Application Flow, Filters & Middleware

Application Fundamentals, Errors, Filters, Middleware

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Table of Contents

1. Application Flow
2. Middleware
3. Filters

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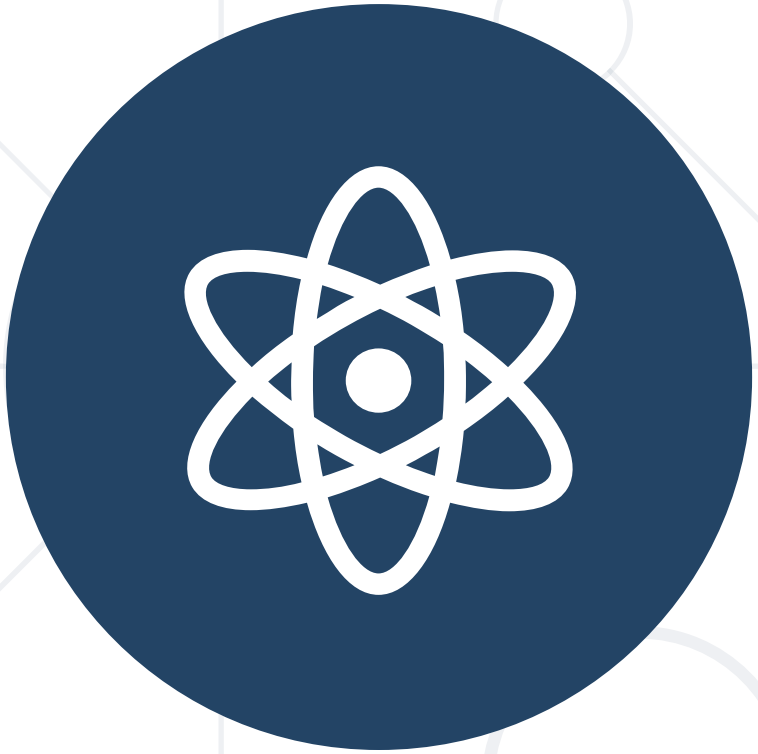
#csharp-web



Application Flow

Application Fundamentals

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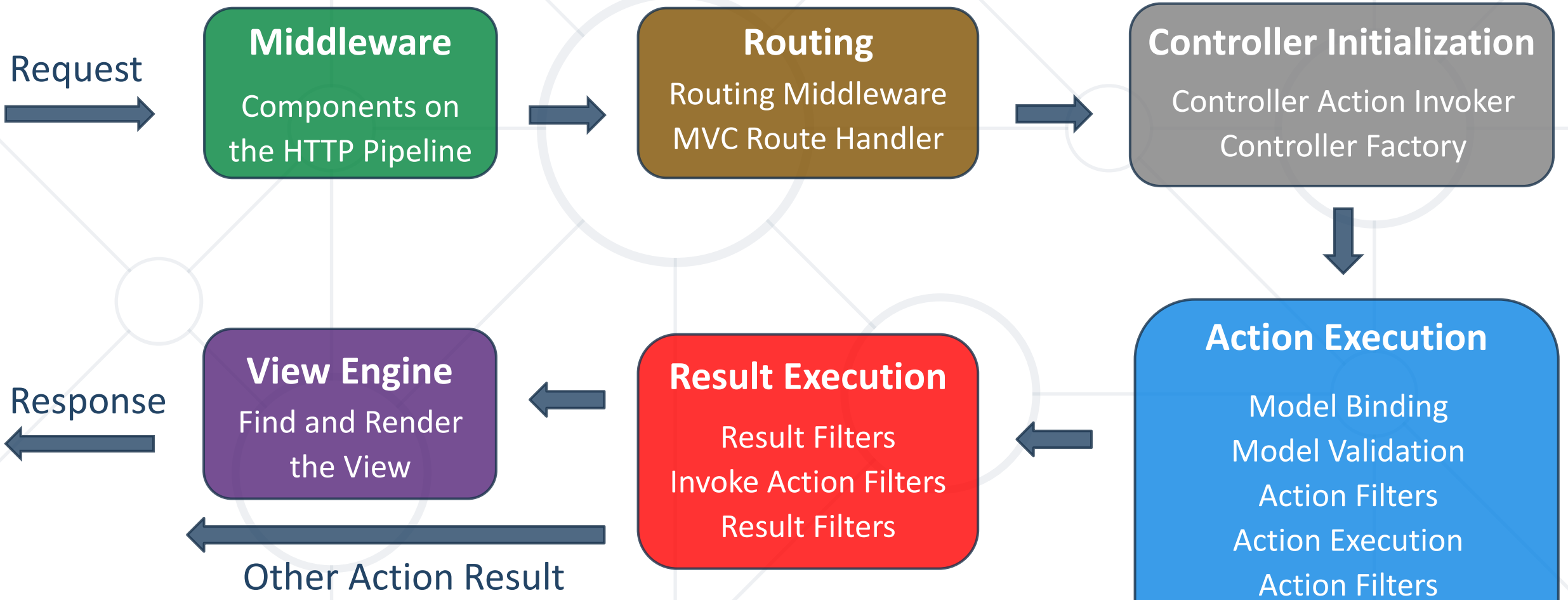
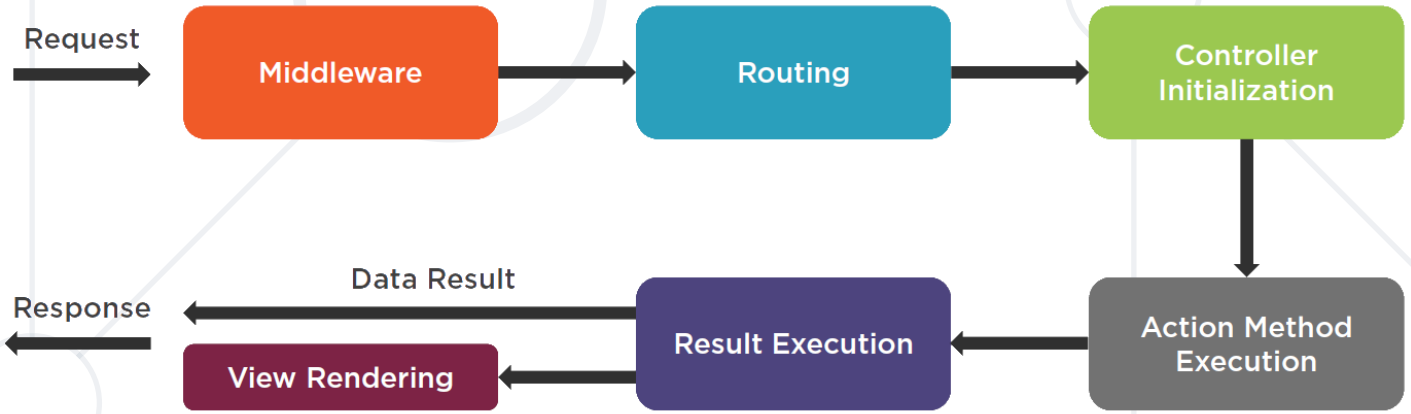
- **Web Applications** handle **Requests** and produce **Responses**
  - The whole process is naturally ordered in some kind of **pipeline**
  - In most cases, the process is **extensible** and **modifiable**
- **Web Applications** have different **deployment environments**
  - The environments determine the **behavior** of the application
  - The environments may also affect the pipeline
- **Web Applications** have initial **configuration**
  - Host, Security, Directories, Conventions, etc.

MVC Request Lifecycle



Controller Context

- The `Controller` is one of the main components in the **Request pipeline**
  - Each `Controller` has its own `ControllerContext`
  - A set of useful properties containing data about the current `Request`
- `ControllerContext` properties
  - `ActionDescriptor`
  - `HttpContext (Request, Response)`
  - `ModelState`
  - `RouteData`
  - `ValidProviderFactories`



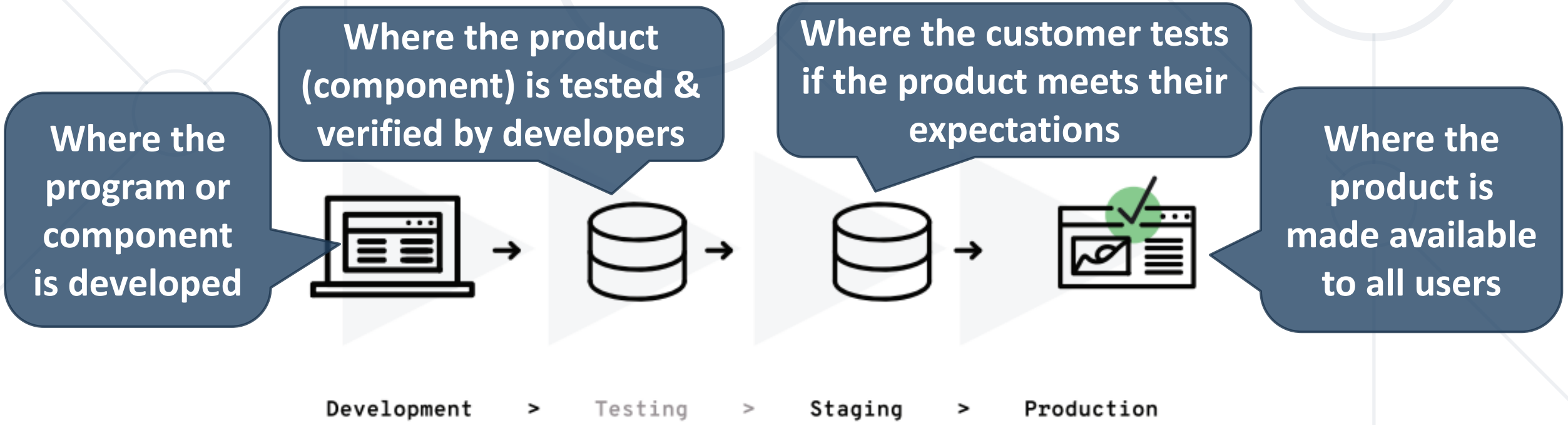
Application Fundamentals

- **ASP.NET Core** uses the **Program.cs** class to
  - Configure the HTTP Request Pipeline
  - Define behavior for different environments

```
if (!app.Environment.IsDevelopment())
{
    app.UseExceptionHandler("/Home/Error");
    app.UseHsts();
}

app.UseHttpsRedirection();
app.UseStaticFiles();
app.UseCookiePolicy();

app.UseMvcWithDefaultRoute();
```

Application Environments (1)

- **Software Deployment** is usually distributed into several **environments**
  - Multi-stage deployment is a **MUST** in Enterprise applications
  - A **computer system** (**virtual** or **real**) which runs your software



Application Environments (2)

- Most environment architectures use the following environments
  - **Dev**
    - The program or component is developed
  - **Test**
    - The product (component) is tested & verified by developers
  - **Stage**
    - The customer tests if the product meets their expectations
  - **Production**
    - The product is made available to all users

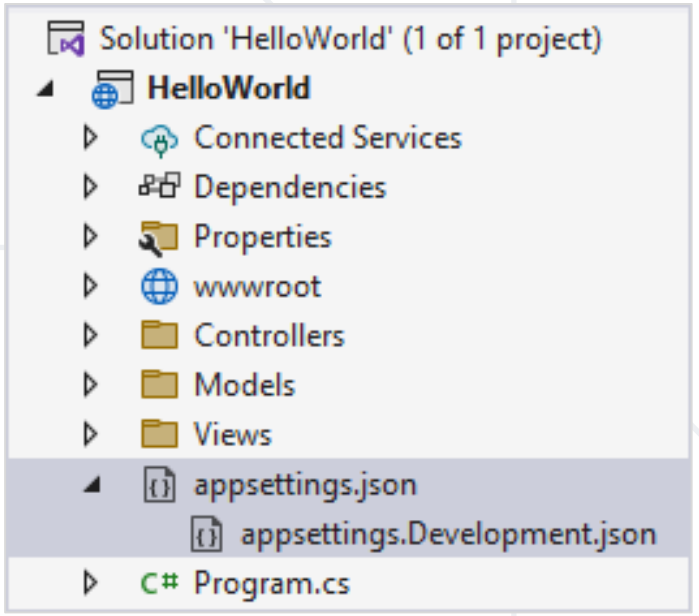
ASP.NET Core Environments

- ASP.NET Core configures app behavior based on **runtime environment**
  - Supports 3 environments – **Development**, **Staging** and **Production**
  - Reads the **Environment variable "ASPNETCORE_ENVIRONMENT"**
  - Environment value is stored in the **EnvironmentName** property of the **Environment** property of the **WebApplication**, returned by the **Build()** method of the **WebApplicationBuilder**
  - The environment can be set to **any value**. The default environment is **Production**

```
if(app.Environment.IsDevelopment()) //TODO: Do Development
if(app.Environment.IsStaging()) //TODO: Do Staging
if(app.Environment.IsProduction()) //TODO: Do Production
if(app.Environment.IsEnvironment("some_environment")) //TODO: Do Something
```

Application Configuration (1)

- App configuration in **ASP.NET Core** is based on **key-value** pairs
  - App configurations are specified in **configuration providers**
- **Configuration providers** read data from **configuration sources**
  - Azure Key Vault, Command-line arguments
  - Custom providers (installed or created)
  - Directory files, Environment variables, etc.
- One of the default sources is **`appsettings.json`**



Application Configuration (2)

- App configuration is read at **app startup** from the providers
  - Configuration properties are mapped in **IConfiguration**
  - **IConfiguration** is available in the app's **DI container**

appsettings.json

```
{
    "Greeting":  "Hello!",
    "Config": {
        "Secret":
        "Can't touch this"
    },
    ...
}
```

HomeController.cs

```
public class HomeController : Controller
{
    private readonly IConfiguration config;
    public HomeController(IConfiguration config)
    {
        this.config = config;
    }
    public IActionResult Config()
    {
        return Content(this.config["Greeting"]);
        // Hello!
    }
}
```

Application Services Configuration (1)

- **Configuration options**, by convention, are set in `Program.cs`
  - Configured before `WebApplicationBuilder` builds the app
  - Accessed by the `Configuration` property of the `WebApplicationBuilder`, returned by the `WebApplication.CreateBuilder(args)` method
  - Typical pattern is adding the service and then configuring it
- Adding services to the service container
  - Makes them available within the app
    - Resolved via **Dependency Injection**
  - Makes them available within the `Program` class

Application Services Configuration (2)

- Services can be configured for **Dependency Injection** differently

```
// Transient objects are always different
// A new instance is provided to every controller and service
builder.Services.AddTransient<DataService>();

// Scoped objects are the same within a request
// They are different across different requests
builder.Services.AddScoped(typeof(DataService));

// Singleton objects are the same for every object and request.
builder.Services.AddSingleton<DataService>();
```

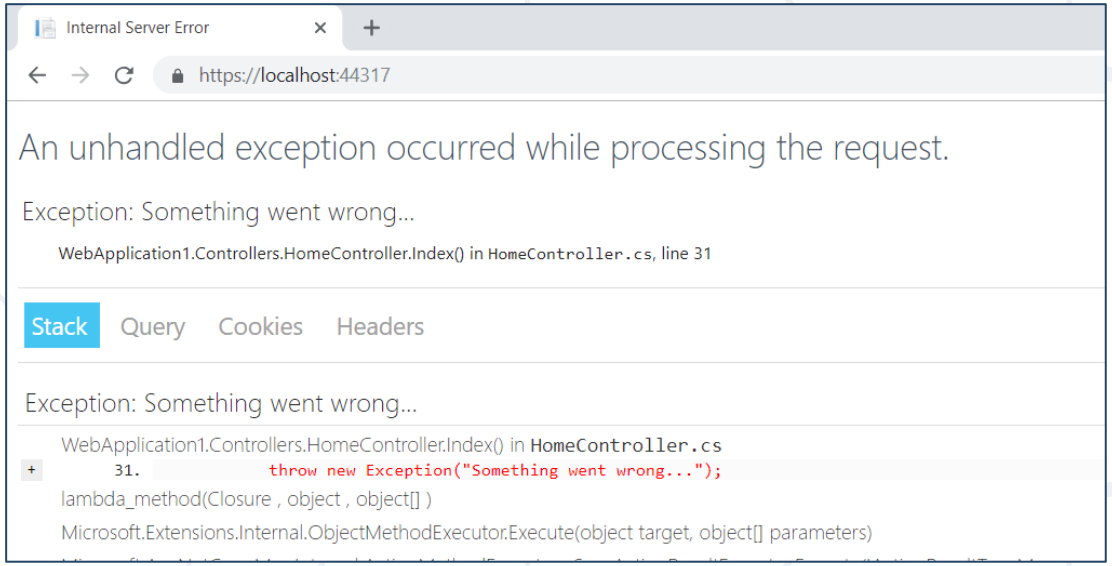
Diagnostics & Custom Error Handlers

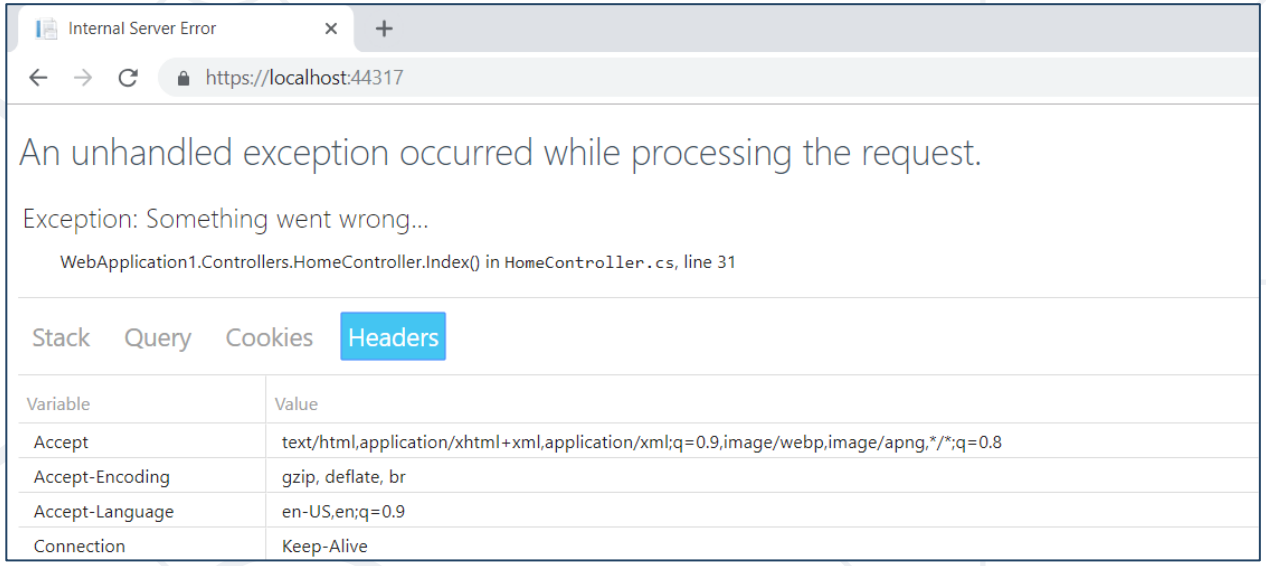
Error Handling

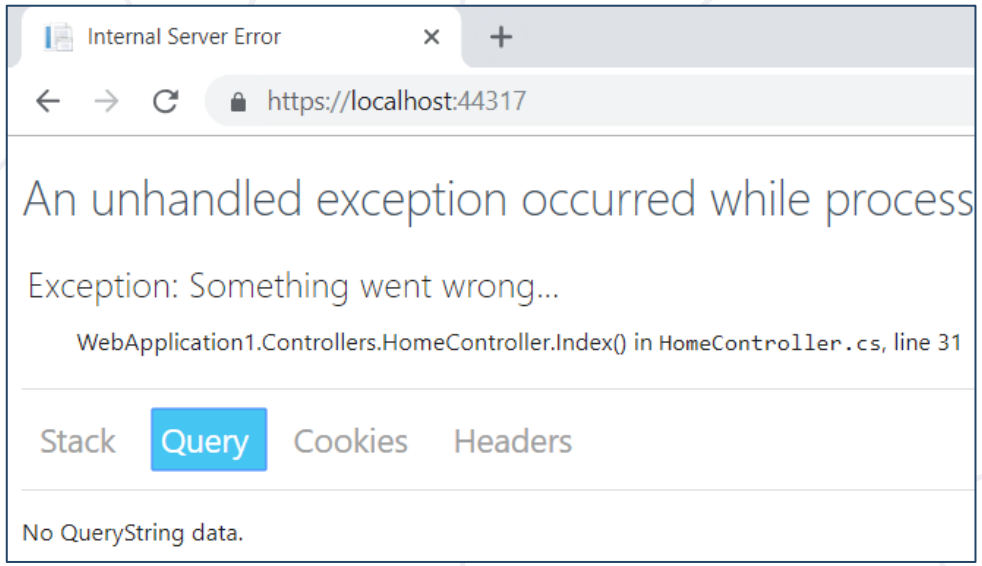
Error Handling

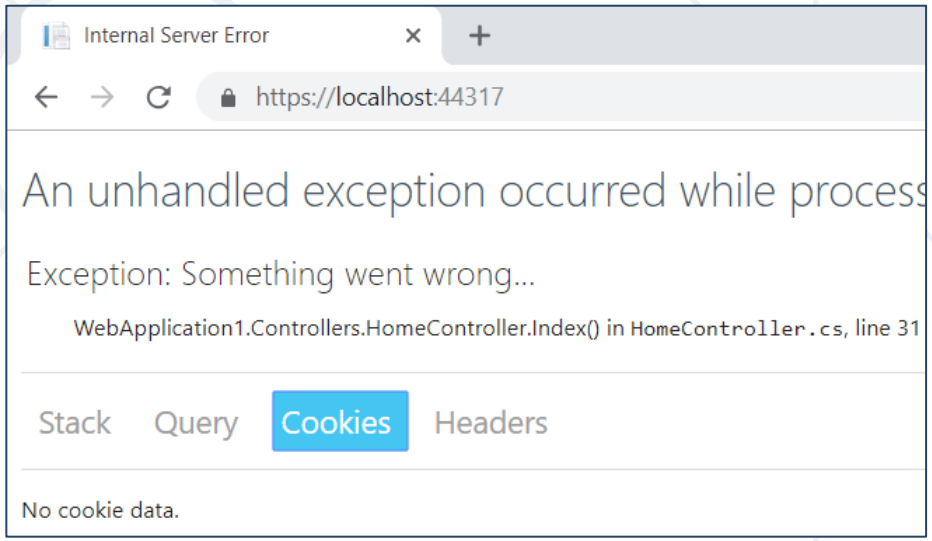
- There are several ways to configure **Error handling** in **ASP.NET Core**
  - Developer Exception Page
  - Exception Handler
  - Status Code Pages
- **ASP.NET Core MVC** apps have additional options for handling errors
  - Exception Filters
  - Model Validation (`ModelState`)

Error Handling (Developer Exception Page)



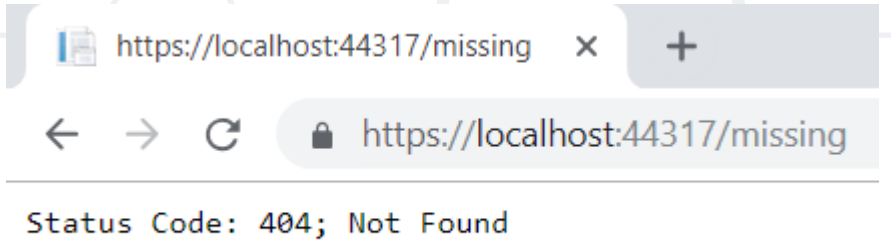


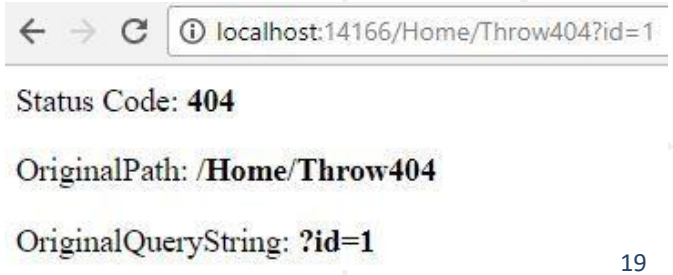




Error Handling (Status Code Pages)

- **ASP.NET Core** apps do not provide **rich** status code pages
  - To provide such, you have to use the **Status Code Pages Middleware**
  - `app.UseStatusCodePages()`
- The Middleware can easily be customized
  - Supports several extension methods. For example:
    - `app.UseStatusCodePagesWithRedirects(…)`
    - `app.UseStatusCodePagesWithReExecute(…)`





Error Handling (Custom Error Handler)

- Configuring a custom exception page is done by using the **ExceptionHandlerMiddleware**

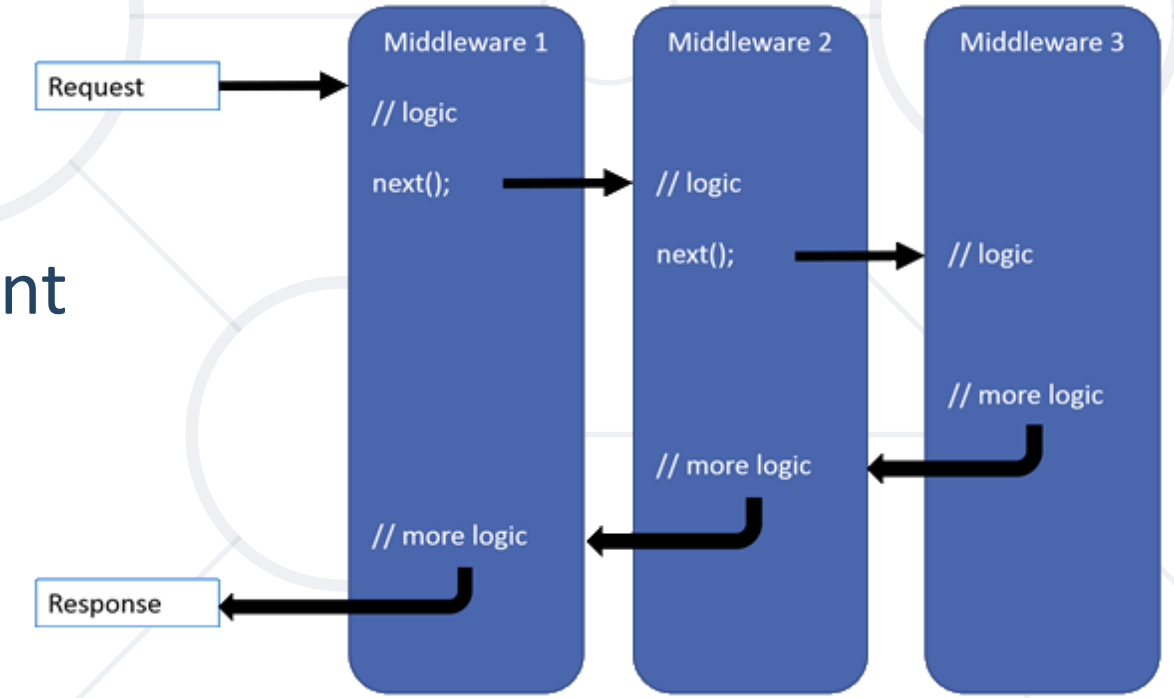
```
app.UseExceptionHandler("/Home/Error");
```

- You can then implement a **handler** for that **route**
  - It can be a **Controller Action**, a **Razor Page** or other handler

Middleware

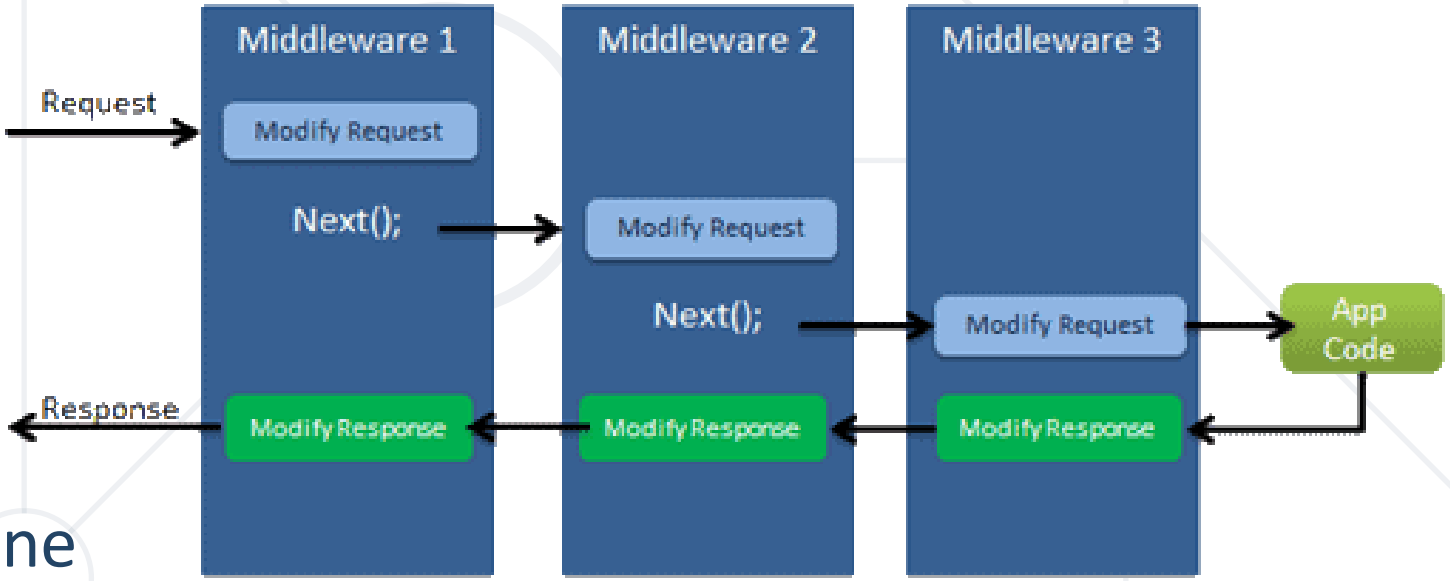
Middleware

- Middleware is a **software**, assembled into an **app pipeline**
- Each **component**
  - Handles **Requests** and **Responses**
  - Chooses whether to pass the request to the next component in the pipeline
  - May perform work **before** or **after** the next component in the pipeline is invoked
- In ASP.NET Core, **request delegates** build the **request pipeline**



Request Delegates (1)

- **Request delegates** handle each **HTTP request**
  - Are configured using the **extension** methods **`Run()`**, **`Map()`** and **`Use()`**
- **Request delegates** (also called **middleware components**) can be:
  - Specified in-line as an anonymous method (called **inline middleware**)
  - Defined in a reusable class
- Each **middleware component** should
  - Invoke the **next component** in the pipeline
  - Or **short-circuiting** the pipeline



Request Delegates (2)

- The `Use()` method is used to **chain** multiple **delegates** together
  - It can **short-circuit** the pipeline (if it does not invoke `next()`)
- The first `Run()` delegate terminates the pipeline
  - `Run()` is a convention
  - Some middleware expose `Run{Middleware}` methods
  - These methods run at the end of the pipeline
- The `Map()` method is used to **branch** the pipeline
  - The **request pipeline** is branched – based on the given **request path**

Creating Your Own Middleware (Inline)

- The **ASP.NET Core Request Pipeline** consists of a sequence of **Request Delegates**, called one after another
- Custom **Request Delegates** are created using the **`IApplicationBuilder`**

```
app.Use(async (context, next) =>
{
    // Do work that doesn't write to the Response.
    await next();
    // Do logging or other work that doesn't write to the Response.
});

//Other code below...
```

Creating Your Own Middleware (Class) (1)

- **Request delegates** can also be defined as classes

```
public class CustomMiddleware
{
    private readonly RequestDelegate next;

    public CustomMiddleware(RequestDelegate next)
    {
        this.next = next;
    }

    // IMyService is injected into InvokeAsync
    public async Task InvokeAsync(HttpContext httpContext, IMyService svc)
    {
        svc.MyProperty = 1000;
        await this.next(httpContext);
    }
}
```

The next delegate in the **pipeline**

Third-party **dependencies** are injected through **DI**

Creating Your Own Middleware (Class) (2)

- The custom **Middleware** class needs to be included into the **pipeline**

```
public static class CustomMiddlewareExtensions
{
    public static IApplicationBuilder UseCustom(this IApplicationBuilder builder)
    {
        return builder.UseMiddleware<CustomMiddleware>();
    }
}
```

- **Program.cs**

```
app.UseCustom();
```

Built-in Middleware (1)

- Some built-in middleware in ASP.NET Core are

Middleware	Import
Authentication	`app.UseAuthentication()`
Cookie Policy	`app.UseCookiePolicy()`
CORS	`app.UseCors()`

Diagnostics	`app.UseDevelopmentExceptionPage()`
	`app.UseExceptionHandler(…)`
	`app.UseStatusCodePages()`

HTTPS Redirection	`app.UseHttpsRedirection()`
HSTS	`app.UseHsts()`
Static Files	`app.UseStaticFiles()`

Built-in Middleware (2)

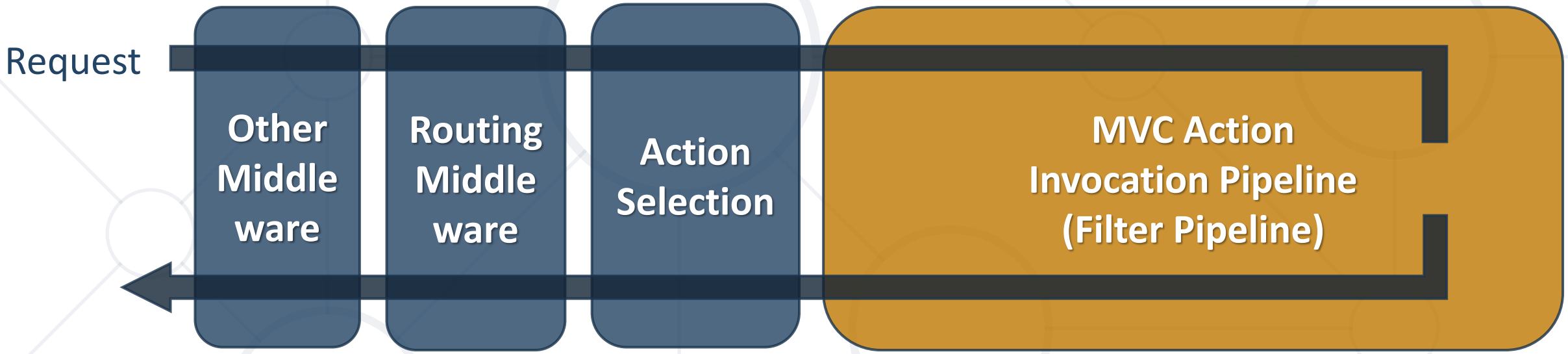
Middleware	Import
Response Caching	`app.UseResponseCaching()`
Response Compression	`app.UseResponseCompression()`
Request Localization	`app.UseRequestLocalization(…)`
Routing	`app.UseRouter(…)`
Session	`app.UseSession()`
URL Rewriting	`app.UseRewriter(…)`
WebSockets	`app.UseWebSockets(…)`
Others	`app.UseWelcomePage()`

- Many more are available on **NuGet**

Filters

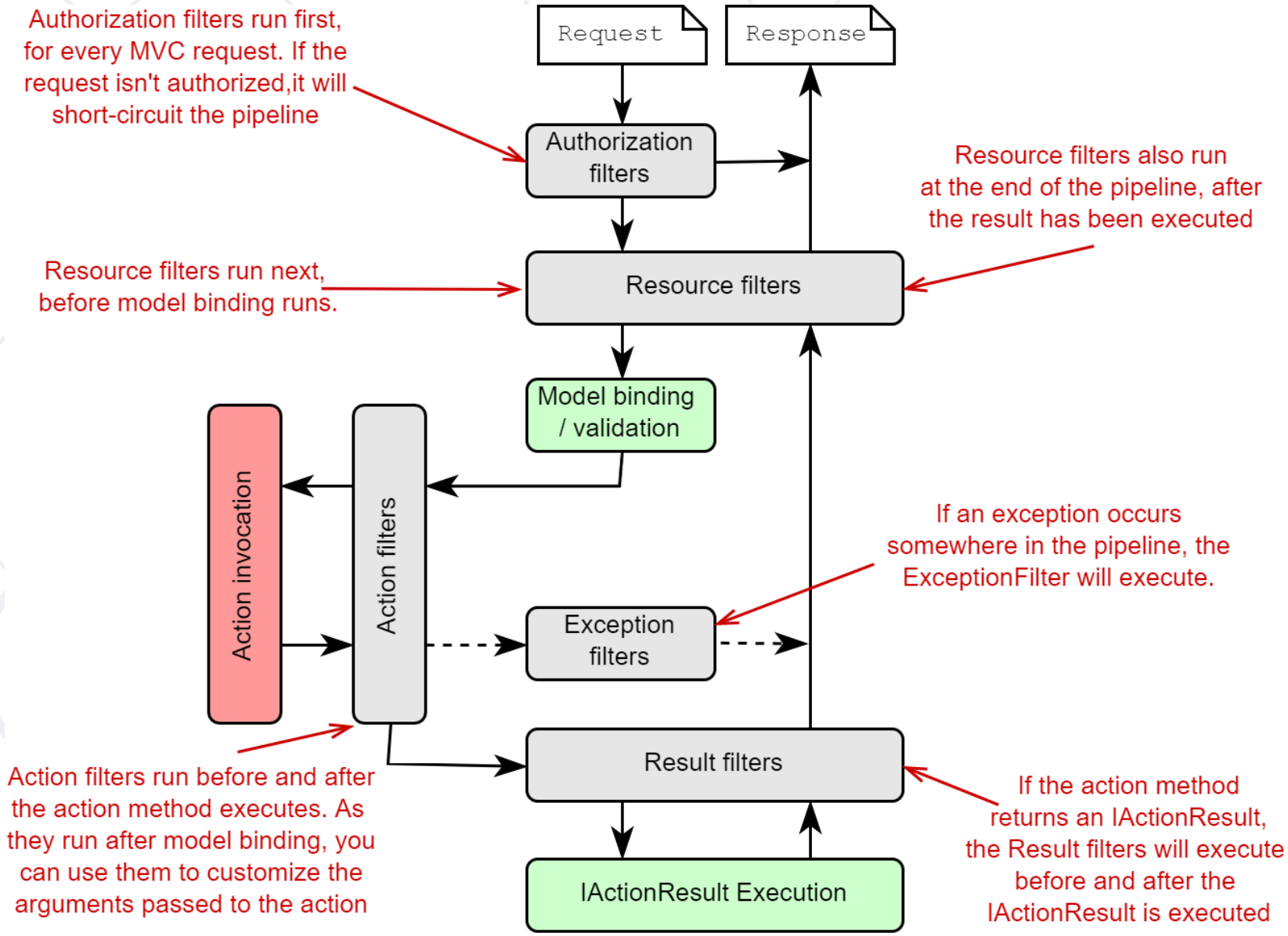
Filters (1)

- **Filters** allow you to run code **before** or **after** specific stages in the **Request Processing Pipeline**



- **Filters** are similar but **NOT** the **same** as **Middleware**
  - Middleware operate on the level of **ASP.NET Core**
  - Filters operate only on the level of **MVC**

Filters (2)


Authorization filters run first, for every MVC request. If the request isn't authorized,it will short-circuit the pipeline
Request
Response
Authorization filters
Resource filters also run at the end of the pipeline, after the result has been executed
Resource filters run next, before model binding runs.
Resource filters
Model binding / validation
Action invocation
Action filters
If an exception occurs somewhere in the pipeline, the ExceptionFilter will execute.
Exception filters
Result filters
Action filters run before and after the action method executes. As they run after model binding, you can use them to customize the arguments passed to the action
If the action method returns an IActionResult, the Result filters will execute before and after the IActionResult is executed
IActionResult Execution

Filters (3)

- There are several types of **Filters**
  - Each is executed on a **different stage** of the **Filter Pipeline**
  - There are **Authorization**, **Resource**, **Action**, **Exception** and **Result Filters**

Filter	Description
Authorization	Run first. Determine if the **Client** is **authorized** to **access** the Requested functionality
Resource	Run immediately **after Authorization**. Can run code **before** and **after** the rest of the **pipeline**
Action	Run immediately **before** and **after** an individual **Action Method** is invoked.
Exception	Used to apply **global policies** for **unhandled errors** that occur.
Result	Run immediately **before** and **after** execution of individual **Action Results**.

Implementing Custom Filters

- **ASP.NET Core MVC Filters** can be both **synchronous** and **asynchronous**

Synchronous

```
public class SampleActionFilter : IActionFilter
{
    public void OnActionExecuting(
                ActionExecutingContext context)
    {
        // DO before the action executes
    }

    public void OnActionExecuted(
                ActionExecutedContext context)
    {
        // DO after the action executes
    }
}
```

Asynchronous

```
public class SampleAsyncActionFilter :
IAsyncActionFilter
{
    public async Task OnActionExecutionAsync(
            ActionExecutingContext context,
            ActionExecutionDelegate next)
    {
        // DO before the action executes
        var resultContext = await next();
        // DO after the action executes
        // resultContext.Result will be set
    }
}
```

Adding Filters to the Pipeline (Global)

- **Filters** are added **globally** in the **MvcOption.Services**
  - Will be applied to all **Controllers** and **Actions**

```
builder.Services.AddMvc(options => {
        options.Filters.Add(new SampleActionFilter()); // instant
        options.Filters.Add(typeof(SampleActionFilter)); // by type
        ...
});
```

Filter Attributes (1)

- **ASP.NET Core** also includes built-in attribute-based **Filters**

```
public class AddHeaderAttribute : ResultFilterAttribute
{
    private readonly string name;
    private readonly string value;

    public AddHeaderAttribute(string name, string value)
    {
        this.name = name;
        this.value = value;
    }

    public override void OnResultExecuting(ResultExecutingContext context)
    {
        context.HttpContext.Response.Headers.Add(this.name,
                new string[] { this.value });
        base.OnResultExecuting(context);
    }
}
```

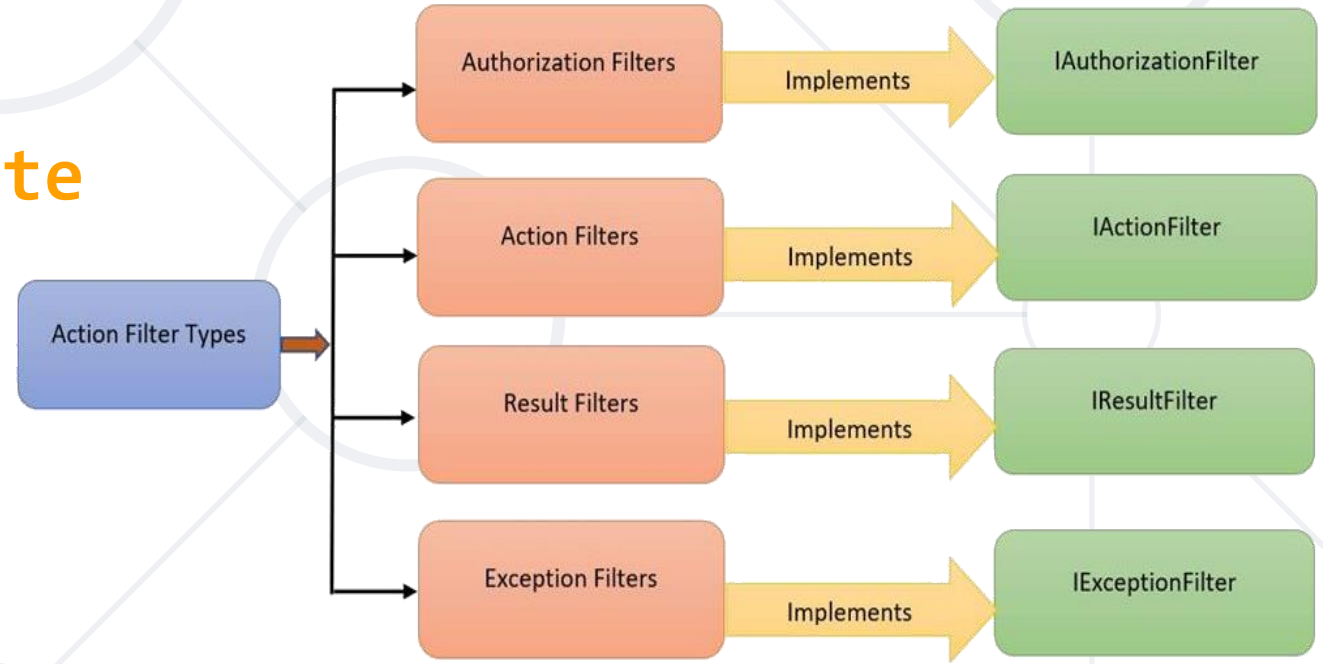
Filter Attributes (2)

- **Attributes** allow **Filters** to accept **arguments**
- This particular **`Filter`** will attach the given **`Header`** and its **value** to every **`Result`** in the **`Controller`**

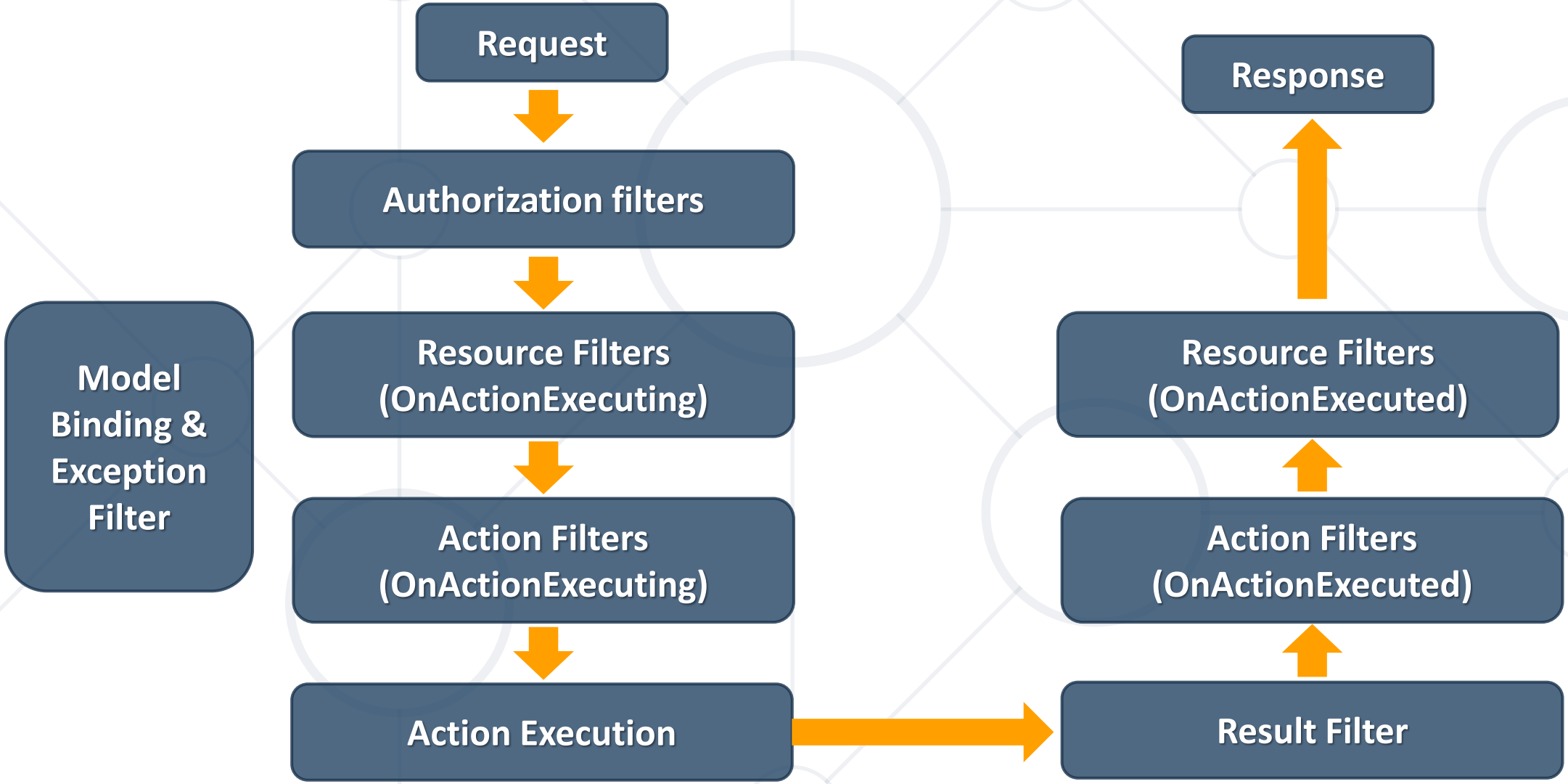
```
[AddHeader("Author", "Steve Smith @ardalis")]
public class SampleController : Controller
{
    public IActionResult Index()
    {
        return Content("Examine the headers using developer tools.");
    }

    public IActionResult Test()
    {
        return Content("Header will be present here too.");
    }
}
```

Filter Attributes (3)

- Several of the **Filter** interfaces have corresponding **Attributes**
  - These can be used as **base classes** for custom implementation
- Filter Attributes
  - `ActionFilterAttribute`
  - `ExceptionFilterAttribute`
  - `ResultFilterAttribute`
  - `FormatFilterAttribute`
  - `ServiceFilterAttribute`
  - `TypeFilterAttribute`



Life cycle


Request
Authorization filters
Resource Filters (OnActionExecuting)
Action Filters (OnActionExecuting)
Action Execution
Model Binding & Exception Filter
Result Filter
Action Filters (OnActionExecuted)
Resource Filters (OnActionExecuted)
Response

Filter Dependency Injection (1)

- **Filters** that are implemented as **Attributes**
  - Are added directly to **Controller** classes or **Action** methods
  - Cannot have **constructor dependencies** provided by **DI**
  - **Parameters** must be supplied where the **attributes** are applied
  - This is a limitation of how filters **attributes** work
- There are several approaches to include **DI** in **Filter Attributes**
  - **`ServiceFilterAttribute`**
  - **`TypeFilterAttribute`**

Filter Dependency Injection (2)

- Service filter implementation types are registered in **DI**
  - **`ServiceFilterAttribute`** retrieves an instance of the filter from **DI**
  - Used only for **Filters** that are registered as **Services**
- **`TypeFilterAttribute`** is similar to **`ServiceFilterAttribute`**
  - The type is not resolved directly from the DI container
  - Type is instantiated using **`ObjectFactory`**
- There are ways to control the **reusability** of the instances
  - There is no guarantee that a **single instance** will be created

Type Filter

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New instance created every time

Service Filter Executes

```
[TypeFilter(typeof(FeatureAuthFilter))]
public IActionResult Index(
{
     return View();
}
```

```
FeatureAuthFilter : IAuthorizationFilter
{
    IFeatureService featureAuth;

    public FeatureAuthFilter(IFeatureService service)
    {
       this.featureAuth = service;
    }
}
```

Instance managed by Dependency Resolver

Service Filter

```
builder.Services.AddSingleton<IFeatureService, FeatureService>();
builder.Services.AddSingleton<FeatureFilter>();
```

Instance managed by Dependency Resolver

Service Filter Executes

```
[TypeFilter(typeof(FeatureAuthFilter))]
public IActionResult Index(
{
     return View();
}
```

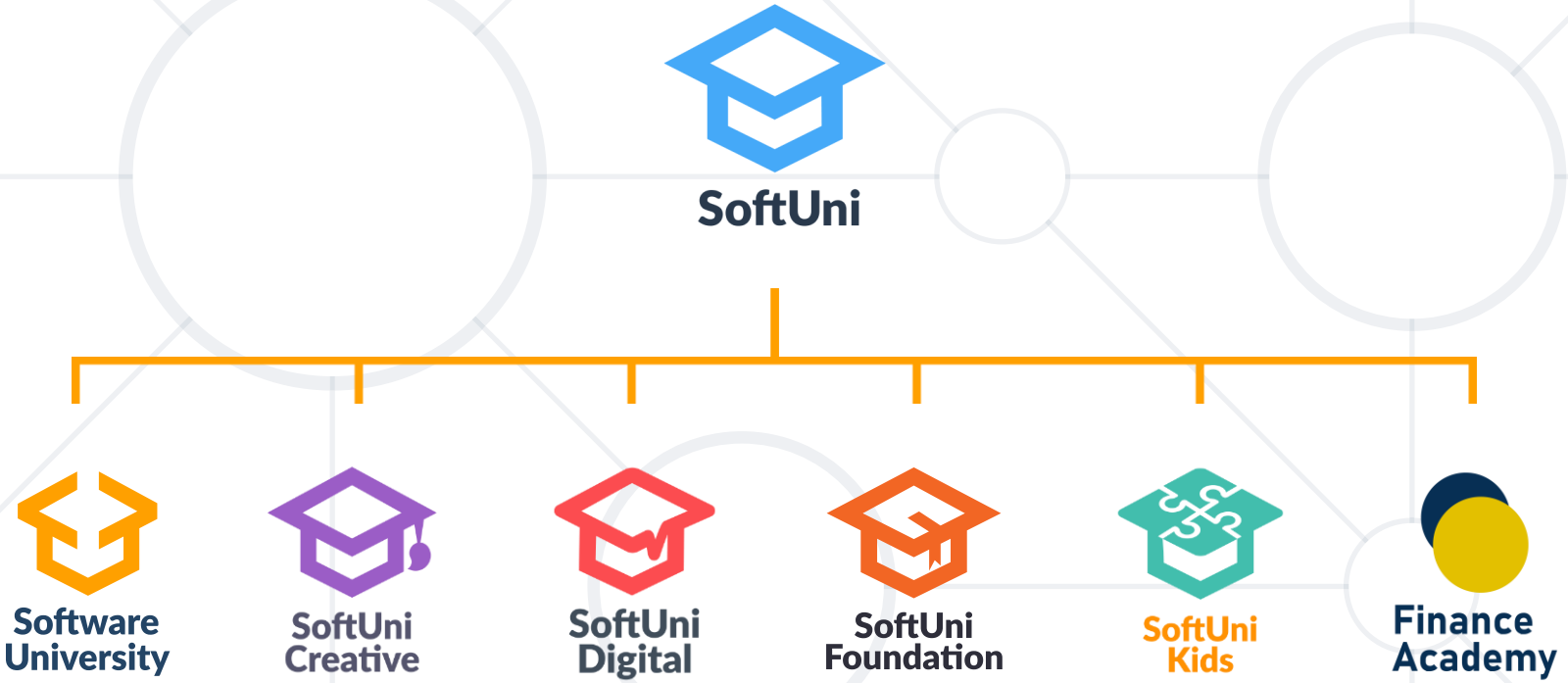
```
FeatureAuthFilter : IAuthorizationFilter
{
    IFeatureService featureAuth;

    public FeatureAuthFilter(IFeatureService service)
    {
       this.featureAuth = service;
    }
}
```

Instance managed by Dependency Resolver

Summary

- Application **Flow**
  - Application Environments
  - Request Lifecycle
  - Error Handling
- **Middleware** == software, assembled into an app pipeline
- **Filters** == allow to run code before or after specific stages in the Request Processing Pipeline

Questions?



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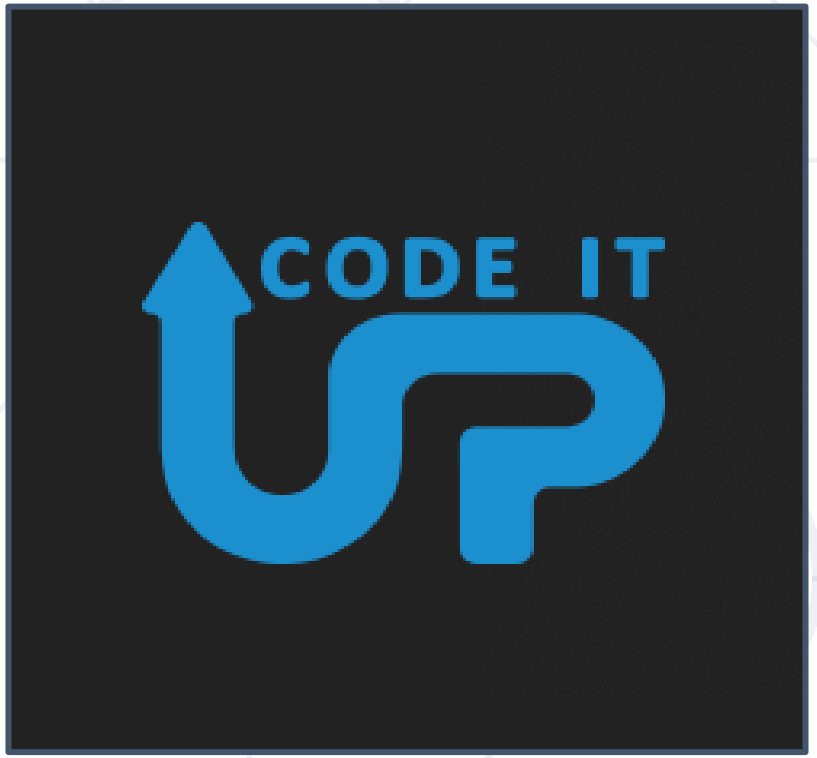

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