Full Stack Web Programming with Blazor WebAssembly and ASP.NET Core Web API

https://www.accelebrate.com
(877) 849-1850 ❖ info@accelebrate.com

Customized Technical Training

Accelebrate
ACCELERATED LEARNING, CELEBRATED RESULTS®

On-Site, Customized Private Training

Don't settle for a one-size-fits-all class! Let Accelebrate tailor a private class to your group's goals and experience. Classes can be delivered at your site or online (or a combination of both) worldwide. Visit our web site at **https://www.accelebrate.com** and contact us at **sales@accelebrate.com** for details.

Public Online Training

Need to train just 1-3 people? Attend one of our regularly scheduled, live, instructor-led public online classes. Class sizes are small (typically 3-6 attendees) and you receive just as much hands-on time and individual attention from your instructor as our private classes. For course dates, times, outlines, pricing, and registration, visit **https://www.accelebrate.com/public-training-schedule.**

Newsletter

Want to find out about our latest class offerings? Subscribe to our newsletter **https://www.accelebrate.com/newsletter**.

Blog

Get insights and tutorials from our instructors and staff! Visit our blog, **https://www.accelebrate.com/blog** and join the discussion threads and get feedback from our instructors!

Learning Resources

Get access to learning guides, tutorials, and past issues of our newsletter at the Accelebrate library, **https://www.accelebrate.com/library**.

Call us for a training quote!

877 849 1850

Accelebrate, Inc. was founded in 2002 with the goal of delivering **private training** that rapidly achieves participants' goals. Each year, our experienced instructors deliver hundreds of classes online and at client sites all over the US, Canada, and abroad. We pride ourselves on our **instructors' real-world experience** and ability to **adapt the training** to your team and their objectives. We offer a wide range of topics, including:

- Angular, React, and Vue
- JavaScript
- Data Science using R, Python, & Julia
- Excel Power Query & Power BI
- Tableau
- .NET & VBA programming
- SharePoint & Microsoft 365
- DevOps
- iOS & Android Development
- PostgreSQL, Oracle, and SQL Server
- Java, Spring, and Groovy
- Agile
- Web/Application Server Admin
- HTML5 & Mobile Web Development
- AWS & Azure
- Adobe & Articulate software
- Docker, Kubernetes, Ansible, & Git
- IT leadership & Project Management
- AND MORE *(see back)*

"It's not often that everything goes according to plan and you feel you really got full value for money spent, but in this case, I feel the investment in the Articulate training has already paid off in terms of employee confidence and readiness."

— Paul, St John's University

Like us on Facebook + Follow us on Twitter + Watch us on YouTube

Visit our website for a complete list of courses!

Adobe & Articulate
Adobe Captivate
Adobe Presenter
Articulate Storyline / Studio
Camtasia
RoboHelp

AWS, Azure, & Cloud
AWS
Azure
Cloud Computing
Google Cloud
OpenStack

Big Data
Alteryx
Apache Spark
Teradata
Snowflake SQL

Data Science and RPA
Blue Prism
Django
Julia
Machine Learning
MATLAB
Python
R Programming
Tableau
UiPath

Database & Reporting
BusinessObjects
Crystal Reports
Excel Power Query
MongoDB
MySQL
NoSQL Databases
Oracle
Oracle APEX
Power BI
PivotTable and PowerPivot
PostgreSQL
SQL Server
Vertica Architecture & SQL

DevOps, CI/CD & Agile
Agile
Ansible
Chef
Diversity, Equity, Inclusion
Docker
Git
Gradle Build System
Jenkins
Jira & Confluence
Kubernetes
Linux
Microservices
Red Hat
Software Design

Java
Apache Maven
Apache Tomcat
Groovy and Grails
Hibernate
Java & Web App Security
JavaFX
JBoss
Oracle WebLogic
Scala
Selenium & Cucumber
Spring Boot
Spring Framework

JS, HTML5, & Mobile
Angular
Apache Cordova
CSS
D3.js
HTML5
iOS/Swift Development
JavaScript
MEAN Stack
Mobile Web Development
Node.js & Express
React & Redux
Svelte
Swift
Xamarin
Vue

Microsoft & .NET
.NET Core
ASP.NET
Azure DevOps
C#
Design Patterns
Entity Framework Core
IIS
Microsoft Dynamics CRM
Microsoft Exchange Server
Microsoft 365
Microsoft Power Platform
Microsoft Project
Microsoft SQL Server
Microsoft System Center
Microsoft Windows Server
PowerPivot
PowerShell
VBA
Visual C++/CLI
Web API

Other
C++
Go Programming
IT Leadership
ITIL
Project Management
Regular Expressions
Ruby on Rails
Rust
Salesforce
XML

Security
.NET Web App Security
C and C++ Secure Coding
C# & Web App Security
Linux Security Admin
Python Security
Secure Coding for Web Dev
Spring Security

SharePoint
Power Automate & Flow
SharePoint Administrator
SharePoint Developer
SharePoint End User
SharePoint Online
SharePoint Site Owner

SQL Server
Azure SQL Data Warehouse
Business Intelligence
Performance Tuning
SQL Server Administration
SQL Server Development
SSAS, SSIS, SSRS
Transact-SQL

Teleconferencing Tools
Adobe Connect
GoToMeeting
Microsoft Teams
WebEx
Zoom

Web/Application Server
Apache httpd
Apache Tomcat
IIS
JBoss
Nginx
Oracle WebLogic

*Visit **www.accelebrate.com/newsletter** to sign up and receive our **newsletters** with information about **new courses**, **free webinars**, **tutorials**, and **blog articles**.*

Call us for a training quote! 877 849 1850 (US/Canada) or +1 678 648 3133

Full Stack with Blazor and ASP.NET Core

Agenda

- Introduction
- .NET SDK
- What's New in C#
- Application Architecture
- Introduction to Blazor
- Blazor Application Component
- Data Binding
- Models
- Application Configuration
- Controllers

Full Stack with Blazor and ASP.NET Core

Agenda

- Web APIs
- Consuming Server Data
- Editing Data
- Custom Components
- JavaScript Interop
- State Management
- Security
- Testing

Full Stack with Blazor and ASP.NET Core

Introduction

- Evolution of the .NET Platform
- .NET SDKs and Runtimes
- Visual Studio and Visual Studio Code

2002 .NET 1.0, C# 1.0, Visual Studio .NET

2003 .NET 1.1, Visual Studio 2003

2004 Mono 1.0

2005 .NET 2.0, C# 2.0, Visual Studio 2005
Generics, Nullable Value Types

2006 .NET 3.0, Mono 1.2
WPF, WCF, WF

2007 .NET 3.5, C# 3.0, Visual Studio 2008
LINQ, Anonymous Types, Lambda Expressions, Extension Methods, Implicit Typing

2008 Entity Framework 1.0

2009 ASP.NET MVC 1.0

2010 .NET 4.0, C# 4.0, ASP.NET MVC 2, Visual Studio 2010
Named / Optional Arguments, Dynamic Binding

2012 .NET 4.5, C# 5.0, Mono 3.0, ASP.NET MVC 4, Visual Studio 2012
Asynchronous Members (async / await)

2013 .NET 4.5.1, ASP.NET MVC 5, Visual Studio 2013
SignalR 1.0

2015 .NET 4.6, C# 6.0, Mono 4.0, Visual Studio 2015, Visual Studio Code 1.0
Expression Bodied Members, Null Propagator, String Interpolation

2016 Xamarin Acquisition, .NET Core 1.0, .NET Standard 1.0
Entity Framework Core 1.0

2017 .NET 4.7, .NET Core 2.0, C# 7.0, Visual Studio 2017
ASP.NET Razor Pages, Out Variables, Tuples, Ref Locals and Returns

2018 GitHub Acquisition, .NET Standard 2.0
Blazor Server

2019 .NET 4.8, .NET Core 3.0, C# 8.0, Visual Studio 2019
gRPC, Default Interface Methods, Using Declarations, Nullable Reference Types

2020 .NET 5, C# 9.0
Blazor WebAssembly, Records, Init Only Setters, Top-Level Statements

2021 .NET 6, C# 10.0, Visual Studio 2022
.NET MAUI

Introduction

Evolution of the .NET Platform

- .NET 1.0 included ASP.NET Web Forms
  - Had the potential to be cross-platform but was only officially supported on Windows
- Current version of this variant is 4.8 and now referred to as ".NET Framework"
- Will be supported for many years to come (end of support for .NET 3.5 SP1 is October 2028)

Introduction

Evolution of the .NET Platform

- The ASP.NET MVC web application framework was introduced in 2009
- Initially presented as an alternative to Web Forms (not a replacement)
- Accompanied by a related framework for building services called Web API

Introduction

Evolution of the .NET Platform

- In 2016, Microsoft introduced a new variant of .NET called .NET Core
- Many components were completely rewritten
- Fully supported on Windows, macOS, and Linux
- Included a subset of the functionality provided by .NET Framework
  - Focused on web-based workloads (web UIs and services)
- Merged MVC and Web API into the core framework

Introduction

Evolution of the .NET Platform

- The version of .NET Core after 3.1 became the "main line" for .NET and was labeled .NET 5.0
- Supports development of Windows Forms and WPF applications that run on Windows
- The ASP.NET framework in .NET still includes the name "Core" to avoid confusion with previous versions of ASP.NET MVC

Introduction

Evolution of the .NET Platform

- The entire .NET platform is made available as open-source
- Community contributions are encouraged via pull requests
  - Thoroughly reviewed and tightly controlled by Microsoft

`github.com/dotnet`

Introduction

.NET SDKs and Runtimes

- .NET Runtime
  - Different version for each platform
  - Provides assembly loading, garbage collection, JIT compilation of IL code, and other runtime services
  - Includes the dotnet tool for launching applications
- ASP.NET Core Runtime
  - Includes additional packages for running ASP.NET Core applications
  - Reduces the number of packages that you need to deploy with your application

Introduction

.NET SDKs and Runtimes

- .NET SDK
  - Includes the .NET runtime for the platform
  - Additional command-line tools for compiling, testing, and publishing applications
  - Contains everything needed to develop .NET applications (with the help of a text editor)

Introduction

.NET SDKs and Runtimes

- Each version of .NET has a lifecycle status
  - Current – Includes the latest features and bug fixes but will only be supported for a short time after the next release
  - LTS (Long-Term Support) – Has an extended support period
  - Preview – Not supported for production use
  - Out of support – No longer supported

`dotnet.microsoft.com/download`

Introduction

Visual Studio and Visual Studio Code

- Visual Studio is available for Windows and macOS
  - Full-featured IDE
- Visual Studio Code is available for Windows, macOS, and Linux
  - Includes IntelliSense and debugging features
  - Thousands of extensions are available for additional functionality

`visualstudio.microsoft.com`

Introduction

Visual Studio and Visual Studio Code

- JetBrains also offers an IDE for .NET development called Rider
- Available for Windows, macOS, and Linux
- Includes advanced capabilities in the areas of refactoring, unit testing, and low-level debugging

www.jetbrains.com/rider

Full Stack with Blazor and ASP.NET Core

.NET SDK

- Installation
- Version Management
- Command-Line Interface (CLI)

.NET SDK

Installation

- The .NET SDK is distributed using each supported platform's native install mechanism
- Requires administrative privileges to install
- A list of installed SDK versions is available by using the .NET Command Line Interface (CLI)

```
dotnet --list-sdks
```

- A complete list of all installed runtimes and SDKs (as well as the default version) is also available

```
dotnet --info
```


.NET SDK

Version Management

- By default, CLI commands use the newest installed version of the SDK
  - This behavior can be overridden with a global.json file

```
{
  "sdk": {
    "version": "3.1.415"
  }
}
```

  - Will be in effect for that directory and all sub-directories

.NET SDK

Version Management

- While the SDK version (tooling) is specified using a global.json file, the runtime version is specified within the project file

```
<PropertyGroup>
  <TargetFramework>net6.0</TargetFramework>
</PropertyGroup>
```


.NET SDK

Version Management

- When an application is launched, it will automatically use the newest available runtime with the same major and minor version number
  - For example, if version 6.0 is specified, the application will use automatically use the 6.0.8 runtime but will not automatically use version 6.1 of the runtime
- Allows for system administrators to apply security patches and runtime bug fixes without the need to recompile and re-deploy the application
- Behavior can be overridden by specifying a RollForward policy value

.NET SDK

Version Management

- The target framework for a project can be an older version than the version of the SDK that you are using
  - For example, you can use version 6 of the SDK to build an application that targets the .NET Core 3.1 runtime

```
<PropertyGroup>
  <TargetFramework>netcoreapp3.1</TargetFramework>
</PropertyGroup>
```

- Recommended approach – Use the newest version of the tools possible and choose a runtime target based on your deployment environment

.NET SDK

Command-Line Interface (CLI)

- Many higher-level tools and IDEs use the CLI "under-the-covers"
- CLI commands consist of the driver (“dotnet”), followed by a “verb” and then possibly some arguments and options

.NET SDK

Command-Line Interface (CLI)

- dotnet new
  - Create a new project from an available template
- dotnet restore
  - Restore the dependencies for a project (download missing NuGet packages)
- dotnet build
  - Build a project and all its dependencies
- dotnet run
  - Run an application from its source code (performs a build if necessary)

.NET SDK

Command-Line Interface (CLI)

- dotnet test
  - Execute unit tests for a project
- dotnet publish
  - Pack an application and its dependencies into a folder for deployment
- And many more…

Full Stack with Blazor and ASP.NET Core

What's New in C#

- Introduction
- Record Types
- Init Only Setters
- Nullable Reference Types
- Global Using Directives
- File-Scoped Namespace Declarations
- Top-Level Statements

What's New in C#

Introduction

- C# 9 introduced with .NET 5
- C# 10 introduced with .NET 6
- Several new features and improvements
  - Complete list available in the online documentation

What's New in C#

Record Types

- Every type in .NET is either a value type or a reference type
  - Struct is a value type
  - Class is a reference type
- Values types are recommended to be defined as immutable and are copied on assignment
  - Use value semantics for equality
  - Supports additional safety and optimizations especially for concurrent programming with shared data

What's New in C#

Record Types

- The record type introduced in C# 9 allows you to easily define an immutable reference type that supports value semantics for equality

```
public record Person
{
    public string LastName { get; }
    public string FirstName { get; }

    public Person(string first, string last) =>
        (FirstName, LastName) = (first, last);
}
```

What's New in C#

Record Types

- None of the properties of a record can be modified once it's created
- Records do support inheritance
- It is easy to create a new record from an existing one via the with keyword

```
var person = new Person("Joe", "Smith");

Person brother = person with { FirstName = "Bill" };
```


What's New in C#

Record Types

- Record types can be a very good fit for things like ViewModels and Data Transfer Objects (DTOs)

What's New in C#

Init Only Setters

- It is very convenient to initialize the properties of an object by using object initialization syntax

```
var product = new Product { Name = "Bread", Price = 2.50 }
```

- However, in the past, this was only possible by defining the properties as writable

What's New in C#

Init Only Setters

- In C# 9, it is now possible to define properties with init only setters
- Properties can be set as part of object initialization but become read-only after that

```
public class Product
{
  public string Name { get; init; }
  public double Price { get; init; }
}
```

What's New in C#

Nullable Reference Types

- By default, value types in .NET cannot be set to null
  - A variable can be defined as a nullable value type so that it can store a null value

```
int? num = null;
```

- Reference types can store null and default to null if not provided with an initial value

```
Product p;  // p is null
```


What's New in C#

Nullable Reference Types

- The most common exception encountered during .NET development is the NullReferenceException
  - Occurs when attempting to access the member of an object that is null
- Safety can be significantly improved by using types that cannot be null unless explicitly identified to allow it

What's New in C#

Nullable Reference Types

- C# 8 introduced the idea of nullable reference types
  - Like values types, reference types are not allowed to be null unless the variable is defined as nullable
- Because of the impact on existing code, this feature was not enabled by default
- Could be enabled via the Nullable annotation in the project file

```
<Nullable>enable</Nullable>
```

- In .NET 6 project templates, this is now included by default

What's New in C#

Nullable Reference Types

- If enabled, compiler warnings will be generated when…
  - Setting a non-nullable reference type to null
  - Defining a reference type that does not initialize all non-nullable reference type members as part of construction
  - Dereferencing a possible null reference without checking for null (or using the null-forgiving operator)

```
string fn = person!.FirstName;
```

What's New in C#

Nullable Reference Types

- It is a good idea to enable nullable reference types for new projects
- Refactoring an existing application to use nullable reference types could require a significant amount of effort

What's New in C#

Global Using Directives

- C# 10 introduces global using directive support
- If the global keyword is present, the using directive will be in effect for every file in the project

```
global using EComm.Core;
```

- Can be in any file but a good practice is to have a separate cs file for all the project's global using directives

What's New in C#

Global Using Directives

- In .NET 6, global using directives for common system namespaces can be included implicitly via a project setting

```
<ImplicitUsings>enable</ImplicitUsings>
```

- This setting is included in new projects by default
- For an ASP.NET project, there are a total of 16 namespaces that will be implicitly referenced

What's New in C#

File-Scoped Namespace Declarations

- Typically, code within a namespace is defined within curly braces

```
namespace Acme.Models
{
  ...
}
```

- C# 10 allows for a namespace declaration to specify that all the code within a file belongs to a specific namespace

```
namespace Acme.Models;

...
```

What's New in C#

Top-Level Statements

- A .NET application requires an entry point function named Main defined within a static class

```
class Program {
  static void Main(string[] args) {
    Console.WriteLine(“Hello, World!“);
  }
}
```

- The C# 10 compiler can recognize executable code that is outside of a class as the code for the entry point and generate the necessary function and static class for you

```
Console.WriteLine(“Hello, World!“);
```


What's New in C#

Top-Level Statements

- ASP.NET Core 6 project templates combine the implicit using feature with top-level statements to minimize the amount of code required in Program.cs

```
var builder = WebApplication.CreateBuilder(args);
var app = builder.Build();

app.MapGet("/", () => "Hello World!");

app.Run();
```

Full Stack with Blazor and ASP.NET Core

Application Architecture

- Introduction
- NuGet Packages
- Application Startup
- Hosting Environments
- Middleware and the Request Pipeline
- Services and Dependency Injection

Application Architecture

Introduction

- Single stack for Web UI and Web APIs
- Modular architecture distributed as NuGet packages
- Flexible, environment-based configuration
- Built-in dependency injection support
- Support for using an MVC-based architecture or a more page-focused architecture by using Razor Pages
- Blazor allows for the implementation of client-side functionality using .NET code

Application Architecture

NuGet Packages

- NuGet is a package manager for .NET
  - `www.nuget.org`
- All the libraries that make up .NET 6 (and many 3rd-party libraries) are distributed as NuGet packages
- NuGet package dependencies are stored in the project file

```
<PackageReference Include="Microsoft.EntityFrameworkCore" Version="6.0.0" />
```


Application Architecture

NuGet Packages

- The dotnet restore command will fetch any referenced NuGet packages that are not available locally
- Uses nuget.org as the package source by default
- Additional or alternative package sources (remote or local) can be specified by using a nuget.config file

Application Architecture

NuGet Metapackages

- Metapackages are a NuGet convention for describing a set of packages that are meaningful together
- Every .NET Core project implicitly references the Microsoft.NETCore.App package
  - ASP.NET Core projects also reference the Microsoft.AspNetCore.App package
- These two metapackages are included as part of the runtime package store
  - Available anywhere the runtime is installed

Application Architecture

Application Startup

- When an ASP.NET Core application is launched, the first code executed is the application's Main method
  - Generated by the compiler if using top-level statements
- Code in the Main method is used to…
  - Create a WebApplication object
  - Configure application services
  - Configure the request processing pipeline
  - Run the application

Application Architecture

Application Startup

- A collection of framework services are automatically registered with the dependency injection system
  - IHostApplicationLifetime
    - Used to handle post-startup and graceful shutdown tasks
  - IHostEnvironment / IWebHostEnvironment
    - Has many useful properties (ex. EnvironmentName)
  - ILoggerFactory
  - IServer
  - And many others…

Application Architecture

Application Startup

- The environment for local machine development can be set in the launchSettings.json file
  - Overrides values set in the system environment
  - Only used on the local development machine
  - Is not deployed
  - Can contain multiple profiles

Application Architecture

Hosting Environments

- EnvironmentName property can be set to any value
- Framework-defined values include:
  - Development
  - Staging
  - Production (default if none specified)
- Typically set using the ASPNETCORE_ENVIRONMENT environment variable
- Can also be configured via launchSettings.json

Application Architecture

Middleware

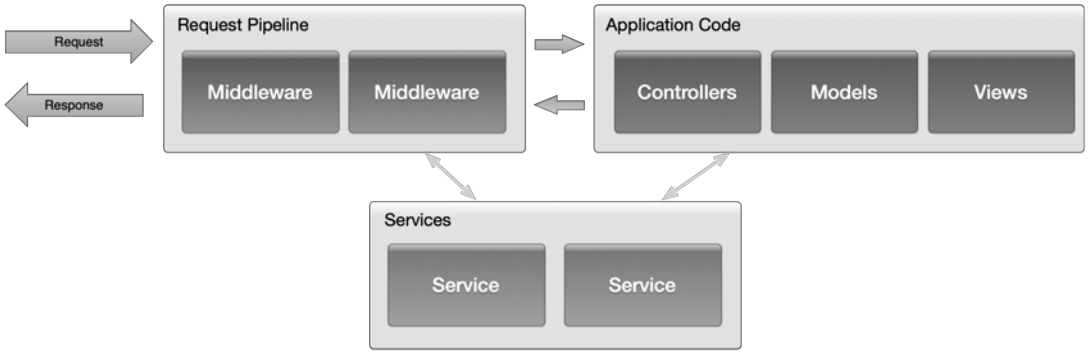
- ASP.NET uses a modular request processing pipeline
- The pipeline is composed of middleware components
- Each middleware component is responsible for invoking the next component in the pipeline or short-circuiting the chain
- Examples of middleware include…
  - Request routing
  - Handling of static files
  - User authentication
  - Response caching
  - Error handling

Application Architecture

Services

- ASP.NET Core also includes the concept of services
- Services are components that are available throughout an application via dependency injection
- An example of a service would be a component that accesses a database or sends an email message

Application Architecture



Application Architecture

Pipeline

- The last piece of middleware in the pipeline is typically the routing middleware
- Routes the incoming request to a controller

Full Stack with Blazor and ASP.NET Core

Introduction to Blazor

- Overview
- Components
- Hosting Models
- Blazor Server
- Blazor WebAssembly
- Supported Platforms

Introduction to Blazor

Overview

- Blazor is a framework for building interactive client-side web UI with .NET code
- Provides an alternative to frameworks such as Angular and React
- Can be used without .NET on the server-side
  - Server just needs to deliver the runtime, assemblies, and static resources to the client

Introduction to Blazor

Overview

- Blazor apps are based on components
  - UI element such as a dialog or data entry form
  - Written using the same Razor syntax used by traditional views and Razor Pages
- Components render into an in-memory representation of the browser's Document Object Model (DOM) called a render tree
  - Used to determine what updates should be applied to the UI

Introduction to Blazor

Components

```
@page "/counter"

<h1>Counter</h1>

<p>Current count: @currentCount</p>

<button class="btn btn-primary" @onclick="IncrementCount">Click me</button>

@code {
    int currentCount = 0;

    void IncrementCount()
    {
        currentCount++;
    }
}
```


Introduction to Blazor

Hosting Models

- Razor Components can be used in one of two different configurations
  - Blazor Server
  - Blazor WebAssembly

Introduction to Blazor

Blazor Server

- With Blazor Server, a JavaScript file (blazor.server.js) is sent to the browser
  - Establishes a persistent connection between the browser and the server using SignalR (WebSockets)
- Message is sent to the server when events occur in the browser
- C# code in the Razor Component is executed on the server
- UI updates are sent to the browser over the SignalR connection
- JavaScript interop allows for…
  - JavaScript functions to be invoked from C#
  - C# code to be triggered from JavaScript

Introduction to Blazor

Blazor Server

- Blazor Server does maintain state information for each connected user
- Scalability of the application is therefore limited by available memory on the server
- Scalability varies based on the application, but Microsoft has tested this and found…
  - 5,000 concurrent users on instance with 1 vCPU and 3.5 GB of memory
  - 20,000 concurrent users on instance with 4 vCPU and 14 GB of memory

Introduction to Blazor

Blazor WebAssembly

- Blazor WebAssembly (WASM) has been getting a lot of attention since its announcement
- Uses the same Razor Components as Blazor Server but the C# code executes on the client
- Microsoft has created a version of the .NET Runtime (CLR) that is written in WebAssembly
  - Allows .NET assemblies (that contain IL code) to be downloaded and executed on the client
  - Code executes in the same browser sandbox as JavaScript
  - Does not require the user to install something ahead of time (browser extension or plug-in)

Introduction to Blazor

Blazor WebAssembly

- When visiting a site that uses Blazor WebAssembly, a small JavaScript file is downloaded (blazor.webassembly.js) that…
  - Downloads the WebAssembly version of the .NET runtime (about 1 MB in size), the app, and all dependencies
- No state is maintained on the server
- .NET classes like HttpClient can be used to communicate with the server
  - Preconfigured in a new Blazor WebAssembly project

Introduction to Blazor

Supported Platforms

- The user must be using a browser that supports WebAssembly
  - Firefox 52 (March 2017)
  - Chrome 57 (March 2017)
  - Edge 16 (September 2017)
  - Safari 11 (September 2017)

Full Stack with Blazor and ASP.NET Core

Blazor Application Component

- Client-Side Routing
- Layout Components
- Debugging

Blazor Application Component

Client-Side Routing

- Blazor WebAssembly is a single-page app (SPA) framework
- A single HTML page is loaded by the browser
  - Loads the framework components and the App component
- App component includes the client-side Router component
  - Intercepts relative URL requests and loads the component with a matching route (@page directive)
  - <base> element must be modified if the host page is not located at the root of the site

Blazor Application Component

Client-Side Routing

- Components that can be loaded via the routing system (and include a @page directive) are typically placed in the Pages folder
- Components that are used by other components but cannot be navigated to directly are typically placed in the Shared folder

Blazor Application Component

Layout Components

- App component typically specifies a default layout
  - Defines common content (e.g., navigation menu)
- Other component content is loaded into a location specified by the layout (@Body)

Blazor Application Component

Debugging

- With a Blazor Server app, debugging is very straightforward since all C# code executes on the server
- With a Blazor WebAssembly app, many common debugging functions (e.g., breakpoints) work if using Edge or Chrome
  - Requires the inspectUri property to be set in launchSettings.json
- The logging system can also be used to write log messages to the browser console
  - Use caution in production environments since the end user can view the browser console

Full Stack with Blazor and ASP.NET Core

Data Binding

- Razor
- One-Way Data Binding
- Attribute Binding
- Event Handling
- Two-Way Data Binding
- Default Actions
- Change Detection

Data Binding

Razor

- Components use Razor to define a mix of HTML markup and C# code
- @code section can be used within a Razor file or code can be placed in a separate file by using a partial class
- Fields, properties, and methods defied in C# are available to be used within the markup
- Properties of a component can be set by another component if the [Parameter] attribute is used

Data Binding

One-Way Data Binding

- Data that flows from the component to the DOM
- Events in the DOM that trigger code to execute

```
<p>Current count: @currentCount</p>

<button class="btn btn-primary" @onclick="IncrementCount">Click me</button>

@code {
    int currentCount = 0;

    void IncrementCount()
    {
        currentCount++;
    }
}
```


Data Binding

Attribute Binding

- The value of an HTML element attribute can also be set with data binding
- If bound to a Boolean expression, Blazor will hide the attribute if the value evaluates to false

Data Binding

Event Handling

- Event handlers use the @on<event> syntax
- Can use a member method or a lambda function

```
@onclick="@(() => currentCount++)">Click me</button>
```

- Invocation will cause Blazor to update the UI with the latest values
- An event handler can accept An EventArgs type
  - Specific type depends on the event

Data Binding

Two-Way Data Binding

- DOM will be updated when the component value changes
- Component value will also be updated when the DOM changes
- Could be accomplished by using two one-way bindings

```
<input value="@increment"
       @onchange="@((ChangeEventArgs e)
                    => increment = int.Parse($"{e.Value}"))" />
```

Data Binding

Two-Way Data Binding

- The @bind syntax can be used to achieve two-way binding
- Tied to the onchange event by default
- The triggering event can be modified

```
<input @bind="@increment" @bind:event="oninput" />
```


Data Binding

Default Actions

- When attaching to an event in Blazor, the browser's default action will still trigger
- This can be explicitly (or conditionally) prevented

```
<input @bind="@increment"
       @onkeypress="KeyHandler"
       @onkeypress:preventDefault />
```

```
<input @bind="@increment"
       @onkeypress="KeyHandler"
       @onkeypress:preventDefault="@shouldPreventDefault" />
```

Data Binding

Change Detection

- When a DOM event triggers code, Blazor assumes values may have been modified
  - Automatically refreshes the UI
- Sometimes, you will need to explicitly tell Blazor to refresh the UI
  - An example is when a background thread updates a field
- Call the StateHasChangegd method of the Component base class

```
var timer = new System.Threading.Timer(
  callback: _ => { IncrementCount(); StateHasChanged(); },
```


Full Stack with Blazor and ASP.NET Core

Models

- Introduction
- Persistence Ignorance
- Dependency Inversion
- Asynchronous Data Access
- Object-Relational Mapping
- Entity Framework Core
- Dapper ORM

Models

Introduction

- Models represent "real world" objects the user is interacting with
- Entities are the objects used during Object-Relational Mapping and provide a way to obtain and persist model data
- The term Data Transfer Object (DTO) is often used to describe an object that carries data between different processes or subsystems
  - A single DTO may contain multiple different entities, exclude some entity properties, or use different property names
  - In a Web API application, the object that get serialized into JSON is often a DTO

Models

Persistence Ignorance

- The model data typically comes from an external source (database, web service, file, etc.)
- For better maintainability and testability, it is a best practice to use a data access component to encapsulate the details about where the model data comes from
- In ASP.NET, data access should be performed by a service made available via dependency injection
  - Makes it easy to test components independently with hard-coded data (no database)

Models

Dependency Inversion

- One of the SOLID design principles is Dependency Inversion
- "High-level modules should not depend on low-level models. Both should depend on abstractions."
  - The web application/service should not be built based on how the data access library was designed
  - An interface should be used to define the functionality that the web application requires
  - The data access library should provide a component that implements the required interface

Models

Asynchronous Data Access

- When performing IO-bound operations (database access, web service calls, etc.), it is a best practice to perform that work asynchronously
- Allows for the efficient use of thread resources
  - Thread pool threads can be used to handle other incoming requests while the IO-bound operation is in progress
  - Improves the scalability of a web application

```
public async Task<IEnumerable<Product>> GetAllProducts()
{
  return await _repository.GetProductsAsync();
}
```

Models

Object-Relational Mapping

- If a data access component communicates with a relational database, a necessary task will be to convert between relational data and C# objects
- This can be done manually by with ADO.NET, or several frameworks exist that can help with this task
  - Entity Framework Core
  - Dapper (3rd-party micro-ORM)
  - AutoMapper (mapping one object to another)

Models

Entity Framework Core

- Modeling based on POCO entities
- Data annotations
- Relationships
- Change tracking
- LINQ support
- Built-in support for SQL Server and Sqlite (3rd-party support for Postgres, MySQL, and Oracle)

Models

Entity Framework Core

- By creating a subclass of DbContext, EF Core can populate your entity objects and persist changes

```
public class ECommContext : DbContext
{
  public DbSet<Product> Products { get; set; }
}
```

- The DbContext can be used to create a new database based on the definition of your model objects or it can work with a database that already exists (as we will do)
- The Migrations feature of EF Core can be used to incrementally apply schema changes to a database (beyond the scope of this course)

Models

Entity Framework Core

- EF Core will make certain assumptions about your database schema based on your entity objects
- For example, EF Core will assume the database table names will match the name of each DbSet property

```
public class ECommContext : DbContext
{
  public DbSet<Product> Products { get; set; }
}
```

Models

Entity Framework Core

- To specify different mappings, you can use data annotations on your entities or use EF's fluent API

```
[Table("Product")]
public class Product
{
  [Column("Name")]
  public string ProductName { get; set; }
}
```

```
protected override void OnModelCreating(ModelBuilder modelBuilder)
{
  modelBuilder.Entity<Product>().ToTable("Product");

  modelBuilder.Entity<Product>().Property(p => p.ProductName)
                                .HasColumnName("Name");
}
```


Models

Entity Framework Core

- Objects retrieved from the context are automatically tracked for changes
- Those changes can be persisted with a call to SaveChanges

```
Product product = _context.Products(p => p.Id == id);
product.ProductName = "Something else";
_context.SaveChanges();
```

Models

Entity Framework Core

- EF Core will not automatically load related entities
- The Include method can be used to perform "eager loading" of one or more related entities

```
_dataContext.Products.Include(p => p.Supplier)
  .SingleOrDefault(p => p.Id == id);
```


Models

Entity Framework Core

- EF Core sends the SQL it generates to the logging system when executed
- Interception API can also be used to obtain or modify the SQL

```
public class HintCommandInterceptor : DbCommandInterceptor
{
  public override InterceptionResult ReaderExecuting(DbCommand command,
      CommandEventData eventData, InterceptionResult result)
  {
    command.CommandText += " OPTION (OPTIMIZE FOR UNKNOWN)";
    return result;
  }
}
```

```
services.AddDbContext(b => b.UseSqlServer(connStr)
    .AddInterceptors(new HintCommandInterceptor()));
```

Models

Entity Framework Core

- EF Core can also be used to execute custom SQL or call a stored procedure

```
var products = context.Products
    .FromSqlRaw("SELECT * FROM dbo.Products")
    .ToList();
```

```
var product = context.Products
    .FromSqlRaw("EXECUTE dbo.GetProduct {0}", id)
    .SingleOrDefault();
```

- In the example above, EF Core uses an ADO.NET parameterized query and SQL injection is not a concern
  - Still an issue if the entire string is constructed first and then passed to FromSqlRaw

Models

Entity Framework Core

- The entity classes can be defined manually, or the code for them can be automatically generated
  - CLI tools
  - Package Manager Console tools in Visual Studio

Models

Entity Framework Core

- EF Core is a large topic and in-depth coverage is beyond the scope of this course
  - Inheritance
  - Shadow Properties
  - Cascading Updates and Deletes
  - Transactions
  - Concurrency Conflicts
  - Migrations

`docs.microsoft.com/en-us/ef/core/`

Models

Dapper ORM

- Dapper is an open-source ORM framework that has become a very popular alternative to Entity Framework

`github.com/StackExchange/Dapper`

- Has less features than EF but provides a good high-performance "middle-ground" between ADO.NET and EF
- Dapper is not specifically covered in this course

Full Stack with Blazor and ASP.NET Core

Application Configuration

- Application Services
- Configuration Providers and Sources
- Configuration API
- Options Pattern

Application Configuration

Application Services

- Services are components that are available throughout an application via dependency injection
- The lifetime of a service can be…
  - Singleton (one instance per application)
  - Scoped (one instance per web request)
  - Transient (new instance each time component requested)
- An example of a service would be a component that accesses a database or sends an email message

Application Configuration

Services

- Services are typically added via extension methods available on IServiceCollection

```
builder.Services.AddDbContext<ApplicationDbContext>(...);
builder.Services.AddScoped<IEmailSender, MyEmailSender>();
builder.Services.AddScoped<ISmsSender, MySmsSender>();
```

- Most methods include the service lifetime as part of the method name (e.g., AddScoped)
- The AddDbContext method is a custom method specifically for adding an Entity Framework DbContext type as a service

Application Configuration

Services

- Services are available throughout the application via dependency injection
- A common practice is to follow the Explicit Dependencies Principle
  - Controllers include all required services as constructor parameters
  - System will provide an instance or throw an exception if the type cannot be resolved via the DI system

```
public class ProductController : ControllerBase
{
  public ProductController(IEmailSender emailSender) {
    ...
  }
}
```

Application Configuration

Configuration Providers and Sources

- Before ASP.NET Core, application settings were typically stored in an application's web.config file
- ASP.NET Core introduced a completely new configuration infrastructure
  - Based on key-value pairs gathered by a collection of configuration providers that read from a variety of different configuration sources

Application Configuration

Configuration Providers and Sources

- Available configuration sources include:
  - Files (INI, JSON, and XML)
  - System environment variables
  - Command-line arguments
  - In-memory .NET objects
  - Azure Key Vault
  - Custom sources

Application Configuration

Configuration Providers and Sources

- The default WebApplicationBuilder adds providers to read settings (in the order shown) from:
  - appsettings.json
  - appsettings.{Environment}.json
  - User secrets
  - System environment variables
  - Command-line arguments
- Values read later override ones read earlier

Application Configuration

Configuration API

- The configuration API provides the ability to read from the constructed collection of name-value pairs
- An object of type IConfiguration is available to be used via dependency injection

```
public class HomeController : ControllerBase
{
  public HomeController(IConfiguration configuration)
  {
    _emailServer = configuration["EmailServer"];
  }
}
```

Application Configuration

Configuration API

- Hierarchical data is read as a single key with components separated by a colon

```
{
  "Email": {
    "Server": "gmail.com",
    "Username": "admin"
  }
}
```

```
public class HomeController
{
  public HomeController(IConfiguration configuration)
  {
    _emailServer = configuration["Email:Server"];
  }
}
```


Full Stack with Blazor and ASP.NET Core

Controllers

- Responsibilities
- Requirements and Conventions
- Dependencies
- Action Results

Controllers

Responsibilities

- The action executed for a particular endpoint is typically a method of a controller
- A controller may need to retrieve or make modifications to model data
- The controller also often determines the appropriate type of response to return
  - HTML, JSON, XML, redirection, error, etc.

Controllers

Responsibilities

- Controller methods that are reachable via the routing system are referred to as controller actions
- Any public method of a controller can be an action if a valid route to that action exists

Controllers

Requirements and Conventions

- For a class to act as a controller, it must…
  - Be defined as public
  - Have a name that ends with Controller or inherit from a class with a name that ends with Controller
- Common conventions (not requirements) are...
  - Place all controllers in a root-level folder named Controllers
  - Inherit from a system class called Controller (or its subclass ControllerBase for an API)
    - Provides many helpful properties and methods

Controllers

Dependencies

- It is a recommended best practice for controllers to follow the Explicit Dependencies Principle
- Specify required dependencies via constructor parameters that can be supplied via dependency injection

```
public class HomeController : Controller
{
  private IEmailSender _emailSender;

  public HomeController(IEmailSender es) {
    _emailSender = es;
  }
}
```

Controllers

Action Results

- IActionResult is implemented by a variety of different return types
- Framework uses the ExecuteResultAsync when creating the HTTP response

```
public IActionResult Index()
{
  var result = new ContentResult()
  result.content = "Hello, World!";
  return result;
}
```

- Writing directly to the response should be avoided
  - Adds a dependency to the HTTP context
  - Make things like unit testing more difficult

Controllers

Action Results

- The base class Controller provides helper methods to generate various types of results
  - View `return View(customer);`
  - Serialized object `return Json(customer);`
  - HTTP status code `return NotFound();`
  - Raw content `return Content("Hello");`
  - Contents of a file `return File(bytes);`
  - Several forms of redirection
    - Redirect, RedirectToRoute, RedirectToAction, …
  - And more...

Controllers

Action Results

- API controllers will typically return an entity type or a DTO

```
[HttpGet("products")]
public IEnumerable<Product> GetAllProducts()
```

- System will create an IActionResult and look at the incoming request to support content negotiation
- IActionResult is still useful when an action can return different return types

```
public IActionResult GetProduct(int id)
{
    if (!_repository.TryGetProduct(id, out var product)) {
        return NotFound();
    }
    return Ok(product);
}
```


Controllers

Asynchronous Controller Actions

- It is common for a controller action to invoke an asynchronous method to perform an IO-bound operation
  - Database access, web service call, etc.
- The action should be marked as async with a return type of Task<T> and await used with the asynchronous method

```
public async Task<IActionResult> Index()
{
  var products = await _repository.GetAllProducts();
  return View(products);
}
```

Controllers

Asynchronous Controller Actions

- Making an action asynchronous does not change the experience for the client
  - No response is sent until the entire action is complete
- Can improve application scalability by allowing the thread pool thread to handle other incoming requests while waiting for the IO-bound operation to complete
- It is also possible to accept a CancellationToken that can be used to handle the cancellation of a long-running request

```
public async Task<IActionResult> Index(CancellationToken token)
{
  var products = await _repository.GetAllProducts(token);
  return View(products);
}
```


Full Stack with Blazor and ASP.NET Core

Web APIs

- API Controllers
- Testing APIs
- Retrieval Operations
- Model Binding
- Update, Create, and Delete Operations
- Cross-Origin Request Sharing (CORS)

Web APIs

API Controllers

- ASP.NET Core includes a class named ControllerBase
  - Includes many properties and methods for handling HTTP requests
- The Controller class inherits from ControllerBase and adds support for views
- If creating a controller that does not have any views, you should inherit directly from ControllerBase

Web APIs

API Controllers

- An API controller should be decorated with the ApiController attribute

```
[ApiController]
public class ProductApiController : ControllerBase
```

  - Automatic HTTP 400 responses for validation failures
  - Problem details for error status codes

Web APIs

API Controllers

- The ProducesResponseType attribute should be used when defining Web API actions

```
[HttpPost]
[ProducesResponseType(StatusCodes.Status201Created)]
[ProducesResponseType(StatusCodes.Status400BadRequest)]
public ActionResult<Product> Create(Product product)
```

- Used by tools like Swagger to generate more descriptive documentation

Web APIs

Testing APIs

- API endpoints that are exposed via GET are easy to test using a web browser
- For other verbs, it can be helpful to have a tool that can be used to craft custom HTTP requests
  - Postman application is very popular (getpostman.com)
  - Many other options are available

Web APIs

Retrieval Operations

- In a Web API, retrieval operations are performed with an HTTP GET request
- If successful, the response should use an HTTP 200 status code

```
[HttpGet("{id}")]
[ProducesResponseType(StatusCodes.Status200OK)]
[ProducesResponseType(StatusCodes.Status400BadRequest)]
[ProducesResponseType(StatusCodes.Status404NotFound)]
public async Task<IActionResult>> GetProduct(int id)
{
  var product = await _repository.GetProduct(id, includeSuppliers: true);
  if (product == null) return NotFound();
  return Ok(product);
}
```


Web APIs

Retrieval Operations

- There are several options available for altering the format of the JSON returned
  - Attributes
  - Custom formatter
  - Data projection

```
public async Task<IActionResult> GetProduct(int id)
{
  var product = await _repository.GetProduct(id, true);
  if (product == null) return NotFound();
  var retVal = new {
    Id = product.Id, Name = product.ProductName,
    Price = product.UnitPrice,
    Supplier = product.Supplier.CompanyName
  };
  return Ok(retVal);
}
```

Web APIs

Update Operations

- In a Web API, update operations are performed with…
  - HTTP PUT – Replaces an existing resource
  - HTTP PATCH – Modifies part of an existing resource
- If successful, the response should be HTTP 204 (no content)

```
public async Task<IActionResult> PutProduct(int id, Product product)
{
  if (id != product.Id) return BadRequest();

  var existingProduct = await _repository.GetProduct(id);
  if (existingProduct == null) return NotFound();

  await _repository.SaveProduct(product);
  return NoContent();
}
```


Web APIs

Create Operations

- In a Web API, create operations are performed with an HTTP POST request
- If successful, the response should use an HTTP 201 (created) status code with a Location header set to the URI of the newly created resource
- The CreatedAtAction and CreatedAtRoute methods can be used to generate a correctly formatted response

```
return CreatedAtAction("GetProduct", new { id = product.Id }, product);
```

Web APIs

Delete Operations

- In a Web API, delete operations are performed with an HTTP DELETE request
- If successful, the response should use an HTTP 204 (no content) status code

```
return new NoContentResult();
```


Web APIs

Cross-Origin Resource Sharing (CORS)

- Browser security prevents a web page from making Ajax requests to another domain
- CORS is a W3C standard that allows a server to relax this policy
- A server can explicitly allow some cross-origin requests
- CORS is configured in ASP.NET Core via a service and middleware

```
services.AddCors();
```

```
app.UseCors(builder =>
    builder.WithOrigins("https://example.com"));
```

Full Stack with Blazor and ASP.NET Core

Consuming Server Data

- Client-Side Application Services
- HttpClient
- Component Lifecycle
- Handling Errors

Consuming Server Data

Client-Side Application Services

- Client-side application services can be registered in a Blazor WebAssembly app
- Components can participate in dependency injection

```
@page "/fetchdata"
@inject HttpClient Http

<h1>Weather forecast</h1>
```

Consuming Server Data

Client-Side Application Services

- Singleton will result in a single shared instance per instance of the application
  - Blazor WebAssembly app open in two separate tabs would be two instances of the app
- Transient will result in a new instance whenever an instance is needed
- Scoped service will have the same lifetime in a Blazor WebAssembly app as a Singleton
  - Different for a Blazor Server app (based on the lifetime of the SignalR connection)

Consuming Server Data

HttpClient

- In a Blazor WebAssembly app, you will use the HttpClient class to communicate with back-end services
- HttpClient uses the browser's network stack
  - Same infrastructure used by JavaScript
- Register an HttpClient as a scoped service for each host you plan to call from your app
  - Remember CORS if host is different than origin

Consuming Server Data

HttpClient

- System.Net.Http.Json namespace defines some helpful extension methods on HttpClient
  - GetFromJsonAsync
  - PostAsJsonAsync
  - PutAsJsonAsync

```
products = await Http.GetFromJsonAsync<Product[]>("api/product");
```


Consuming Server Data

HttpClient

- Sometimes, it may be necessary to specify custom request properties

```
var requestMessage = new HttpRequestMessage() {
  Method = new HttpMethod("POST"),
  RequestUri = new Uri("https://localhost:10000/api/TodoItems"),
  Content = JsonContent.Create(new TodoItem {
    Name = "My New Todo Item",
    IsComplete = false
  })
};

requestMessage.Content.Headers.Add("x-custom-header", "value");

var response = await Http.SendAsync(requestMessage);
var responseStatusCode = response.StatusCode;

responseBody = await response.Content.ReadAsStringAsync();
```

Consuming Server Data

Component Lifecycle

- A component includes several methods you can override to execute code at different points in a component's lifecycle
  - Constructor
  - SetParameters[Async]
  - OnInitialized[Async]
  - OnParametersSet[Async]
  - ShouldRender
  - OnAfterRender[Async]
    - Receives a Boolean argument that specifies if it is the first render

Consuming Server Data

Component Lifecycle

- The asynchronous version of a lifecycle method should be used if you will be using await (e.g., calling a Web API)
  - If not, the synchronous version should be used
- All the asynchronous lifecycle methods will cause the component to re-render when complete (called by the system with await)
  - Except for OnAfterRenderAsync
- The OnAfterRender[Async] method is a good place for executing JavaScript that accesses elements in the DOM

Consuming Server Data

Component Lifecycle

- The typical approach for a component that renders server data is to...
  - Render a UI that tells the user what is happening
  - Fetch the data asynchronously using HttpClient (via await) within the component's OnInitializedAsync

Consuming Server Data

Handling Errors

- Normal C# exception handling code can be used to handle errors that occur when using HttpClient
- Use a field that can display a message to the use via data binding

```
protected override async Task OnInitializedAsync()
{
  try {
    products = await Http.GetFromJsonAsync ... ;
  }
  catch (Exception exception) {
    exceptionMessage = exception.Message;
  }
}
```

Full Stack with Blazor and ASP.NET Core

Editing Data

- Route Parameters
- NavigationManager
- Accepting User Input
- Validation

Editing Data

Route Parameters

- When a component needs information about what to display, a route parameter can be used to set a component parameter

```
@page "/edit/{id}"
```

```
@code {
  [Parameter]
  public string? Id { get; set; }
}
```

Editing Data

Route Parameters

- A route parameter can be marked as optional
- You can provide a default value in OnInitilaized

```
@page "/welcome/{name?}"
```

```
@code {
  [Parameter]
  public string? Name { get; set; }

  protected override void OnInitialized()
  {
    Name = Name ?? "Guest";
  }
}
```


Editing Data

NavigationManager

- The Blazor Router component automatically handles standard navigation elements (e.g., links)
- When you need to handle navigation tasks programmatically, the NavigationManager object provides helpful events and methods
  - Available to a component via dependency injection

```
@inject NavigationManager NavigationManager
```

```
private void EditProduct(int id)
{
  NavigationManager.NavigateTo($"edit/{id}");
}
```

Editing Data

Accepting User Input

- When creating a component for accepting user input, standard HTML <input> elements are typically used
  - @bind attribute used to connect value to component field
- An HTML <form> element does not need to be used
  - onclick binding on a button can trigger client-side code to make navigation decisions
  - However, using the EditForm component can make validation tasks easier

Editing Data

Validation

- You can implement client-side validation in a manual way via events and data binding
- You can also use the EditForm component bound to a model that uses data annotations
  - Required, EmailAddress, MaxLength, RegularExpression, ...
- DataAnnotationsValidator component can be used to provide user feedback

```
<EditForm Model="@product" OnValidSubmit="SaveProduct">
<DataAnnotationsValidator />
```

Editing Data

Validation

- The ValidationMessage component can be used to display the text of the error message from a data annotation

```
<InputText id="ProductName" @bind-Value="@product.ProductName" />
<ValidationMessage For="@(() => product.ProductName)" />
```

- Visual styles are defined via CSS

```
.valid.modified:not([type=checkbox]) {
    outline: 1px solid #26b050;
}
.invalid {
    outline: 1px solid red;
}
.validation-message {
    color: red;
}
```


Editing Data

Validation

- The EditForm provides callbacks for handling form submissions
  - OnValidSubmit
  - OnInvalidSubmit
  - OnSubmit

Full Stack with Blazor and ASP.NET Core

Custom Components

- Introduction
- Child Content
- Two-Way Data Binding Between Components
- Cascading Parameters

Custom Components

Introduction

- It is very common to create reusable shared custom components in a Blazor app
- Components in the Shared folder can easily be used by other components
  - Do not include a @page directive

Custom Components

Child Content

- A custom component may be used to wrap content that is provided to it
- This is commonly done by providing a component parameter named ChildContent of type RenderFragment

Custom Components

Two-Way Data Binding Between Components

- A property of a component can be bound to the property of a child component with @bind-[property]

```
<Alert @bind-Show="ShowAlert">
```

- Child component must implement a property that the parent can use to listen for changes
  - Must use the naming convention of [property]Changed
  - Can be of type Action<propertyType>
  - Invoke the action when the property changes

Custom Components

Two-Way Data Binding Between Components

- Remember that a component will automatically re-render itself when an event handler is triggered but not when a bound property changes in another way (async operation)

```
StateHasChanged();
```

- Using an EventCallback<T> instead of an Action<T> will cause Blazor to see a property change as an event
  - Will invoke StateHasChanged

Custom Components

Cascading Parameters

- Data binding makes it easy for a parent component to pass data to a child component
- Simple data binding can be cumbersome when a parent needs to make data available to a more deeply nested component
- The CascadingValue component can be used to wrap a component hierarchy and supply a value to all the components within its subtree

```
<CascadingValue Value="@msg">
  <div class="content px-4">
      @Body
  </div>
</CascadingValue>
```

Custom Components

Cascading Parameters

- CascadingParameter attribute used by a child component to access the value

```
[CascadingParameter]
public string Msg { get; set; } = string.Empty;
```


Full Stack with Blazor and ASP.NET Core

JavaScript Interop

- Overview
- JavaScript Initializers
- Location of JavaScript
- Call JavaScript from .NET
- Call .NET from JavaScript

JavaScript Interop

Overview

- A Blazor app can invoke JavaScript functions from .NET code and JavaScript code can invoke .NET functions
- Use caution when mutating the DOM from JavaScript
  - Undefined behavior can occur if the state of the DOM no longer matches Blazor's internal representation

JavaScript Interop

JavaScript Initializers

- It is easy to define JavaScript code that will be automatically triggered by Blazor lifecycle events
- Create a JavaScript file in the wwwroot named [assembly].lib.module.js

```
export function beforeStart(options, extensions) {
    console.log("beforeStart");
}

export function afterStarted(blazor) {
    console.log("afterStarted");
}
```

JavaScript Interop

Location of JavaScript

- External JavaScript files that will be used throughout an app should be loaded after the Blazor script reference in the host page

```
  <script src="_framework/blazor.webassembly.js"></script>
  <script src="js/site.js"></script>
</body>
```


JavaScript Interop

Location of JavaScript

- JavaScript that is only used by a specific component can be collocated with the component
- Use the filename of the component with .js appended
  - When published, the script will be moved to the web root
- Import the JavaScript file in the OnAfterRenderAsync method

```
module = await JS.InvokeAsync<IJSObjectReference>(
    "import", "./Pages/Index.razor.js");
```

JavaScript Interop

Call JavaScript from .NET

- To call JavaScript from .NET, an IJSRuntime instance is required
- Use dependency injection to obtain the IJSRuntime

```
@page "/fetchdata"
@inject IJSRuntime JS
```

- App-level JavaScript functions will be available directly via the IJSRuntime

```
await JS.InvokeVoidAsync("doSomething", someVal);
```


JavaScript Interop

Call JavaScript from .NET

- For component collocated JavaScript, use an IJSObjectReference that gets set in OnAfterRenderAsync

```
private IJSObjectReference? module;

protected override async Task OnAfterRenderAsync(bool firstRender)
{
  if (firstRender) {
    module = await JS.InvokeAsync<IJSObjectReference>("import",
      "./Pages/Index.razor.js ");
  }
}
```

```
await module.InvokeAsync<string>("doSomething", someValue);
```

JavaScript Interop

Call .NET from JavaScript

- To invoke a static .NET method from JavaScript, use DotNet.invokeMethod or DotNet.invokeMethodAsync

```
DotNet.invokeMethodAsync('{ASSEMBLY NAME}',
  '{.NET METHOD ID}', {ARGUMENTS});
```

- The .NET method must be public, static, and have the [JSInvokable] attribute

```
[JSInvokable]
public static Task<int[]> ReturnArrayAsync()
{
  return Task.FromResult(new int[] { 1, 2, 3 });
}
```


JavaScript Interop

Call .NET from JavaScript

```
<button onclick="returnArrayAsync()">
  Trigger .NET static method
</button>
```

```
<script>
  window.returnArrayAsync = () => {
    DotNet.invokeMethodAsync('MyBlazorApp', 'ReturnArrayAsync')
      .then(data => {
        console.log(data);
      });
    };
</script>
```

JavaScript Interop

Call .NET from JavaScript

- To invoke an instance .NET method, a DotNetObjectReference is used

```
@code {
  private DotNetObjectReference<FetchData>? dotNetProxy;

  public async Task TriggerDotNetInstanceMethod()
  {
    dotNetProxy = DotNetObjectReference.Create(this);
    result = await JS.InvokeAsync<string>("sayHello", dotNetProxy);
  }

  [JSInvokable]
  public string GetHelloMessage() => $"Hello, {name}!";

  public void Dispose()
  {
    dotNetProxy?.Dispose();
  }
}
```


JavaScript Interop

Call .NET from JavaScript

- To invoke an instance .NET method, a DotNetObjectReference must be used

```
<script>
  window.sayHello = (dotNetProxy) => {
    return dotNetProxy.invokeMethodAsync('GetHelloMessage');
  };
</script>
```

Full Stack with Blazor and ASP.NET Core

State Management

- Overview
- Browser Storage
- Server-Side Storage

State Management

Overview

- A Blazor app keeps its state in memory
  - Redner tree
  - Component properties
  - Dependency injection instances
  - JavaScript interop data
- Refreshing the browser will restart the app and all state in memory will be lost

State Management

Browser Storage

- Modern web browsers allow you to persist data in the browser
- Local storage
  - Data persists until explicitly cleared
  - Shared across tabs
- Session storage
  - Scoped to the browser tab
  - Cleared when the tab is closed

State Management

Browser Storage

- Blazor WebAssembly does not include built-in support for browser storage
- Can be used via JavaScript interop
- Blazored.LocalStorage is a third-party NuGet package

State Management

Server-Side Storage

- Use caution with browser storage
- Can be viewed and potentially modified by the user
- Corrupted storage values could crash the component when read
- In an app with authentication, storing state on the server might be a better option
  - Read and write data via a Web API
  - Can persist across sessions, browsers, and even machines

Full Stack with Blazor and ASP.NET Core

Security

- Overview
- Blazor Authentication
- Blazor Authorization
- JSON Web Token (JWT)
- Web API Authentication

Security

Overview

- Blazor WebAssembly apps run on the client
- You can implement access control to restrict who can load the app
- Once loaded, an app can use authorization checks to customize the UI
  - For example, only show a delete button to administrators
- The Blazor app cannot enforce authorization rules
  - Can be modified or bypassed on the client-side
- Authorization rules must be enforced on the server-side when the relevant API method is called

Security

Blazor Authentication

- Blazor WebAssembly authentication is provided via Microsoft.AspNetCore.Components.WebAssembly.Authentication
- Blazor WebAssembly uses an AuthenticationStateProvider to keep track of the authentication state of the current user
- An AuthenticationStateProvide must implement GetAuthenticationStateAsync
  - Returns an AuthenticationState object that contains information about the current user (claims)
- User claims typically come from an access token that is often saved in browser local storage

Security

Blazor Authentication

- The identity provider that generates the access token can use a variety of mechanisms to verify the identity of the user
  - MFA, X.509 certificates, active directory, smart cards, retina scan, etc.

Security

Blazor Authentication

- Using an AuthorizeRouteView instead of a RouteView in App.razor will make it easy to add authorization rules to pages
  - NotAuthorized component can be used to provide custom content when the user is not authorized
- Wrapping the Router component in a CascadingAuthenticationState component makes it easy to obtain information about the authentication state at any time
  - Accessed via the context property

Security

Blazor Authorization

- Different content can be displayed based on the authentication state with the AuthorizeView component

```
<AuthorizeView>
  <Authorized>
    <p>You are authorized!</p>
  </Authorized>
  <NotAuthorized>
    <p>You are not authorized</p>
  </NotAuthorized>
</AuthorizeView>
```

```
<AuthorizeView Roles="Admin">
  ...
</AuthorizeView>
```


Security

Blazor Authorization

- An app can require authorization across the entire app by adding the [Authorize] attribute to the _Imports.razor file

```
@using Microsoft.AspNetCore.Authorization
@attribute [Authorize]
```

```
@attribute [Authorize(Roles="Admin")]
```

- The authentication component should be sure to allow anonymous access

```
@using Microsoft.AspNetCore.Components.WebAssembly.Authentication
@attribute [AllowAnonymous]
```

Security

Blazor Authentication

- The authentication component will often redirect the user to an authorization endpoint (identity provider) outside of the app
  - Will include a login callback to receive the response
- The IP will generate a token and redirect the user to the provided login callback
- The app will process the callback
  - Store the access token in local storage
  - Notify the ApplicationStateProvider

Security

JSON Web Token (JWT)

- JSON Web Token (JWT) is an open, industry standard (RFC 7519) method for representing claims security between two parties
- Claims can be verified and trusted because the token is digitally signed
  - Using a shared secret (HMAC) or with a public/private key pair
- Tokens can be encrypted but typically do not need to be

Security

JSON Web Token (JWT)

- The token header specifies the type of the token and the signing algorithm being used

```
{
  "alg": "HS256",
  "typ": "JWT"
}
```

- The header is Base64Url encoded and forms the first part of the JWT

Security

JSON Web Token (JWT)

- The second part of the token is the payload which contains the claims
- There are a set of predefined claims which are not mandatory but are recommended
  - iss: Issuer
  - exp: Expiration time
  - sub: Subject
    - Unique identifier of the authenticated entity
  - aud: Audience
    - Identifies the recipients that the JWT is intended for

Security

JSON Web Token (JWT)

- The third part of the token is the signature
- Generated using the encoded header, encoded payload, a secret, and the algorithm specified in the header
- Ensures that the token has not been altered
- A secure pre-shared secret can provide verification of a known issuing authority
- The issuing authority's public key can be used to perform verification if signed with the authority's private key

Security

JSON Web Token (JWT)

- Blazor app does not need to validate an access token
- Claims only used to customize the UI
- Passed to the server where all aspects of the token need to be verified before performing an action

Security

JSON Web Token (JWT)

- The token issuing server can be an external identity provider (Facebook, Twitter, Microsoft, etc.) or you can create your own using ASP.NET Core
- To work with JWTs in an API project, add the Microsoft.AspNetCore.Authentication.JwtBearer package
- If creating your own token issuing server, it may be a good idea to use a third-party library to handle many of the security-related details
  - IdentityServer

Security

Web API Authentication

- If acting as a token issuing authority, you will need to generate the token with the appropriate claims

```
var key = new SymetricSecurityKey(
  Encoding.UTF8.GetBytes(_configuration["jwt_key"].Value);

var creds = new SigningCredentials(
  key, SecurityAlgorithms.HmacSha512Signature);

var token = new JwtSecurityToken(
  claims: claims,
  expires: DateTime.Now.AddDays(1),
  signingCredentials: creds);

return new JwtSecurityTokenHandler().WriteToken(token);
```

Security

Web API Authentication

- To authenticate API calls, you will need to configure the authentication service and middleware

```
services.AddAuthentication(JwtBearerDefaults.AuthenticationScheme)
  .AddJwtBarer(options => {
    options.TokenValidationParameters = new TokenValidationParameters
    {
      ValidateIssuerSigningKey = true,
      IssuerSigningKey = Encoding.UTF8.GetBytes(_config["jwt_key"].Value),
      ValidateIssuer = true,
      ValidateAudience = true,
      ValidateLifetime = true
    };
  });
```

```
app.UseAuthentication();
app.UseAuthorization();
```


Security

Web API Authentication

- Blazor app will need to pass the access token as an HTTP header when making API calls

```
_httpClient.DefaultRequestHeaders.Authorization =
    new AuthenticationHeaderValue("Bearer", token);
```

Security

Web API Authentication

- It is also possible to create a custom authentication scheme / handler
  - Can create a subclass AuthenticationHandler and override HandleAuthenticateAsync
- When developing a custom authentication scheme, extreme care should be taken to ensure security vulnerabilities are not introduced

Security

Web API Authentication

- To read the claims from the JWT on the client simply requires decoding and parsing the JSON

```
public static IEnumerable<Claim> ParseClaimsFromJwt(string jwt) {
  var payload = jwt.Split('.')[1];
  var jsonBytes = ParseBase64WithoutPadding(payload);
  var keyValuePairs =
    JsonSerializer.Deserialize<Dictionary<string, object>>(jsonBytes);

  return keyValuePairs.Select(kvp => new Claim(kvp.Key, kvp.Value.ToString()));
}

private static byte[] ParseBase64WithoutPadding(string base64) {
  switch (base64.Length % 4) {
    case 2: base64 += "=="; break;
    case 3: base64 += "="; break;
  }
  return Convert.FromBase64String(base64);
}
```

Full Stack with Blazor and ASP.NET Core

Testing

- Introduction
- Unit Testing
- xUnit
- Testing Server-Side Controllers
- Testing Blazor Components
- Integration Testing

Testing

Introduction

- Testing your code for accuracy and errors is at the core of good software development
- Testability and a loosely-coupled design go hand-in-hand
- Even if not writing tests, keeping testability in mind helps to create more flexible, maintainable software
- The inherit separation of concerns in MVC-style applications can make them much easier to test

Testing

Introduction

- Unit testing
  - Test individual software components or methods
- Integration testing
  - Ensure that an application's components function correctly when assembled together

Testing

Unit Testing

- A unit test is an automated piece of code that involves the unit of work being tested, and then checks some assumptions about a noticeable end result of that unit

Testing

Unit Testing

- A unit of work is the sum of actions that take place between the invocation of a public method in the system and a single noticeable end result by a test of that system
- A noticeable end result can be observed without looking at the internal state of the system and only through its public API
  - Public method returns a value
  - Noticeable change to the behavior of the system without interrogating private state
  - Callout to a third-party system over which the test has no control

Testing

Unit Testing

- Good unit tests are…
  - Automated and repeatable
  - Easy to implement
  - Relevant tomorrow
  - Easy to run
  - Run quickly
  - Consistent in its results
  - Fully isolated (runs independently of other test)

Testing

Unit Testing

- A unit test is typically composed of three main actions
  - Arrange objects, creating and setting them up as necessary
  - Act on the object
  - Assert that something is as expected

Testing

Unit Testing

- Often, the object under test relies on another object over which you have no control (or doesn't work yet)
- A stub is a controllable replacement for an existing dependency in the system
  - By using a stub, you can test your code without dealing with the dependency directly
- A mock object is used to test that your object interacts with other objects correctly
  - Mock object is a fake object that decides whether the unit test has passed or failed based on how the mock object is being used by the object under test

Testing

xUnit

- A test project is a class library with references to a test runner and the projects being tested
- Several different testing frameworks are available for .NET
  - Visual Studio includes project templates for the MSTest, xUnit, and NUnit frameworks
- xUnit has steadily been gaining in popularity both inside and outside of Microsoft

Testing

xUnit

- Fact attribute is used to define a test that represents something that should always be true
- Theory attribute is used to define a test that represents something that should be true for a particular set of data

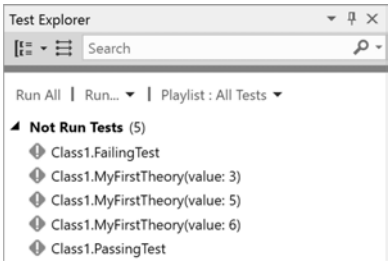
```
[Fact]
public void PassingTest()
{
  Assert.Equal(4, Add(2, 2));
}
```

```
[Theory]
[InlineData(3)]
[InlineData(5)]
[InlineData(6)]
public void MyFirstTheory(int value)
{
  Assert.True(IsOdd(value));
}
```

Testing

xUnit

- Tests can be run using the Visual Studio Test Explorer



- Tests can also be run by using the .NET Core command line interface

```
> dotnet test
```


Testing

Testing Server-Side Controllers

- When looking to test a controller, ensure that all dependencies are explicit so that stubs and mocks can be used when needed
- When testing a controller action, check for things like…
  - What is the type of the response returned?
  - If a view result, what is the type of the model?
  - What does the model contain?

Testing

Testing Blazor Components

- To write units tests for Blazor components within an xUnit project, the bUnit package can be used

Testing

Integration Testing

- Integration tests check that an app functions correctly at a level that includes the app's supporting infrastructure
  - Request processing pipeline
  - Database
  - File system

Testing

Integration Testing

- The Microsoft.AspNetCore.Mvc.Testing package provides a collection of components to help with integration testing
  - Test web host
  - In-memory test server
  - WebApplicationFactory