ASP.NET Core: Model-View-Controller (MVC) Pattern

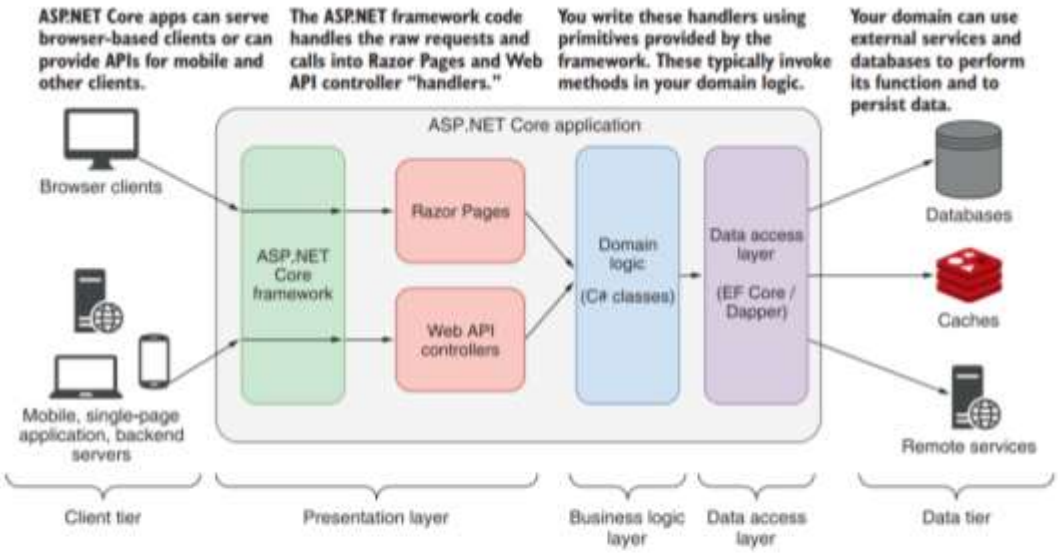

Figure 1.1 A typical ASP.NET Core application consists of several layers. The ASP.NET Core framework code handles requests from a client, dealing with the complex networking code. The framework then calls into handlers (Razor Pages and Web API controllers) that you write using primitives provided by the framework. Finally, these handlers call into your application's domain logic, which are typically C# classes and objects without any ASP.NET Core-specific dependencies.

Some of the key infrastructure improvements include:

- Middleware "pipeline" for defining your application's behavior
- Built-in support for dependency injection
- Combined UI (MVC) and API (Web API) infrastructure
- Highly extensible configuration system
- Scalable for cloud platforms by default using asynchronous programming

The largest obstacle likely to come across: **no longer support for Web Forms or WCF server.**

Getting an application up and running typically involves four basic steps:

1 Generate—Create the base application from a template to get started.

2 Restore—Restore all the packages and dependencies to the local project folder

using NuGet.

3 Build—Compile the application and generate all the necessary assets.

4 Run—Run the compiled application.

Visual Studio and the .NET CLI include many ASP.NET Core templates for building different types of applications. For example,

a. Razor Pages web application—Razor Pages applications generate HTML on the server and are designed to be viewed by users in a web browser directly.

b. MVC (Model-View-Controller) application—MVC applications are similar to Razor Pages apps in that they generate HTML on the server and are designed to be viewed by users directly in a web browser. They use traditional MVC controllers instead of Razor Pages.

The Startup class: Configuring your application

Program.cs is responsible for configuring a lot of the infrastructure for

the app, but you configure some of your app's behavior in Startup. The Startup class is responsible for configuring two main aspects of your application:

1. Service registration(dependency injection)—Any classes that your application depends on for providing functionality—both those used by the framework and those specific to your application—must be registered so that they can be correctly instantiated at runtime.
2. Middleware and endpoints—How your application handles and responds to requests.

The IHostBuilder created in Program calls ConfigureServices and then Configure, as shown in figure 2.10. Each call configures a different part of your application, mak□ing it available for subsequent method calls. Any services registered in the ConfigureServices method are available to the Configure method. Once configuration is complete, an IHost is created by calling Build() on the IHostBuilder.

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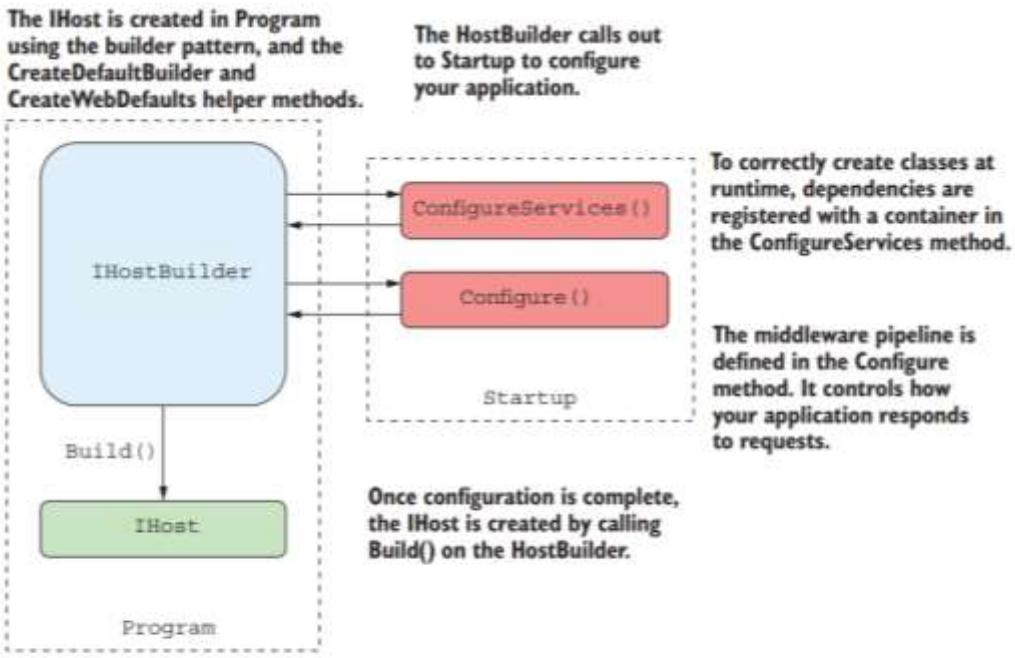


Figure 2.10 The `IHostBuilder` is created in Program.cs and calls methods on `Startup` to configure the application's services and middleware pipeline. Once configuration is complete, the `IHost` is created by calling `Build()` on the `IHostBuilder`.

An interesting point about the Startup class is that it doesn't implement an interface as such. Instead, the methods are invoked by using **reflection** to find methods with the predefined names of Configure and ConfigureServices. This makes the class more flexible and enables you to modify the signature of the method to accept additional parameters that are fulfilled automatically.

Reflection in .NET allows you to obtain information about types in your application at runtime. You can use reflection to create instances of classes at runtime and to invoke and access them.

Dependency Injection/adding services:

ASP.NET Core uses small, modular components for each distinct feature. This allows individual features to evolve separately, with only a loose coupling to others, and it's generally considered good design practice. The downside to this approach is that it places the burden on the consumer of a feature to

correctly instantiate it. Within your application, these modular components are exposed as one or more services that are used by the application.

DEFINITION Within the context of ASP.Net Core, **service** refers to any class that provides functionality to an application. These could be classes exposed by a library or code you've written for your application.

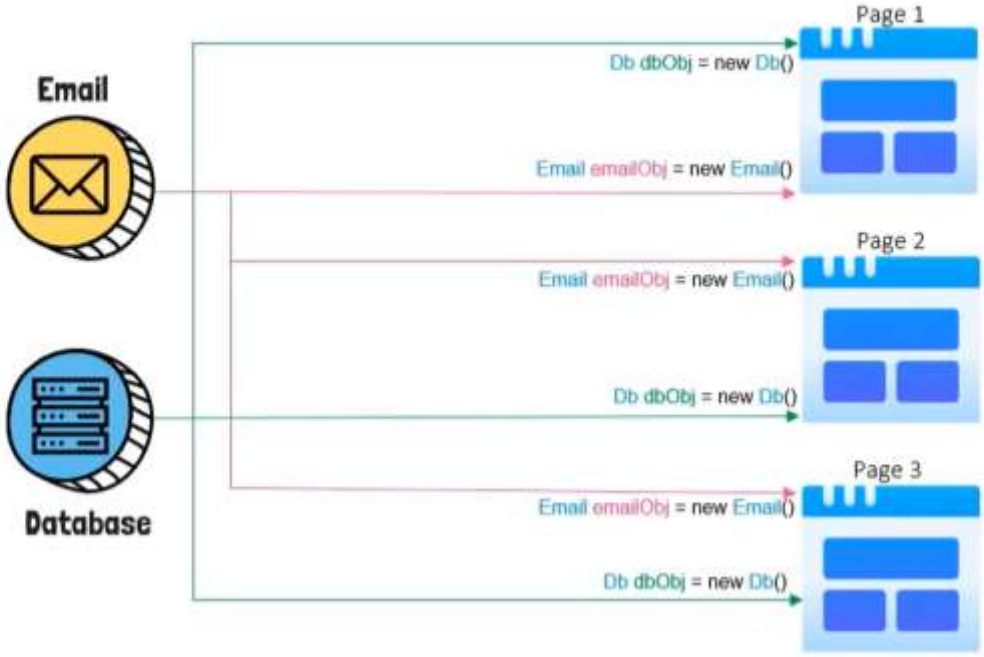
Typically, you'll register the dependencies of your application into a "container," which can then be used to create any service. This is true for both your own custom application services and the framework services used by ASP.NET Core. You must register each service with the container before it can be used in your application.

e.g. services.AddRazorPages(); //to get Razor pages services in the app.

You may be surprised that a complete Razor Pages application only includes a single call to add the necessary services, but the AddRazorPages() method is an extension method that encapsulates all the code required to set up the Razor Pages services. Behind the scenes, it adds various Razor services for rendering HTML, formatting services, routing services, and many more.

IServiceCollection is a list of every known service that your application will need to use. By adding a new service to it, you ensure that whenever a class declares a dependency on your service, the Inversion of Control (Ioc) container knows how to provide it.

WITHOUT DEPENDENCY INJECTION



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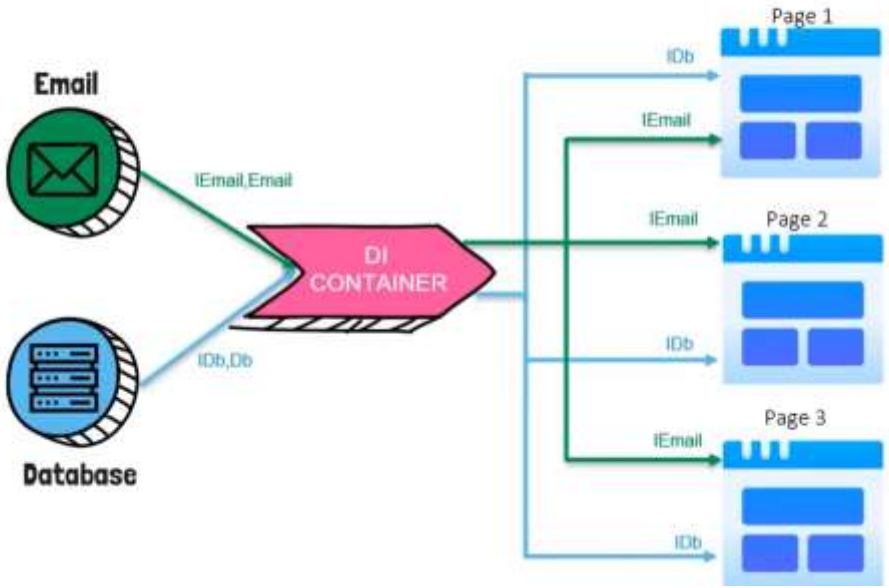
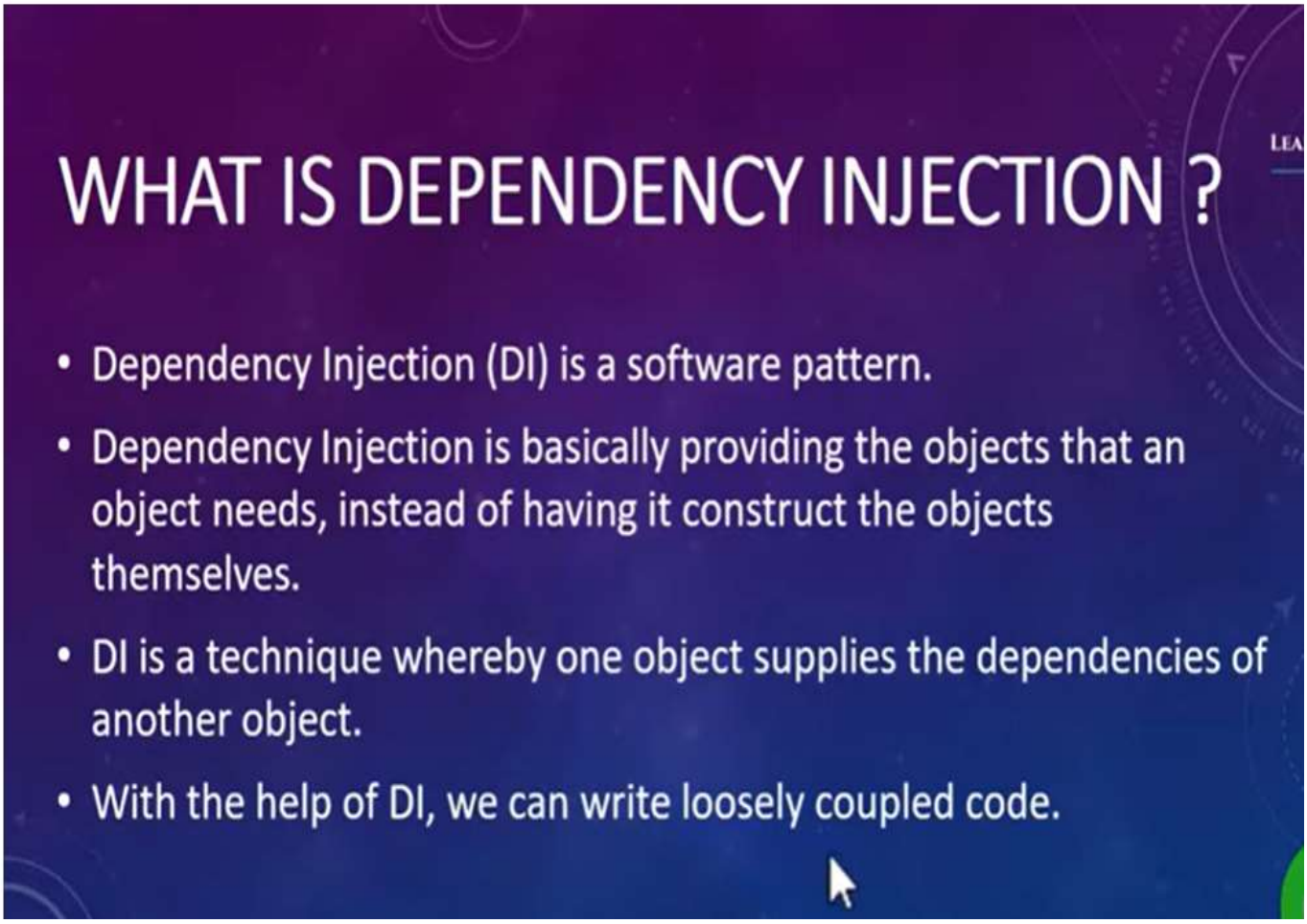




Middleware Pipeline:

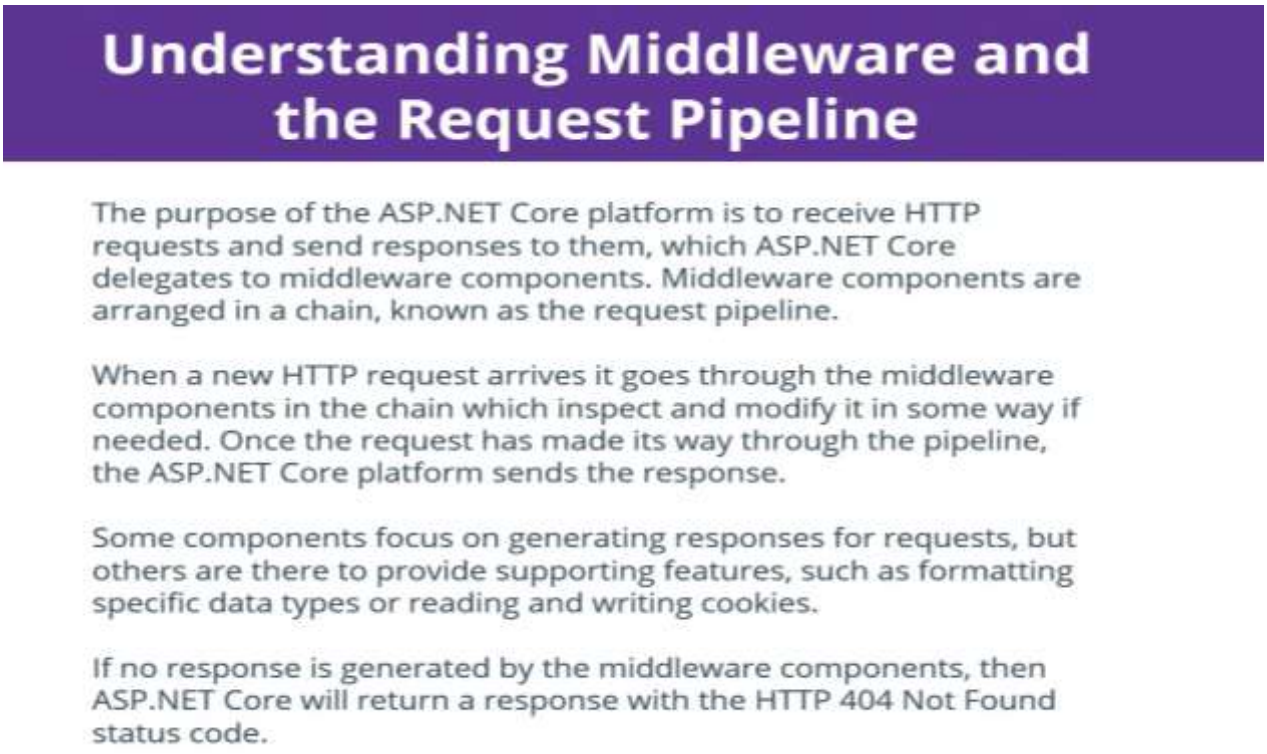
Middleware consists of small components that execute in sequence when the application receives an HTTP request. Kestrel is responsible for receiving the request data and constructing a C# representation of the request, but it doesn't attempt to generate a response directly. For that, Kestrel hands the HttpContext to the middleware pipeline found in every ASP.NET Core application. The series of components in the pipeline process the incoming request to perform common operations such as logging, handling exceptions, or serving static files.

The order of the calls in this method is important, as the order in which they're added to the builder is the order in which they'll execute in the final pipeline. Middleware can only use objects created by previous middleware in the pipeline—it can't access objects created by later middleware.

Middleware can

1. Handle an incoming HTTP request by generating an HTTP response
2. Process an incoming HTTP request, modify it, and pass it on to another piece of middleware
3. Process an outgoing HTTP response, modify it, and pass it on to either another piece of middleware or the ASP.NET Core web server

You can use middleware in a multitude of ways in your own applications. For example, a piece of logging middleware might note when a request arrived and then pass it on to another piece of middleware. Meanwhile, an image-resizing middleware component might spot an incoming request for an image with a specified size, generate the requested image, and send it back to the user without passing it on. The most important piece of middleware in most ASP.NET Core applications is the EndpointMiddleware class. This class normally generates all your HTML pages and API responses (for Web API applications).



DEFINITION This arrangement, where a piece of middleware can call another piece of middleware, which in turn can call another, and so on, is referred to as a pipeline. You can think of each piece of middleware as a section of pipe—when you connect all the sections, a request flows through one piece and into the next.

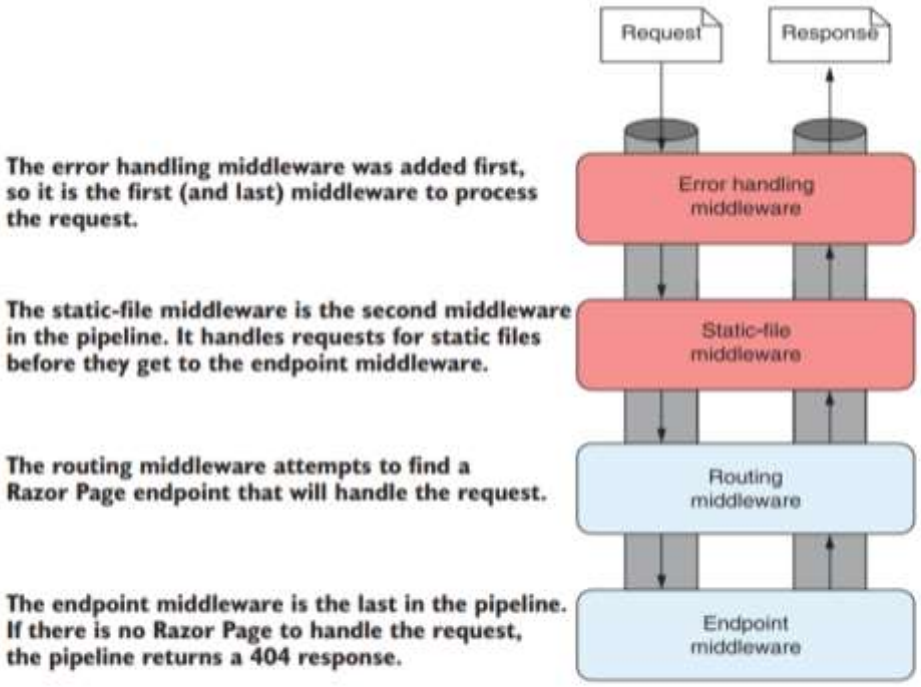


Figure 3.11 The middleware pipeline for the example application in listing 3.3. The order in which you add the middleware to `IApplicationBuilder` defines the order of the middleware in the pipeline.

```
public class Startup
{
    public void ConfigureServices(IServiceCollection services
    {
        services.AddRazorPages();
    }
    public void Configure(IApplicationBuilder app)
    {
        app.UseWelcomePage("/");
        app.UseExceptionHandler("/Error");
        app.UseStaticFiles();
        app.UseRouting();
        app.UseEndpoints(endpoints =>
        {
            endpoints.MapRazorPages();
        });
    }
}
```

WelcomePageMiddleware handles all requests to the "/" path and returns a sample HTML response.

Requests to "/" will never reach the endpoint middleware.

Even though you know the endpoint middleware can also handle the `"/"` path, `WelcomePageMiddleware` is earlier in the pipeline, so it returns a response when it receives the request to `"/"`, short-circuiting the pipeline, as shown in figure 3.13. None of the other middleware in the pipeline runs for the request, so none has an opportunity to generate a response.

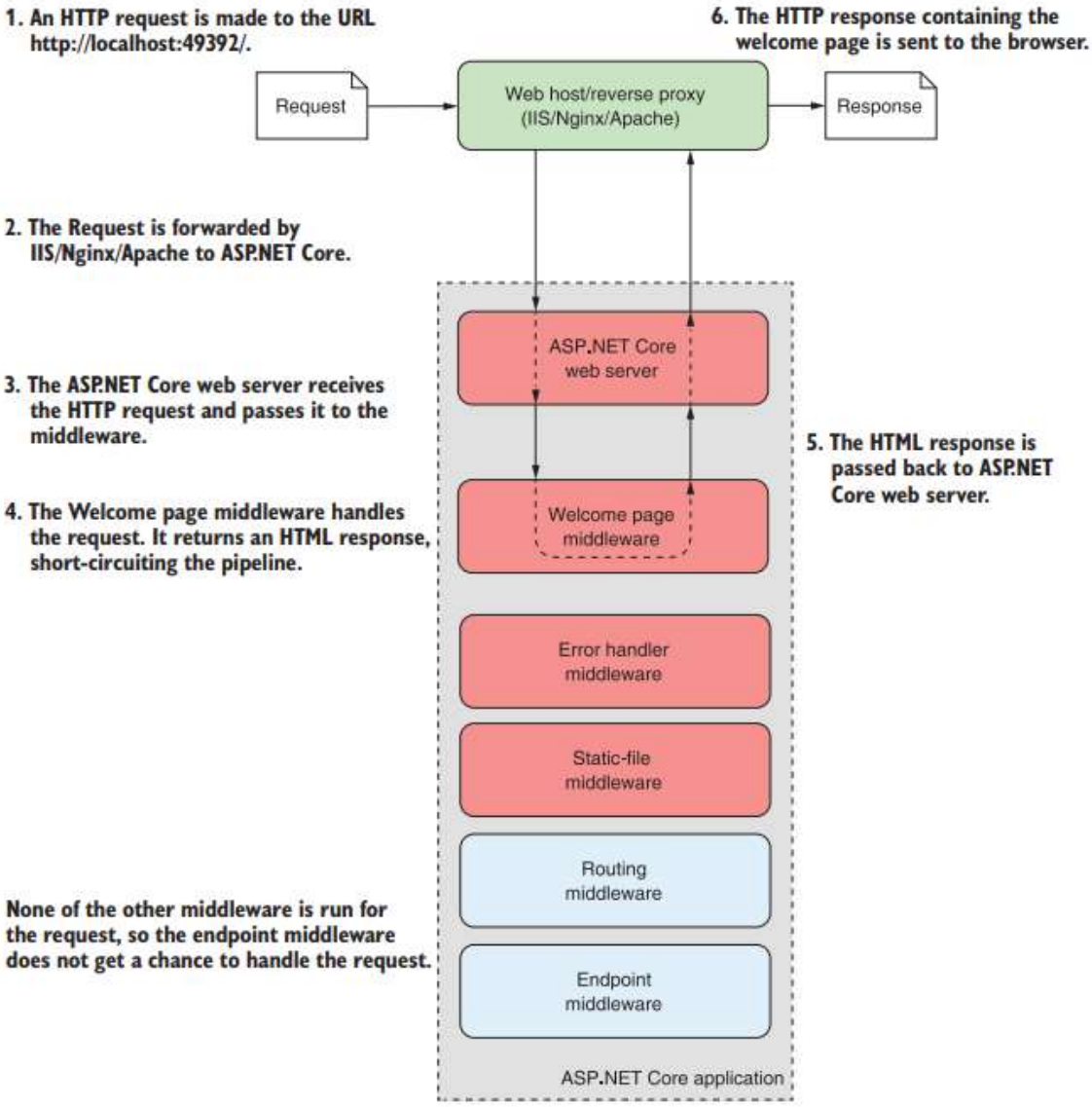


Figure 3.13 Overview of the application handling a request to the "/" path. The welcome page middleware is first in the middleware pipeline, so it receives the request before any other middleware. It generates an HTML response, short-circuiting the pipeline. No other middleware runs for the request.

In ASP.NET Core web applications, your middleware pipeline will normally include the EndpointMiddleware. This is typically where you write the bulk of your application logic, calling various other classes in your app. It also serves as the main entry point for users to interact with your app. It typically takes one of three forms:

1. **An HTML web application** designed for direct use by users—If the application is consumed directly by users, as in a traditional web application, then Razor Pages is responsible for generating the web pages that the user interacts with. It handles requests for URLs, it receives data posted using forms, and it generates the HTML that users use to view and navigate your app.
2. **An API** designed for consumption by another machine or in code—The other main possibility for a web application is to serve as an API to backend server processes, to a mobile app, or to a client framework for building single-page applications (SPAs). In this case, your application serves data in machine-readable formats such as JSON or XML instead of the human-focused HTML output.
3. **Both an HTML web application and an API**—It is also possible to have applications that serve both needs. This can let you cater to a wider range of clients while sharing logic in your application.

For Razor Pages, the entry point is a page handler that resides in a Razor Page's PageModel. A page handler is a method that runs in response to a request. By default, the path of a Razor Page on disk controls the URL path that the Razor Page responds to. For example, a request to the URL /products/list corresponds to the Razor Page at the path pages/Products/List.cshtml. Razor Pages can contain any number of page handlers, but only one runs in response to a given request.

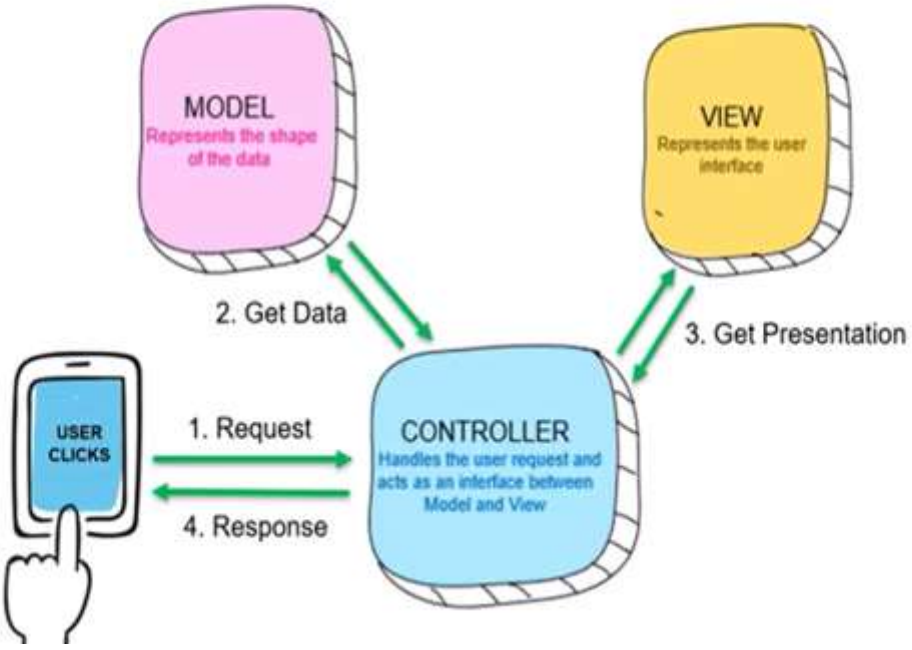
ROUTING IN MVC

The URL pattern for routing is considered after the domain name.

- https://localhost:55555/Category/Index/3
- https://localhost:55555/{controller}/{action}/{id}

URL	Controller	Action	Id
https://localhost:55555/Category/Index	Category	Index	Null
https://localhost:55555/Category	Category	Index	Null
https://localhost:55555/Category/Edit/3	Category	Edit	3
https://localhost:55555/Product/Details/3	Product	Details	3

MVC ARCHITECTURE



Each component in the MVC design pattern is responsible for a single aspect of the overall system, which, when combined, can be used to generate a UI.

In general, the order of events when an application responds to a user interaction or request is as follows:

1. The controller (the Razor Page handler) receives the request.
2. Depending on the request, the controller either fetches the requested data from the application model using injected services, or it updates the data that makes up the model.
3. The controller selects a view to display and passes a representation of the model to it.
4. The view uses the data contained in the model to generate the UI.

Consider a request to view a product page for an e-commerce application. The controller would receive the request and would know how to contact some product service that's part of the application model. This might fetch the details of the requested product from a database and return them to the controller.

Alternatively, imagine that a controller receives a request to add a product to the user's shopping cart. The controller would receive the request and most likely would invoke a method on the model to request that the product be added. The model would then update its internal representation of the user's cart, by adding, for example, a new row to a database table holding the user's data.

Why do we need page models or MVC patterns at all?

The key thing to remember is that you now have a framework for performing arbitrarily complex functions in response to a request. You could easily update the handler method to load data from the database, send an email, add a product to a basket, or create an invoice—all in response to a simple HTTP request. This extensibility is where a lot of the power in Razor Pages (and the MVC pattern in general) lies.

The other important point is that you've separated the execution of these methods from the generation of the HTML itself. If the logic changes and

you need to add behavior to a page handler, you don't need to touch the HTML generation code, so you're less likely to introduce bugs. Conversely, if you need to change the UI slightly, change the color of the title for example, then your handler method logic is safe. This is the concept derived from **SoC**. One of the advantages of the model being independent of the view is that it improves testability. UI code is classically hard to test, as it's dependent on the environment—anyone who has written UI tests simulating a user clicking buttons and typing in forms knows that it's typically fragile. By keeping the model independent of the view, you can ensure the model stays easily testable, without any dependencies on UI constructs. As the model often contains your application's business logic, this is clearly a good thing.

The view can use the data passed to it by the controller to generate the appropriate HTML response. The view is only responsible for generating the final representation of the data; it's not involved in any of the business logic.

The dangers of tight coupling

Generally speaking, it's a good idea to reduce coupling between logically separate parts of your application as much as possible. This makes it easier to update your application without causing adverse effects or requiring modifications in seemingly unrelated areas. Applying the MVC pattern is one way to help with this goal.

As an example of when coupling rears its head, I remember a case a few years ago when I was working on a small web app. In our haste, we had not properly decoupled our business logic from our HTML generation code, but initially there were no obvious problems—the code worked, so we shipped it!

A few months later, someone new started working on the app and immediately "helped" by renaming an innocuous spelling error in a class in the business layer. Unfortunately, the names of those classes had been used to generate our HTML code, so renaming the class caused the whole website to break in users' browsers! Suffice it to say, we made a concerted effort to apply the MVC pattern after that and ensure that we had a proper separation of concerns.

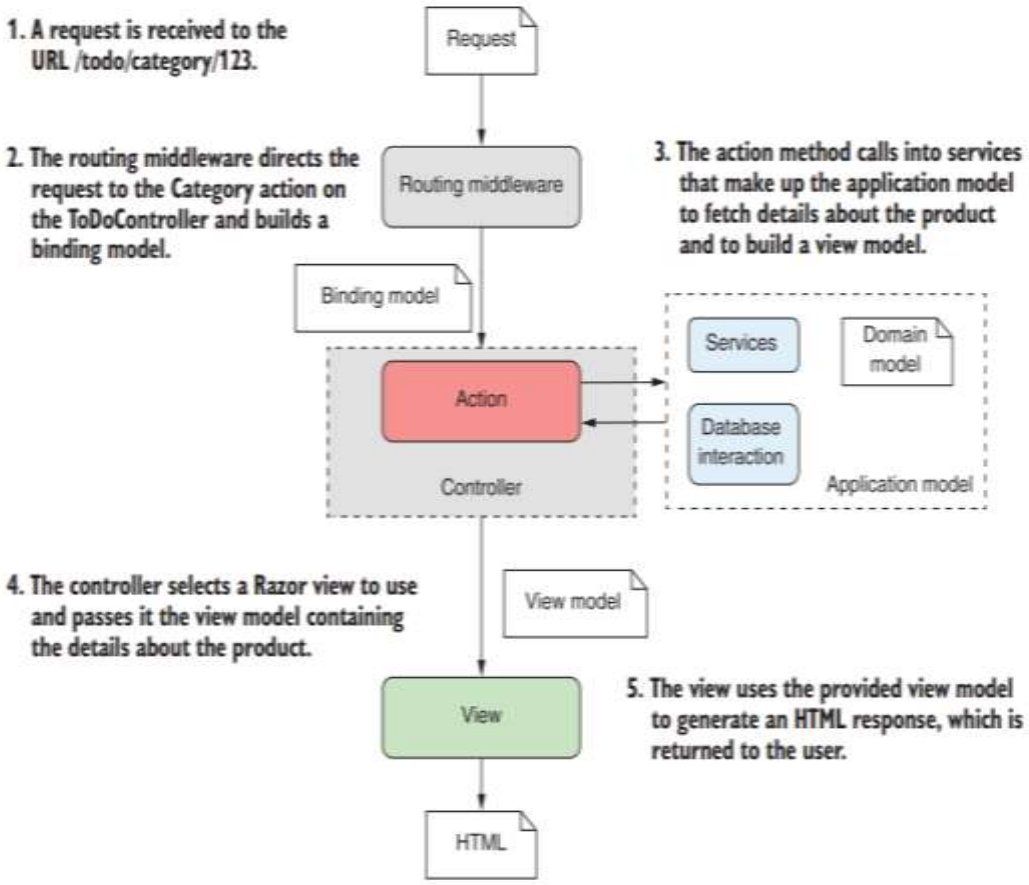


Figure 4.10 A complete MVC controller request for a category. The MVC controller pattern is almost identical to that of Razor Pages, shown in figure 4.6. The controller is equivalent to a Razor Page, and the action is equivalent to a page handler.

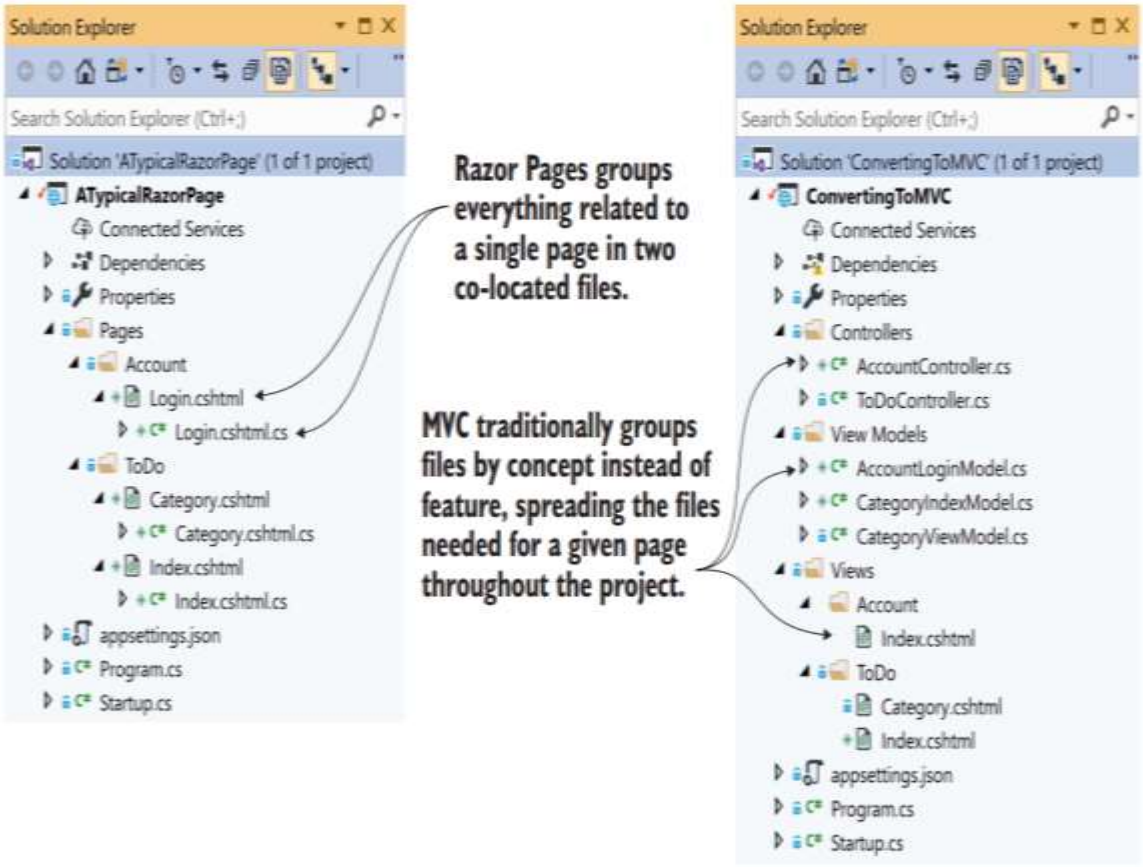


Figure 4.11 Comparing the folder structure for an MVC project to the folder structure for a Razor Pages project

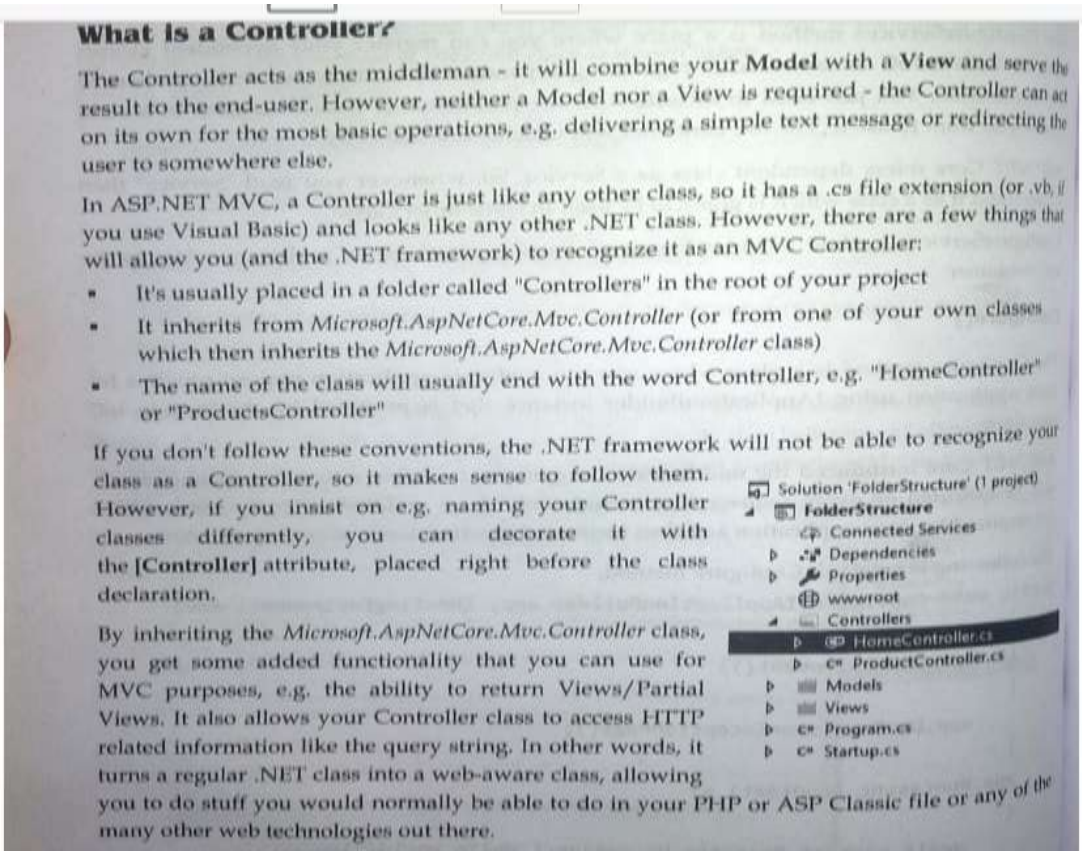
Model or View Model

Model defines the shape of the entity or data with business logic, and via EF and Linq query the controller fetches the data from the database tables as per the need, which is later passed onto the views by action method of the controller. A **View model** in the MVC pattern is all the data required by the view to render a UI. It's typically some transformation of the data contained in the application model, plus extra information required to render the page, such as the page's title.

NOTE Razor Pages use the PageModel class itself as the view model for the

Razor view, by exposing the required data as properties.

NOTE *In this description of MVC, the model is considered to be a complex beast, containing all the logic for how to perform an action, as well as any internal state. The Razor Page PageModel class is not the model we're talking about! Unfortunately, as in all software development, naming things is hard.*



What is a Controller?

The Controller acts as the middleman - it will combine your **Model** with a **View** and serve the result to the end-user. However, neither a Model nor a View is required - the Controller can act on its own for the most basic operations, e.g. delivering a simple text message or redirecting the user to somewhere else.

In ASP.NET MVC, a Controller is just like any other class, so it has a .cs file extension (or .vb if you use Visual Basic) and looks like any other .NET class. However, there are a few things that will allow you (and the .NET framework) to recognize it as an MVC Controller:

- It's usually placed in a folder called "Controllers" in the root of your project
- It inherits from *Microsoft.AspNetCore.Mvc.Controller* (or from one of your own classes which then inherits the *Microsoft.AspNetCore.Mvc.Controller* class)
- The name of the class will usually end with the word Controller, e.g. "HomeController" or "ProductsController"

If you don't follow these conventions, the .NET framework will not be able to recognize your class as a Controller, so it makes sense to follow them. However, if you insist on e.g. naming your Controller classes differently, you can decorate it with the **[Controller]** attribute, placed right before the class declaration.

By inheriting the *Microsoft.AspNetCore.Mvc.Controller* class, you get some added functionality that you can use for MVC purposes, e.g. the ability to return Views/Partial Views. It also allows your Controller class to access HTTP related information like the query string. In other words, it turns a regular .NET class into a web-aware class, allowing you to do stuff you would normally be able to do in your PHP or ASP Classic file or any of the many other web technologies out there.

The Controller Responsibilities

The Controller has three major responsibilities

- Handle the Request
- Build a Model
- Send the Response

Handle the Request

The Controller is responsible to Handle Request from the User.

Builds the Module

The Controller Action method executes the application logic and builds a model

Sends the Result

Finally, it should return the Result in HTML/File/Json/XML or whatever the format requested by the user.

Actions

Since a Controller is just a regular .NET class, it can have fields, properties and methods. Especially the methods of a Controller class are interesting, because they are the connection between the browser (and therefore the user) and your application. For that reason, **the methods of a Controller class is referred to as actions** - a method usually corresponds to an action in your application, which then returns something to the browser/user.

Since a browser works by calling a URL, you need something that translates URL's to a corresponding Controller and action (method). For instance, the browser might request a URL like */products/1/* and then you want your *ProductsController* to handle this request with a method/action called *Details*. This is done with the concept of Routing, just know that **Routing is what connects URL's to actions on your Controllers**.

Now the Edit action can only be accessed with a GET request. This has the added benefit of allowing you to have multiple methods with the same name, as long as they don't accept the same request method. So for instance, you could have two methods called Edit: The first one would be available for GET requests and generate the FORM for editing an item, while the second one would only be available for POST requests and be used to update the item when the FORM was posted back to the server. It could look like this:

```
[HttpGet]
public IActionResult Edit()
{
        return View();
}

[HttpPost]
public IActionResult Edit(Product product)
{
        product.Save();
        return Content("Product updated!");
}
```

Now whenever a request is made to the Edit() method/action, the actual method responding to the request will be based on whether it's a GET or a POST request.

Action Result Types

Actions are the methods defined on a Controller. Actions are invoked when a requested URL is matched to an Action on a Controller (this is done by the Routing system). When the Action (method) finishes it work, it will usually return something to the client and that something will usually be implementing the **IActionResult** interface (or Task<IActionResult> if the method is asynchronous).

As soon as your Controller inherits the built-in base Controller class (*Microsoft.AspNetCore.Mvc.Controller*), we are supplied with a wide range of helper methods for generating the response (the action result). The **View()** method. It will take the matching View file and turn it into an instance of the **ViewResult** class, which implements the *IActionResult* interface. After that, ASP.NET MVC will automatically transform it into a response to the browser - in this case in the form of an "OK" status code and then a body of HTML.

A view is far from the only possible result of a Controller action, though. Since the result will eventually be returned to a browser, the available methods should cover all possible outcomes of a HTTP request, so a Controller action can of course also result in a redirect, a 404 (Page not Found) or any of the other HTTP status codes. Here's an incomplete list of the most interesting and useful methods for generating an Action result:

- **Content()** - returns the specified string as plain text to the client (usually a browser)
- **View()** - returns a View to the client
- **PartialView()** - returns a Partial View to the client

- **File()** - returns the content of a specified file to the client
- **Json()** - returns a JSON response to the client
- **Redirect()** and **RedirectPermanent()** - returns a redirect response to the browser (temporary or permanent), redirecting the user to another URL
- **StatusCode()** - returns a custom status code to the client

For instance, the **Content()** method simply generates an instance of the **ContentResult** class and fills the **Content** property with the value you pass into the method.

Since there are many types of responses which implements the IActionResult interface, your actions can return any of them, based on the logic of your method. A common use case for this is to return either a View or a piece of content if the requested content is found, or a 404 (Page not Found) error if its not found. It could look like this:

```
public IActionResult Details(int id)
{
        Product product = GetProduct(id);
        if (product != null)
                return View(product);
        return NotFound();
}
```

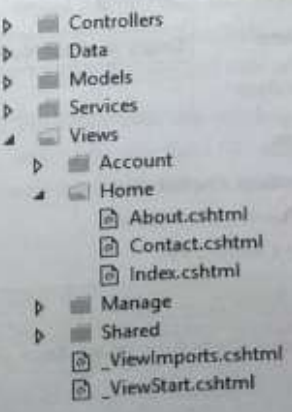
In the first line, we try to load the requested product, using a to-be-implemented GetProduct() method. If the product is found, we return it inside of a View using the **View()** method - if not, we return a 404 error using the **NotFound()** helper method, which basically just creates an instance of the **NotFoundResult** class. So in this case, there are two possible outcomes of the action, but there could be even more, if needed - you are free to return anything that implements the IActionResult interface.

RENDERING HTML WITH VIEWS

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



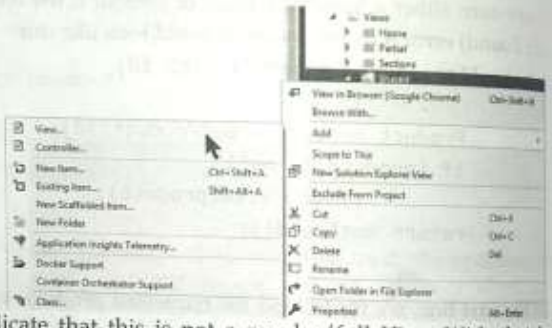
views for the *About*, *Contact*, and *Index* (homepage) webpages. When a user requests one of these three webpages, controller actions in the *Home* controller determine which of the three views is used to build and return a webpage to the user.

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.

Partial Views in ASP.NET MVC usually follow these conventions:

- They are located in the same folder as the View using it, or if multiple views are using it (the most common situation) they should be placed in a "Shared" folder inside of your Views folder
- Its filename usually starts with an underscore, simply to indicate that this is not a regular/full View With that in place, let's add the Partial View. We'll add it to our *Shared* folder, to ensure that all of our Views can access it easily:



Benefits of using Views

Views help to establish separation of concerns (SoC) 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.

When to choose MVC controllers over Razor Pages

1. When you don't want to render views—Razor Pages are best for page-based applications, where you're rendering a view for the user. If you're building a Web API, you should use MVC controllers instead.

2. When you're converting an existing MVC application to ASP.NET Core—If you already have an ASP.NET application that uses MVC, it's probably not worth converting your existing MVC controllers to Razor Pages. It makes more sense to keep your existing code, and perhaps to look at doing new development in the application with Razor Pages.
3. When you're doing a lot of partial page updates—It's possible to use JavaScript in an application to avoid doing full page navigations by only updating part of the page at a time. This approach, halfway between fully server-side rendered and a client-side application may be easier to achieve with MVC controllers than Razor Pages.

Summary

1. The MVC design pattern allows for a separation of concerns between the business logic of your application, the data that's passed around, and the display of data in a response.
2. Razor Pages are built on the ASP.NET Core MVC framework, and they use many of the same primitives. They use conventions and a different project layout to optimize for page-based scenarios.
3. MVC controllers contain multiple action methods, typically grouped around a high -level entity. Razor Pages groups all the page handlers for a single page in one place, grouping around a page/feature instead of an entity.
4. Each Razor Page is equivalent to a mini controller focused on a single page, and each Razor Page handler corresponds to a separate action method.
5. Razor Pages should inherit from the PageModel base class.
6. A single Razor Page handler is selected based on the incoming request's URL, the HTTP verb, and the request's query string, in a process called routing.
7. Page handlers should generally delegate to services to handle the business logic required by a request, instead of performing the

changes themselves. This ensures a clean separation of concerns that aids testing and improves application structure.

8. Page handlers can have parameters whose values are taken from properties of the incoming request in a process called model binding. Properties decorated with [BindProperty] can also be bound to the request.
9. By default, properties decorated with [BindProperty] are not bound for GET requests. To enable binding, use [BindProperty(SupportsGet = true)].
10. Page handlers can return a PageResult or void to generate an HTML response.
11. You can send users to a new Razor Page using a RedirectToPageResult.
12. The PageModel base class exposes many helper methods for creating an ActionResult.