseHeaderValues;

    // Translating ASP.NET 4's HttpContext.Response.RedirectLocation
    httpContext.Response.Headers[HeaderNames.Location] = "http://www.example.com";
    // Or
    httpContext.Response.Redirect("http://www.example.com");

    // GetTypedHeaders extension method provides strongly typed access to many headers
    var responseHeaders = httpContext.Response.GetTypedHeaders();

    // Translating ASP.NET 4's HttpContext.Response.CacheControl
    responseHeaders.CacheControl = new CacheControlHeaderValue
    {
        MaxAge = new System.TimeSpan(365, 0, 0, 0)
        // Many more properties available
    };

    // If you use .Net 4.6+, Task.CompletedTask will be a bit faster
    return Task.FromResult(0);
}

```

## HttpContext.Response.Cookies

Cookies travel to the browser in a *Set-Cookie* response header. As a result, sending cookies requires the same callback as used for sending response headers:

```

public async Task Invoke(HttpContext httpContext)
{
    // ...
    httpContext.Response.OnStarting(SetCookies, state: httpContext);
    httpContext.Response.OnStarting(SetHeaders, state: httpContext);
}

```

The `SetCookies` callback method would look like the following:

```

private Task SetCookies(object context)
{
    var httpContext = (HttpContext)context;

    IResponseCookies responseCookies = httpContext.Response.Cookies;

    responseCookies.Append("cookie1name", "cookie1value");
    responseCookies.Append("cookie2name", "cookie2value",
        new CookieOptions { Expires = System.DateTime.Now.AddDays(5), HttpOnly = true });

    // If you use .Net 4.6+, Task.CompletedTask will be a bit faster
    return Task.FromResult(0);
}

```

## Additional resources

- [HTTP Handlers and HTTP Modules Overview](#)
- [Configuration](#)
- [Application Startup](#)
- [Middleware](#)

# Migrate from ASP.NET Core 1.x to 2.0

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By Scott Addie

In this article, we walk you through updating an existing ASP.NET Core 1.x project to ASP.NET Core 2.0. Migrating your application to ASP.NET Core 2.0 enables you to take advantage of [many new features and performance improvements](#).

Existing ASP.NET Core 1.x applications are based off of version-specific project templates. As the ASP.NET Core framework evolves, so do the project templates and the starter code contained within them. In addition to updating the ASP.NET Core framework, you need to update the code for your application.

## Prerequisites

See [Get Started with ASP.NET Core](#).

## Update Target Framework Moniker (TFM)

Projects targeting .NET Core should use the [TFM](#) of a version greater than or equal to .NET Core 2.0. Search for the `<TargetFramework>` node in the `.csproj` file, and replace its inner text with `netcoreapp2.0` :

```
<TargetFramework>netcoreapp2.0</TargetFramework>
```

Projects targeting .NET Framework should use the TFM of a version greater than or equal to .NET Framework 4.6.1. Search for the `<TargetFramework>` node in the `.csproj` file, and replace its inner text with `net461` :

```
<TargetFramework>net461</TargetFramework>
```

### NOTE

.NET Core 2.0 offers a much larger surface area than .NET Core 1.x. If you're targeting .NET Framework solely because of missing APIs in .NET Core 1.x, targeting .NET Core 2.0 is likely to work.

## Update .NET Core SDK version in global.json

If your solution relies upon a [global.json](#) file to target a specific .NET Core SDK version, update its `version` property to use the 2.0 version installed on your machine:

```
{
  "sdk": {
    "version": "2.0.0"
  }
}
```

## Update package references

The `.csproj` file in a 1.x project lists each NuGet package used by the project.

In an ASP.NET Core 2.0 project targeting .NET Core 2.0, a single [metapackage](#) reference in the `.csproj` file replaces the collection of packages:

```
<ItemGroup>
  <PackageReference Include="Microsoft.AspNetCore.All" Version="2.0.0" />
</ItemGroup>
```

All the features of ASP.NET Core 2.0 and Entity Framework Core 2.0 are included in the metapackage.

ASP.NET Core 2.0 projects targeting .NET Framework should continue to reference individual NuGet packages.

Update the `Version` attribute of each `<PackageReference />` node to 2.0.0.

For example, here's the list of `<PackageReference />` nodes used in a typical ASP.NET Core 2.0 project targeting .NET Framework:

```
<ItemGroup>
  <PackageReference Include="Microsoft.AspNetCore" Version="2.0.0" />
  <PackageReference Include="Microsoft.AspNetCore.Authentication.Cookies" Version="2.0.0" />
  <PackageReference Include="Microsoft.AspNetCore.Diagnostics.EntityFrameworkCore" Version="2.0.0" />
  <PackageReference Include="Microsoft.AspNetCore.Identity.EntityFrameworkCore" Version="2.0.0" />
  <PackageReference Include="Microsoft.AspNetCore.Mvc" Version="2.0.0" />
  <PackageReference Include="Microsoft.AspNetCore.Mvc.Razor.ViewCompilation" Version="2.0.0" />
  PrivateAssets="All" />
  <PackageReference Include="Microsoft.AspNetCore.StaticFiles" Version="2.0.0" />
  <PackageReference Include="Microsoft.EntityFrameworkCore.Design" Version="2.0.0" PrivateAssets="All" />
  <PackageReference Include="Microsoft.EntityFrameworkCore.SqlServer" Version="2.0.0" />
  <PackageReference Include="Microsoft.EntityFrameworkCore.Tools" Version="2.0.0" PrivateAssets="All" />
  <PackageReference Include="Microsoft.VisualStudio.Web.BrowserLink" Version="2.0.0" />
  <PackageReference Include="Microsoft.VisualStudio.Web.CodeGeneration.Design" Version="2.0.0" />
  PrivateAssets="All" />
</ItemGroup>
```

## Update .NET Core CLI tools

In the `.csproj` file, update the `Version` attribute of each `<DotNetCliToolReference />` node to 2.0.0.

For example, here's the list of CLI tools used in a typical ASP.NET Core 2.0 project targeting .NET Core 2.0:

```
<ItemGroup>
  <DotNetCliToolReference Include="Microsoft.EntityFrameworkCore.Tools.DotNet" Version="2.0.0" />
  <DotNetCliToolReference Include="Microsoft.Extensions.SecretManager.Tools" Version="2.0.0" />
  <DotNetCliToolReference Include="Microsoft.VisualStudio.Web.CodeGeneration.Tools" Version="2.0.0" />
</ItemGroup>
```

## Rename Package Target Fallback property

The `.csproj` file of a 1.x project used a `PackageTargetFallback` node and variable:

```
<PackageTargetFallback>$(<PackageTargetFallback>);portable-net45+win8+wp8+wpa81;</PackageTargetFallback>
```

Rename both the node and variable to `AssetTargetFallback`:

```
<AssetTargetFallback>$(<AssetTargetFallback>);portable-net45+win8+wp8+wpa81;</AssetTargetFallback>
```

## Update Main method in Program.cs

In 1.x projects, the `Main` method of *Program.cs* looked like this:

```
using System.IO;
using Microsoft.AspNetCore.Hosting;

namespace AspNetCoreDotNetCore1App
{
    public class Program
    {
        public static void Main(string[] args)
        {
            var host = new WebHostBuilder()
                .UseKestrel()
                .UseContentRoot(Directory.GetCurrentDirectory())
                .UseIISIntegration()
                .UseStartup<Startup>()
                .UseApplicationInsights()
                .Build();

            host.Run();
        }
    }
}
```

In 2.0 projects, the `Main` method of *Program.cs* has been simplified:

```
using Microsoft.AspNetCore;
using Microsoft.AspNetCore.Hosting;

namespace AspNetCoreDotNetCore2App
{
    public class Program
    {
        public static void Main(string[] args)
        {
            BuildWebHost(args).Run();
        }

        public static IWebHost BuildWebHost(string[] args) =>
            WebHost.CreateDefaultBuilder(args)
                .UseStartup<Startup>()
                .Build();
    }
}
```

The adoption of this new 2.0 pattern is highly recommended and is required for product features like [Entity Framework \(EF\) Core Migrations](#) to work. For example, running `Update-Database` from the Package Manager Console window or `dotnet ef database update` from the command line (on projects converted to ASP.NET Core 2.0) generates the following error:

```
Unable to create an object of type '<Context>'. Add an implementation of
'IDesignTimeDbContextFactory<Context>' to the project, or see https://go.microsoft.com/fwlink/?linkid=851728
for additional patterns supported at design time.
```

## Add configuration providers

In 1.x projects, adding configuration providers to an app was accomplished via the `Startup` constructor. The steps involved creating an instance of `ConfigurationBuilder`, loading applicable providers (environment variables, app

settings, etc.), and initializing a member of `IConfigurationRoot`.

```
public Startup(IHostingEnvironment env)
{
    var builder = new ConfigurationBuilder()
        .SetBasePath(env.ContentRootPath)
        .AddJsonFile("appsettings.json", optional: false, reloadOnChange: true)
        .AddJsonFile($"appsettings.{env.EnvironmentName}.json", optional: true);

    if (env.IsDevelopment())
    {
        builder.AddUserSecrets<Startup>();
    }

    builder.AddEnvironmentVariables();
    Configuration = builder.Build();
}

public IConfigurationRoot Configuration { get; }
```

The preceding example loads the `Configuration` member with configuration settings from `appsettings.json` as well as any `appsettings.<EnvironmentName>.json` file matching the `IHostingEnvironment.EnvironmentName` property. The location of these files is at the same path as `Startup.cs`.

In 2.0 projects, the boilerplate configuration code inherent to 1.x projects runs behind-the-scenes. For example, environment variables and app settings are loaded at startup. The equivalent `Startup.cs` code is reduced to `IConfiguration` initialization with the injected instance:

```
public Startup(IConfiguration configuration)
{
    Configuration = configuration;
}

public IConfiguration Configuration { get; }
```

To remove the default providers added by `WebHostBuilder.CreateDefaultBuilder`, invoke the `Clear` method on the `IConfigurationBuilder.Sources` property inside of `ConfigureAppConfiguration`. To add providers back, utilize the `ConfigureAppConfiguration` method in `Program.cs`:

```
public static void Main(string[] args)
{
    BuildWebHost(args).Run();
}

public static IWebHost BuildWebHost(string[] args) =>
    WebHost.CreateDefaultBuilder(args)
        .UseStartup<Startup>()
        .ConfigureAppConfiguration((hostContext, config) =>
    {
        // delete all default configuration providers
        config.Sources.Clear();
        config.AddJsonFile("myconfig.json", optional: true);
    })
    .Build();
```

The configuration used by the `CreateDefaultBuilder` method in the preceding code snippet can be seen [here](#).

For more information, see [Configuration in ASP.NET Core](#).

## Move database initialization code

In 1.x projects using EF Core 1.x, a command such as `dotnet ef migrations add` does the following:

1. Instantiates a `Startup` instance
2. Invokes the `ConfigureServices` method to register all services with dependency injection (including `DbContext` types)
3. Performs its requisite tasks

In 2.0 projects using EF Core 2.0, `Program.BuildWebHost` is invoked to obtain the application services. Unlike 1.x, this has the additional side effect of invoking `startup.Configure`. If your 1.x app invoked database initialization code in its `Configure` method, unexpected problems can occur. For example, if the database doesn't yet exist, the seeding code runs before the EF Core Migrations command execution. This problem causes a `dotnet ef migrations list` command to fail if the database doesn't yet exist.

Consider the following 1.x seed initialization code in the `Configure` method of `Startup.cs`:

```
app.UseMvc(routes =>
{
    routes.MapRoute(
        name: "default",
        template: "{controller=Home}/{action=Index}/{id?}");
});

SeedData.Initialize(app.ApplicationServices);
```

In 2.0 projects, move the `SeedData.Initialize` call to the `Main` method of `Program.cs`:

```
var host = BuildWebHost(args);

using (var scope = host.Services.CreateScope())
{
    var services = scope.ServiceProvider;

    try
    {
        // Requires using RazorPagesMovie.Models;
        SeedData.Initialize(services);
    }
    catch (Exception ex)
    {
        var logger = services.GetRequiredService<ILogger<Program>>();
        logger.LogError(ex, "An error occurred seeding the DB.");
    }
}

host.Run();
```

As of 2.0, it's bad practice to do anything in `BuildWebHost` except build and configure the web host. Anything that's about running the application should be handled outside of `BuildWebHost` — typically in the `Main` method of `Program.cs`.

## Review Razor view compilation setting

Faster application startup time and smaller published bundles are of utmost importance to you. For these reasons, [Razor view compilation](#) is enabled by default in ASP.NET Core 2.0.

Setting the `MvcRazorCompileOnPublish` property to true is no longer required. Unless you're disabling view

compilation, the property may be removed from the `.csproj` file.

When targeting .NET Framework, you still need to explicitly reference the [Microsoft.AspNetCore.Mvc.Razor.ViewCompilation](#) NuGet package in your `.csproj` file:

```
<PackageReference Include="Microsoft.AspNetCore.Mvc.Razor.ViewCompilation" Version="2.0.0" PrivateAssets="All" />
```

## Rely on Application Insights "light-up" features

Effortless setup of application performance instrumentation is important. You can now rely on the new [Application Insights](#) "light-up" features available in the Visual Studio 2017 tooling.

ASP.NET Core 1.1 projects created in Visual Studio 2017 added Application Insights by default. If you're not using the Application Insights SDK directly, outside of `Program.cs` and `Startup.cs`, follow these steps:

1. If targeting .NET Core, remove the following `<PackageReference />` node from the `.csproj` file:

```
<PackageReference Include="Microsoft.ApplicationInsights.AspNetCore" Version="2.0.0" />
```

2. If targeting .NET Core, remove the `UseApplicationInsights` extension method invocation from `Program.cs`:

```
public static void Main(string[] args)
{
    var host = new WebHostBuilder()
        .UseKestrel()
        .UseContentRoot(Directory.GetCurrentDirectory())
        .UseIISIntegration()
        .UseStartup<Startup>()
        .UseApplicationInsights()
        .Build();

    host.Run();
}
```

3. Remove the Application Insights client-side API call from `_Layout.cshtml`. It comprises the following two lines of code:

```
@inject Microsoft.ApplicationInsights.AspNetCore.JavaScriptSnippet JavaScriptSnippet
@Html.Raw(JavaScriptSnippet.FullScript)
```

If you are using the Application Insights SDK directly, continue to do so. The 2.0 [metapackage](#) includes the latest version of Application Insights, so a package downgrade error appears if you're referencing an older version.

## Adopt authentication/Identity improvements

ASP.NET Core 2.0 has a new authentication model and a number of significant changes to ASP.NET Core Identity. If you created your project with Individual User Accounts enabled, or if you have manually added authentication or Identity, see [Migrate Authentication and Identity to ASP.NET Core 2.0](#).

## Additional resources

- [Breaking Changes in ASP.NET Core 2.0](#)

# Migrate authentication and Identity to ASP.NET Core 2.0

6/21/2018 • 8 minutes to read • [Edit Online](#)

By [Scott Addie](#) and [Hao Kung](#)

ASP.NET Core 2.0 has a new model for authentication and [Identity](#) which simplifies configuration by using services. ASP.NET Core 1.x applications that use authentication or Identity can be updated to use the new model as outlined below.

## Authentication Middleware and services

In 1.x projects, authentication is configured via middleware. A middleware method is invoked for each authentication scheme you want to support.

The following 1.x example configures Facebook authentication with Identity in *Startup.cs*:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddIdentity<ApplicationUser, IdentityRole>()
        .AddEntityFrameworkStores<ApplicationContext>();

}

public void Configure(IApplicationBuilder app, ILoggerFactory loggerfactory)
{
    app.UseIdentity();
    app.UseFacebookAuthentication(new FacebookOptions {
        AppId = Configuration["auth:facebook:appid"],
        AppSecret = Configuration["auth:facebook:appsecret"]
    });
}
```

In 2.0 projects, authentication is configured via services. Each authentication scheme is registered in the `ConfigureServices` method of *Startup.cs*. The `UseIdentity` method is replaced with `UseAuthentication`.

The following 2.0 example configures Facebook authentication with Identity in *Startup.cs*:

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddIdentity<ApplicationUser, IdentityRole>()
        .AddEntityFrameworkStores<ApplicationContext>();

    // If you want to tweak Identity cookies, they're no longer part of IdentityOptions.
    services.ConfigureApplicationCookie(options => options.LoginPath = "/Account/LogIn");
    services.AddAuthentication()
        .AddFacebook(options =>
    {
        options.AppId = Configuration["auth:facebook:appid"];
        options.AppSecret = Configuration["auth:facebook:appsecret"];
    });
}

public void Configure(IApplicationBuilder app, ILoggerFactory loggerfactory) {
    app.UseAuthentication();
}
```

The `UseAuthentication` method adds a single authentication middleware component which is responsible for automatic authentication and the handling of remote authentication requests. It replaces all of the individual middleware components with a single, common middleware component.

Below are 2.0 migration instructions for each major authentication scheme.

### Cookie-based authentication

Select one of the two options below, and make the necessary changes in `Startup.cs`:

#### 1. Use cookies with Identity

- Replace `useIdentity` with `UseAuthentication` in the `Configure` method:

```
app.UseAuthentication();
```

- Invoke the `AddIdentity` method in the `ConfigureServices` method to add the cookie authentication services.
- Optionally, invoke the `ConfigureApplicationCookie` or `ConfigureExternalCookie` method in the `ConfigureServices` method to tweak the Identity cookie settings.

```
services.AddIdentity< ApplicationUser, IdentityRole>()
    .AddEntityFrameworkStores< ApplicationDbContext >()
    .AddDefaultTokenProviders();

services.ConfigureApplicationCookie(options => options.LoginPath = "/Account/LogIn");
```

#### 2. Use cookies without Identity

- Replace the `UseCookieAuthentication` method call in the `Configure` method with `UseAuthentication`:

```
app.UseAuthentication();
```

- Invoke the `AddAuthentication` and `AddCookie` methods in the `ConfigureServices` method:

```
// If you don't want the cookie to be automatically authenticated and assigned to
// HttpContext.User,
// remove the CookieAuthenticationDefaults.AuthenticationScheme parameter passed to
// AddAuthentication.
services.AddAuthentication(CookieAuthenticationDefaults.AuthenticationScheme)
    .AddCookie(options =>
{
    options.LoginPath = "/Account/LogIn";
    options.LogoutPath = "/Account/LogOff";
});
```

### JWT Bearer Authentication

Make the following changes in `Startup.cs`:

- Replace the `UseJwtBearerAuthentication` method call in the `Configure` method with `UseAuthentication`:

```
app.UseAuthentication();
```

- Invoke the `AddJwtBearer` method in the `ConfigureServices` method:

```
services.AddAuthentication(JwtBearerDefaults.AuthenticationScheme)
    .AddJwtBearer(options =>
{
    options.Audience = "http://localhost:5001/";
    options.Authority = "http://localhost:5000/";
});
```

This code snippet doesn't use Identity, so the default scheme should be set by passing `JwtBearerDefaults.AuthenticationScheme` to the `AddAuthentication` method.

## OpenID Connect (OIDC) authentication

Make the following changes in `Startup.cs`:

- Replace the `UseOpenIdConnectAuthentication` method call in the `Configure` method with `UseAuthentication`:

```
app.UseAuthentication();
```

- Invoke the `AddOpenIdConnect` method in the `ConfigureServices` method:

```
services.AddAuthentication(options =>
{
    options.DefaultScheme = CookieAuthenticationDefaults.AuthenticationScheme;
    options.DefaultChallengeScheme = OpenIdConnectDefaults.AuthenticationScheme;
})
.AddCookie()
.AddOpenIdConnect(options =>
{
    options.Authority = Configuration["auth:oidc:authority"];
    options.ClientId = Configuration["auth:oidc:clientid"];
});
```

## Facebook authentication

Make the following changes in `Startup.cs`:

- Replace the `UseFacebookAuthentication` method call in the `Configure` method with `UseAuthentication`:

```
app.UseAuthentication();
```

- Invoke the `AddFacebook` method in the `ConfigureServices` method:

```
services.AddAuthentication()
    .AddFacebook(options =>
{
    options.AppId = Configuration["auth:facebook:appid"];
    options.AppSecret = Configuration["auth:facebook:appsecret"];
});
```

## Google authentication

Make the following changes in `Startup.cs`:

- Replace the `UseGoogleAuthentication` method call in the `Configure` method with `UseAuthentication`:

```
app.UseAuthentication();
```

- Invoke the `AddGoogle` method in the `ConfigureServices` method:

```
services.AddAuthentication()
    .AddGoogle(options =>
{
    options.ClientId = Configuration["auth:google:clientid"];
    options.ClientSecret = Configuration["auth:google:clientsecret"];
});
```

## Microsoft Account authentication

Make the following changes in *Startup.cs*:

- Replace the `UseMicrosoftAccountAuthentication` method call in the `Configure` method with `UseAuthentication`:

```
app.UseAuthentication();
```

- Invoke the `AddMicrosoftAccount` method in the `ConfigureServices` method:

```
services.AddAuthentication()
    .AddMicrosoftAccount(options =>
{
    options.ClientId = Configuration["auth:microsoft:clientid"];
    options.ClientSecret = Configuration["auth:microsoft:clientsecret"];
});
```

## Twitter authentication

Make the following changes in *Startup.cs*:

- Replace the `UseTwitterAuthentication` method call in the `Configure` method with `UseAuthentication`:

```
app.UseAuthentication();
```

- Invoke the `AddTwitter` method in the `ConfigureServices` method:

```
services.AddAuthentication()
    .AddTwitter(options =>
{
    options.ConsumerKey = Configuration["auth:twitter:consumerkey"];
    options.ConsumerSecret = Configuration["auth:twitter:consumersecret"];
});
```

## Setting default authentication schemes

In 1.x, the `AutomaticAuthenticate` and `AutomaticChallenge` properties of the `AuthenticationOptions` base class were intended to be set on a single authentication scheme. There was no good way to enforce this.

In 2.0, these two properties have been removed as properties on the individual `AuthenticationOptions` instance. They can be configured in the `AddAuthentication` method call within the `ConfigureServices` method of *Startup.cs*:

```
services.AddAuthentication(CookieAuthenticationDefaults.AuthenticationScheme);
```

In the preceding code snippet, the default scheme is set to `CookieAuthenticationDefaults.AuthenticationScheme` ("Cookies").

Alternatively, use an overloaded version of the `AddAuthentication` method to set more than one property. In the

following overloaded method example, the default scheme is set to `CookieAuthenticationDefaults.AuthenticationScheme`. The authentication scheme may alternatively be specified within your individual `[Authorize]` attributes or authorization policies.

```
services.AddAuthentication(options =>
{
    options.DefaultScheme = CookieAuthenticationDefaults.AuthenticationScheme;
    options.DefaultChallengeScheme = OpenIdConnectDefaults.AuthenticationScheme;
});
```

Define a default scheme in 2.0 if one of the following conditions is true:

- You want the user to be automatically signed in
- You use the `[Authorize]` attribute or authorization policies without specifying schemes

An exception to this rule is the `AddIdentity` method. This method adds cookies for you and sets the default authenticate and challenge schemes to the application cookie `IdentityConstants.ApplicationScheme`. Additionally, it sets the default sign-in scheme to the external cookie `IdentityConstants.ExternalScheme`.

## Use `HttpContext` authentication extensions

The `IAuthenticationManager` interface is the main entry point into the 1.x authentication system. It has been replaced with a new set of `HttpContext` extension methods in the `Microsoft.AspNetCore.Authentication` namespace.

For example, 1.x projects reference an `Authentication` property:

```
// Clear the existing external cookie to ensure a clean login process
await HttpContext.Authentication.SignOutAsync(_externalCookieScheme);
```

In 2.0 projects, import the `Microsoft.AspNetCore.Authentication` namespace, and delete the `Authentication` property references:

```
// Clear the existing external cookie to ensure a clean login process
await HttpContext.SignOutAsync(IdentityConstants.ExternalScheme);
```

## Windows Authentication (HTTP.sys / IISIntegration)

There are two variations of Windows authentication:

1. The host only allows authenticated users
2. The host allows both anonymous and authenticated users

The first variation described above is unaffected by the 2.0 changes.

The second variation described above is affected by the 2.0 changes. As an example, you may be allowing anonymous users into your application at the IIS or `HTTP.sys` layer but authorizing users at the Controller level. In this scenario, set the default scheme to `IISDefaults.AuthenticationScheme` in the `ConfigureServices` method of `Startup.cs`:

```
services.AddAuthentication(IISDefaults.AuthenticationScheme);
```

Failure to set the default scheme accordingly prevents the authorize request to challenge from working.

## IdentityCookieOptions instances

A side effect of the 2.0 changes is the switch to using named options instead of cookie options instances. The ability to customize the Identity cookie scheme names is removed.

For example, 1.x projects use [constructor injection](#) to pass an `IdentityCookieOptions` parameter into `AccountController.cs`. The external cookie authentication scheme is accessed from the provided instance:

```
public AccountController(
    UserManager< ApplicationUser > userManager,
    SignInManager< ApplicationUser > signInManager,
    IOptions< IdentityCookieOptions > identityCookieOptions,
    IEmailSender emailSender,
    ISmsSender smsSender,
    ILoggerFactory loggerFactory)
{
    _userManager = userManager;
    _signInManager = signInManager;
    _externalCookieScheme = identityCookieOptions.Value.ExternalCookieAuthenticationScheme;
    _emailSender = emailSender;
    _smsSender = smsSender;
    _logger = loggerFactory.CreateLogger< AccountController >();
}
```

The aforementioned constructor injection becomes unnecessary in 2.0 projects, and the `_externalCookieScheme` field can be deleted:

```
public AccountController(
    UserManager< ApplicationUser > userManager,
    SignInManager< ApplicationUser > signInManager,
    IEmailSender emailSender,
    ISmsSender smsSender,
    ILoggerFactory loggerFactory)
{
    _userManager = userManager;
    _signInManager = signInManager;
    _emailSender = emailSender;
    _smsSender = smsSender;
    _logger = loggerFactory.CreateLogger< AccountController >();
}
```

The `IdentityConstants.ExternalScheme` constant can be used directly:

```
// Clear the existing external cookie to ensure a clean login process
await HttpContext.SignOutAsync(IdentityConstants.ExternalScheme);
```

## Add IdentityUser POCO navigation properties

The Entity Framework (EF) Core navigation properties of the base `IdentityUser` POCO (Plain Old CLR Object) have been removed. If your 1.x project used these properties, manually add them back to the 2.0 project:

```

/// <summary>
/// Navigation property for the roles this user belongs to.
/// </summary>
public virtual ICollection<IdentityUserRole<int>> Roles { get; } = new List<IdentityUserRole<int>>();

/// <summary>
/// Navigation property for the claims this user possesses.
/// </summary>
public virtual ICollection<IdentityUserClaim<int>> Claims { get; } = new List<IdentityUserClaim<int>>();

/// <summary>
/// Navigation property for this users login accounts.
/// </summary>
public virtual ICollection<IdentityUserLogin<int>> Logins { get; } = new List<IdentityUserLogin<int>>();

```

To prevent duplicate foreign keys when running EF Core Migrations, add the following to your `IdentityDbContext` class' `OnModelCreating` method (after the `base.OnModelCreating();` call):

```

protected override void OnModelCreating(ModelBuilder builder)
{
    base.OnModelCreating(builder);
    // Customize the ASP.NET Identity model and override the defaults if needed.
    // For example, you can rename the ASP.NET Identity table names and more.
    // Add your customizations after calling base.OnModelCreating(builder);

    builder.Entity< ApplicationUser >()
        .HasMany(e => e.Claims)
        .WithOne()
        .HasForeignKey(e => e.UserId)
        .IsRequired()
        .OnDelete(DeleteBehavior.Cascade);

    builder.Entity< ApplicationUser >()
        .HasMany(e => e.Logins)
        .WithOne()
        .HasForeignKey(e => e.UserId)
        .IsRequired()
        .OnDelete(DeleteBehavior.Cascade);

    builder.Entity< ApplicationUser >()
        .HasMany(e => e.Roles)
        .WithOne()
        .HasForeignKey(e => e.UserId)
        .IsRequired()
        .OnDelete(DeleteBehavior.Cascade);
}

```

## Replace GetExternalAuthenticationSchemes

The synchronous method `GetExternalAuthenticationSchemes` was removed in favor of an asynchronous version.

1.x projects have the following code in `ManageController.cs`:

```

var otherLogins = _signInManager.GetExternalAuthenticationSchemes().Where(auth => userLogins.All(ul =>
    auth.AuthenticationScheme != ul.LoginProvider)).ToList();

```

This method appears in `Login.cshtml` too:

```

var loginProviders = SignInManager.GetExternalAuthenticationSchemes().ToList();


@foreach (var provider in loginProviders)
        {
            <button type="submit" class="btn btn-default" name="provider"
            value="@provider.AuthenticationScheme" title="Log in using your @provider.DisplayName
            account">@provider.AuthenticationScheme</button>
        }


</form>
}

```

In 2.0 projects, use the `GetExternalAuthenticationSchemesAsync` method:

```

var schemes = await _signInManager.GetExternalAuthenticationSchemesAsync();
var otherLogins = schemes.Where(auth => userLogins.All(ul => auth.Name != ul.LoginProvider)).ToList();

```

In `Login.cshtml`, the `AuthenticationScheme` property accessed in the `foreach` loop changes to `Name`:

```

var loginProviders = (await SignInManager.GetExternalAuthenticationSchemesAsync()).ToList();


@foreach (var provider in loginProviders)
        {
            <button type="submit" class="btn btn-default" name="provider" value="@provider.Name"
            title="Log in using your @provider.DisplayName account">@provider.DisplayName</button>
        }


</form>
}

```

## ManageLoginsViewModel property change

A `ManageLoginsViewModel` object is used in the `ManageLogins` action of `ManageController.cs`. In 1.x projects, the object's `OtherLogins` property return type is `IList<AuthenticationDescription>`. This return type requires an import of `Microsoft.AspNetCore.Http.Authentication`:

```

using System.Collections.Generic;
using Microsoft.AspNetCore.Http.Authentication;
using Microsoft.AspNetCore.Identity;

namespace AspNetCoreDotNetCore1App.Models.ManageViewModels
{
    public class ManageLoginsViewModel
    {
        public IList<UserLoginInfo> CurrentLogins { get; set; }

        public IList<AuthenticationDescription> OtherLogins { get; set; }
    }
}

```

In 2.0 projects, the return type changes to `IList<AuthenticationScheme>`. This new return type requires replacing the `Microsoft.AspNetCore.Http.Authentication` import with a `Microsoft.AspNetCore.Authentication` import.

```
using System.Collections.Generic;
using Microsoft.AspNetCore.Authentication;
using Microsoft.AspNetCore.Identity;

namespace AspNetCoreDotNetCore2App.Models.ManageViewModels
{
    public class ManageLoginsViewModel
    {
        public IList<UserLoginInfo> CurrentLogins { get; set; }

        public IList<AuthenticationScheme> OtherLogins { get; set; }
    }
}
```

## Additional resources

For additional details and discussion, see the [Discussion for Auth 2.0](#) issue on GitHub.