ASP.NET Core Databases

Working with Entity Framework Core

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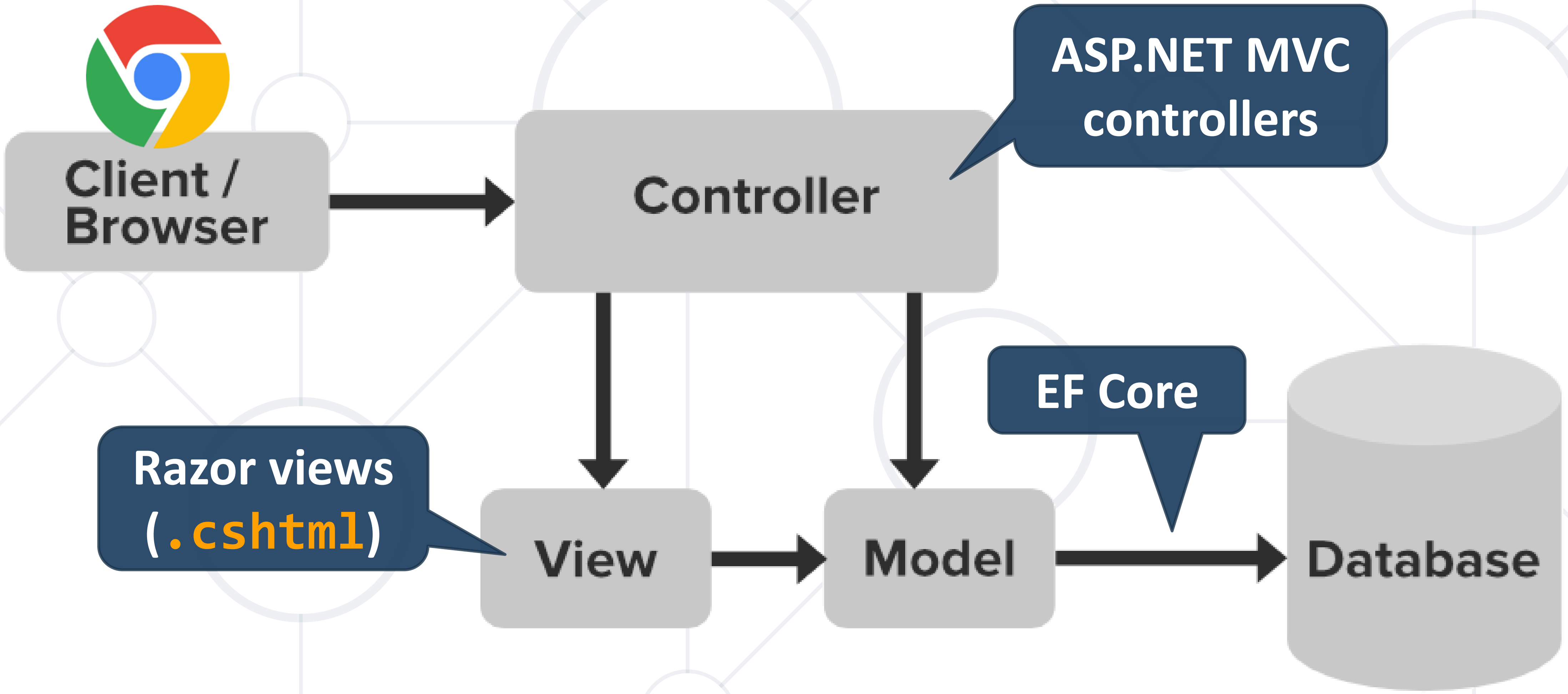
Code First Approach

Entity Framework Core

Entity Framework Core: Overview

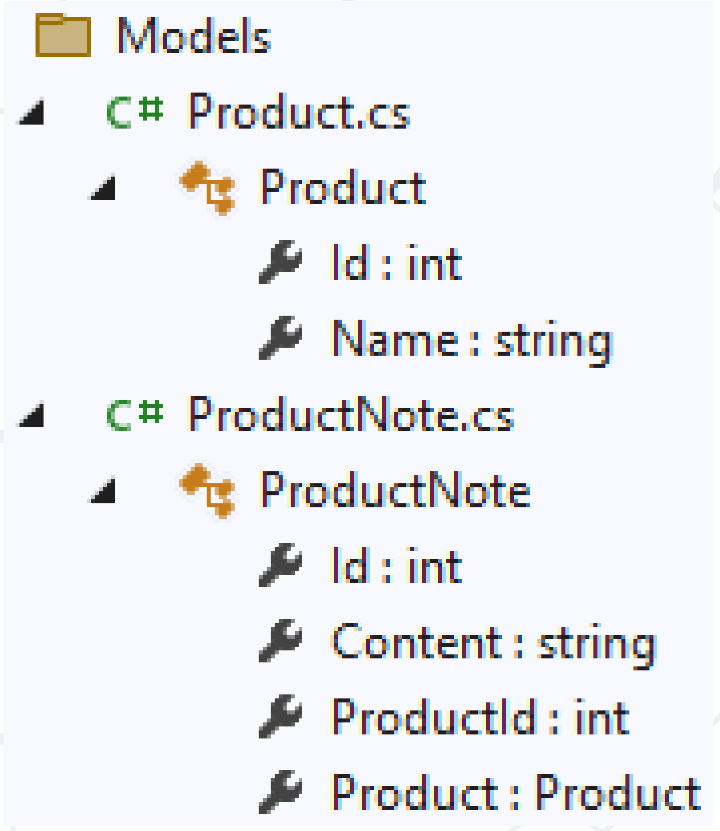
- The standard **ORM framework** for **.NET**
- Provides LINQ-based data queries and **CRUD** operations
- Automatic **change tracking** of in-memory objects
- Works with many relational databases (with different providers)
- Open source with independent release cycle

ASP.NET Core MVC + Entity Framework

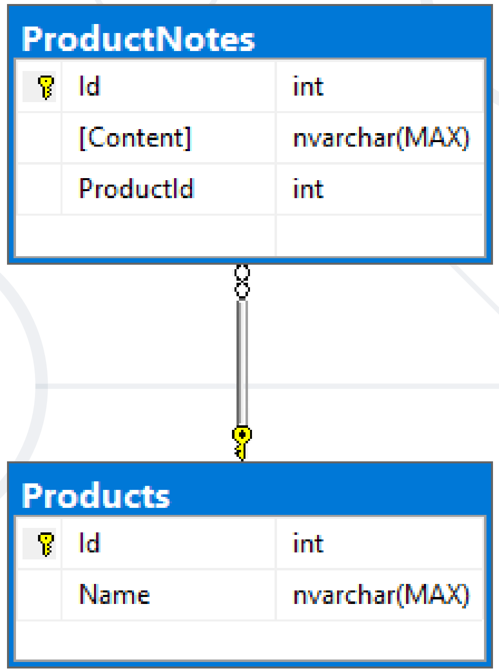


What is the Code First Approach?

- **Code First** means to write the .NET classes and let EF Core create the **database** from the **mappings**



```
Models
◢ C# Product.cs
   ◢ Product
        Id : int
        Name : string
◢ C# ProductNote.cs
   ◢ ProductNote
        Id : int
        Content : string
        ProductId : int
        Product : Product
```



ProductNotes

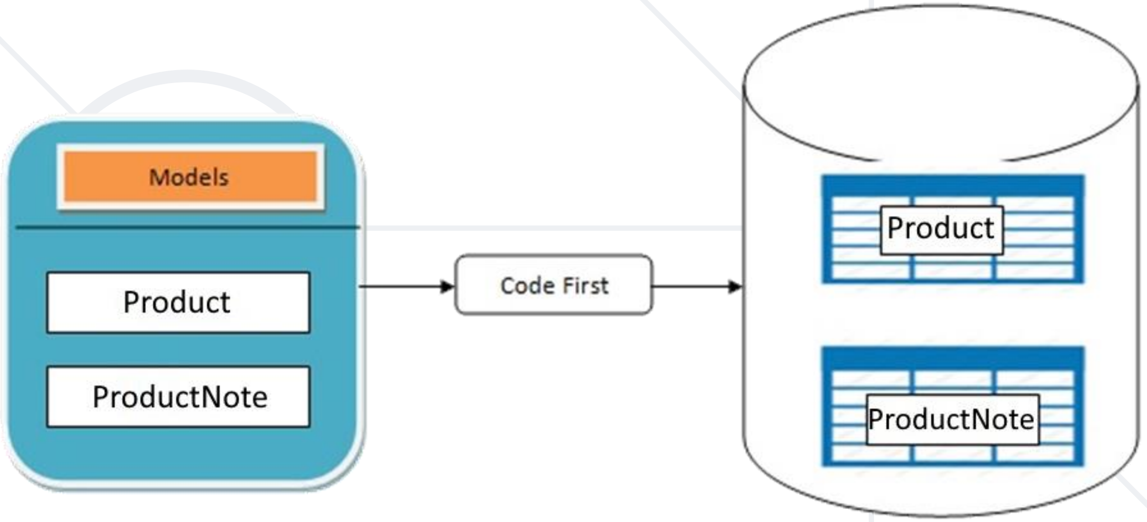
🔑	Id	int
	[Content]	nvarchar(MAX)
	ProductId	int

Products

🔑	Id	int
	Name	nvarchar(MAX)

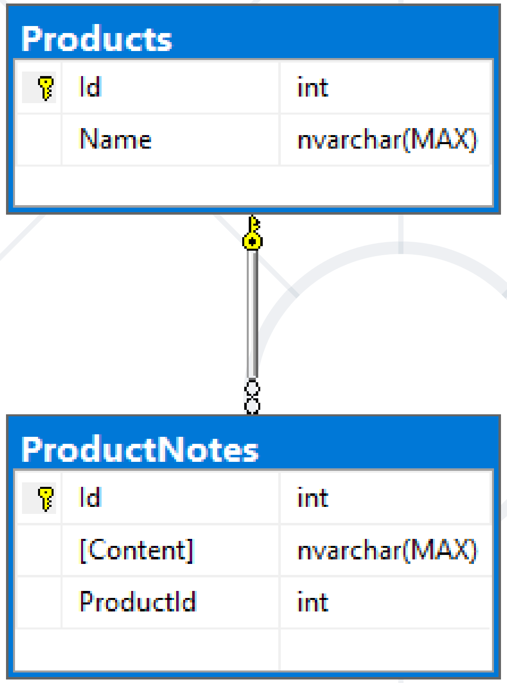
Why Use Code First?

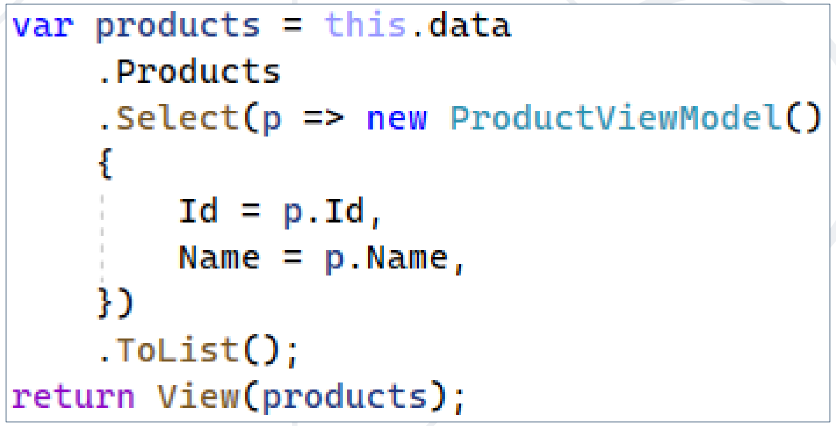
- Write code **without** having to define **mappings** in XML or **create** database **tables**
- Define objects in **C# format**
- Enables database persistence with no configuration
- Changes to code can be **reflected** (migrated) in the schema
- **Data Annotations** or **Fluent API** describe properties
  - **`Key`**, **`Required`**, **`MinLength`**, etc.



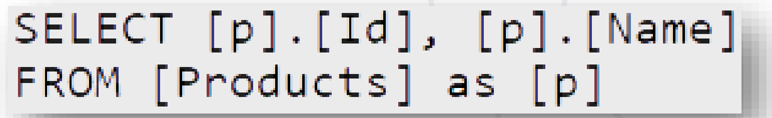
Code First Basic Workflow

1. Define the data model (**Code First** or **Scaffold from DB**)
2. Write & execute query over **`IQueryable`**
3. EF generates & executes an **SQL query** in the DB





```
var products = this.data
    .Products
    .Select(p => new ProductViewModel()
    {
        Id = p.Id,
        Name = p.Name,
    })
    .ToList();
return View(products);
```



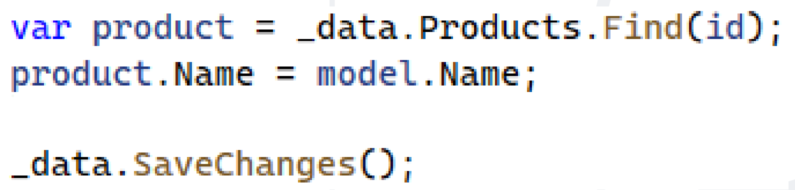
```
SELECT [p].[Id], [p].[Name]
FROM [Products] as [p]
```

Code First Basic Workflow

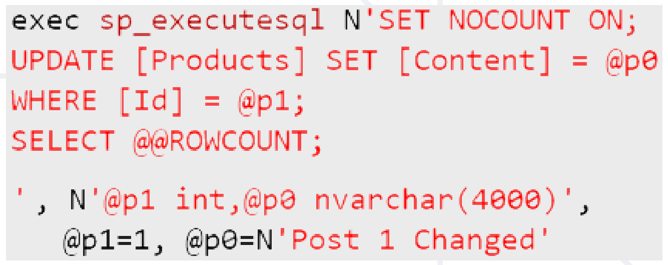
4. EF transforms the query results into .NET objects

5. Modify data with C# code and call "**Save Changes()**"

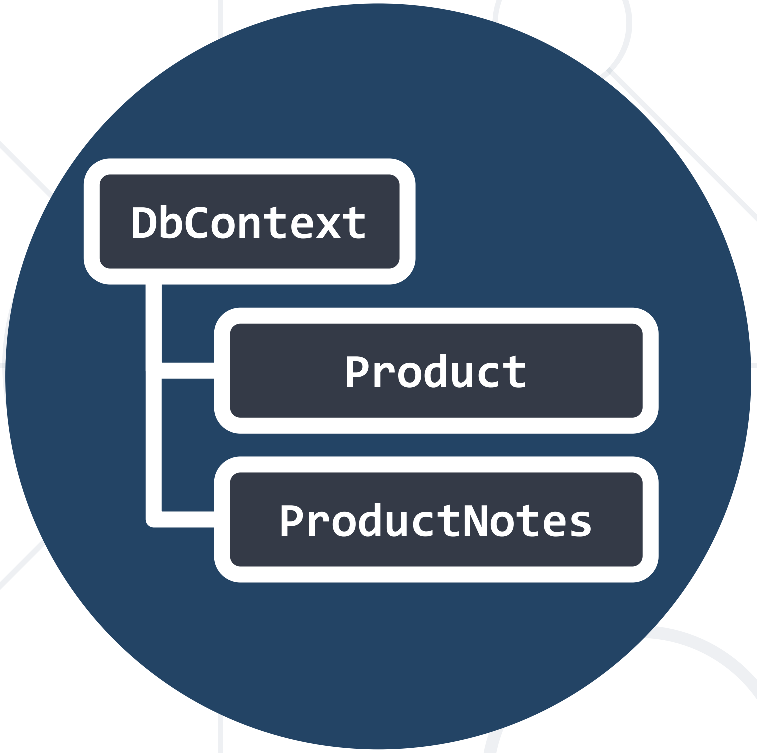
6. Entity Framework generates & executes SQL command to modify the DB



```
var product = _data.Products.Find(id);
product.Name = model.Name;

_data.SaveChanges();
```



```
exec sp_executesql N'SET NOCOUNT ON;
UPDATE [Products] SET [Content] = @p0
WHERE [Id] = @p1;
SELECT @@ROWCOUNT;

', N'@p1 int,@p0 nvarchar(4000)',
  @p1=1, @p0=N'Post 1 Changed'
```



EF Core Components

Overview of System Objects

Domain Classes (Models)

- Bunch of normal C# classes (POCO)
  - May contain **navigation properties** for **table relationships**

```
public class ProductNote
{
    public int Id { get; set; }
    public string Content { get; set; }
    public int ProductId { get; set; }
    public Product Product { get; set; }
}
```

Primary key

Foreign key

Navigation property

- Recommended to be in a **separate class library**

Domain Classes (Models)

- Another example of a domain class (model)

```
public class Product
{
  public int Id { get; set; }
  public string Name { get; set; }
  public IList<ProductNote> ProductNotes { get; set; }
            = new List<ProductNote>();
}
```

One-to-many relationship

The DbContext Class

- Usually named after the database, e.g., **ShoppingListDbContext**

```
public class ShoppingListDbContext : DbContext
```

Inherits the **DbContext** class

- Manages model classes using **DbSet<T>** type
- Easily navigate through **table relations**
- Managing database **creation**/**deletion**/**migration**
- Executing **LINQ queries** as native **SQL queries**
- **DbContext** properties
  - **Database** – **EnsureCreated**/**Deleted** methods, DB Connection
  - **ChangeTracker** – holds info about the **automatic change tracker**

Defining DbContext Class

```
using Microsoft.EntityFrameworkCore;

public class ShoppingListDbContext : DbContext
{
  public ShoppingListDbContext
      (DbContextOptions<ShoppingListDbContext> options)
           : base(options)
           => Database.EnsureCreated();

  public DbSet<Product> Products { get; set; }
  public DbSet<ProductNote> ProductNotes { get; set; }

  protected override void OnModelCreating(ModelBuilder builder)
  {
     builder.Entity<Product>()
      .HasMany(p => p.ProductNotes)
      .WithOne(r => r.Product);
  }
}
```

EF Reference

Accepts **options** through the constructor

Collections of entities

Use the Fluent API to describe our **table relations** to EF Core

EF Core Configuration

NuGet Packages, Configuration

EF Core Setup

- To add EF Core support to a project in Visual Studio
  - Install it from **Package Manager Console**

```
Install-Package Microsoft.EntityFrameworkCore
```

  - Or using **.NET Core CLI**

```
dotnet add package Microsoft.EntityFrameworkCore
```

- EF Core is modular – any **data providers** must be installed too

```
Microsoft.EntityFrameworkCore.SqlServer
```

- To use the Entity Framework Core **CLI tools**, install also

```
Microsoft.EntityFrameworkCore.Design
```

How to Connect to SQL Server?

- In ASP.NET Core **connection string** is in the **`appsettings.json`** file and has the following **properties**

```
"ConnectionStrings": {
    "DefaultConnection": "Server=(localdb)\\mssqllocaldb;
        Database=ShoppingList;Trusted_Connection=True;
        MultipleActiveResultSets=true"}
```

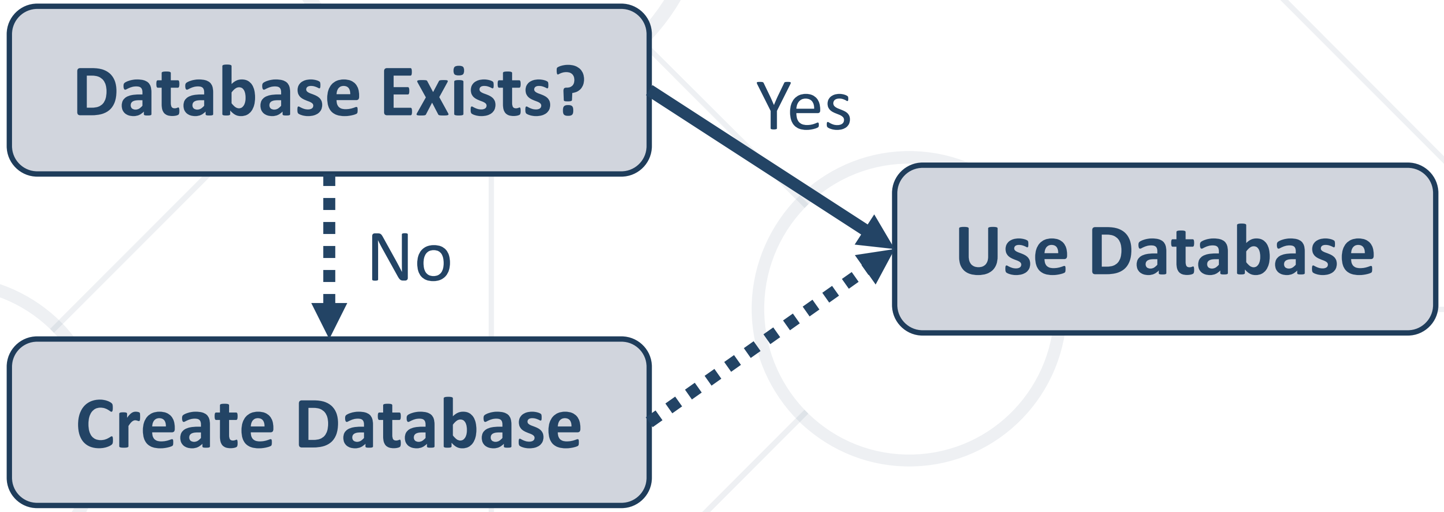
How to Connect to SQL Server?

- Use the **DbContext** and tell it to use SQL with the **connection string** in in the **Program** class

```
var connectionString = builder
     .Configuration
     .GetConnectionString("DefaultConnection");

builder
     .Services
     .AddDbContext<ShoppingListDbContext>(
          x => x.UseSqlServer(connectionString));
```

Database.EnsureCreated()

- When you create the DB context, you can call `Database.EnsureCreated()`
- This will **create the DB + schema**, when the DB is missing



- `EnsureCreated()` does not use migrations → you should drop the enrite DB when you change the DB schema

Database.EnsureCreated() – Example

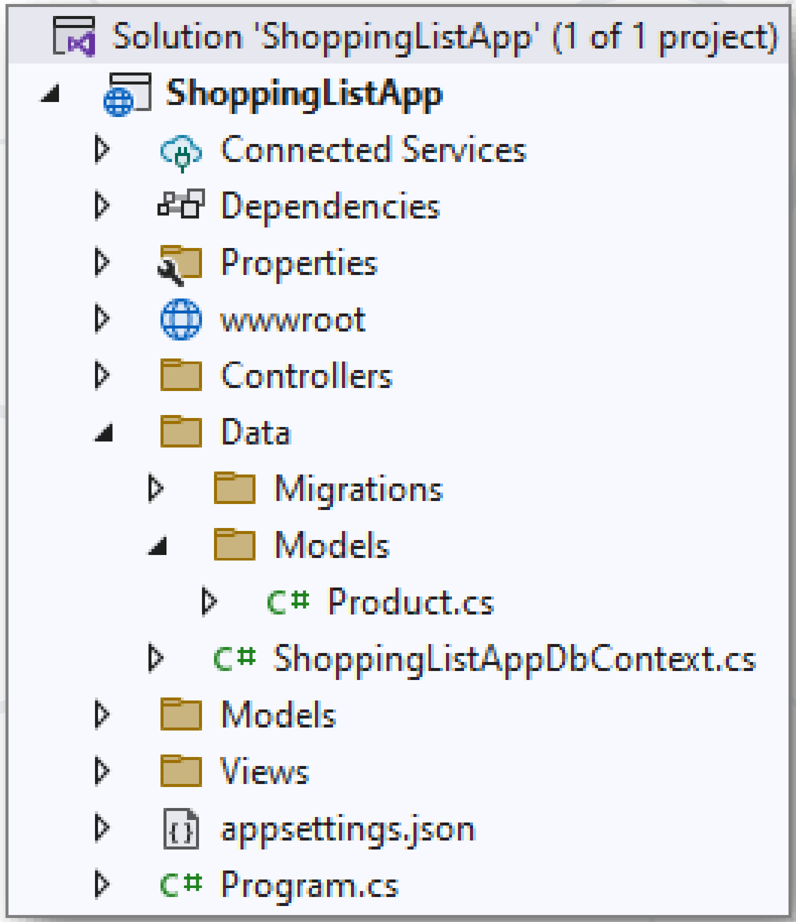
```
public class ShoppingListDbContext : DbContext
{
  public ShoppingListDbContext(
    DbContextOptions<ShoppingListDbContext> options)
    : base(options)
       => Database.EnsureCreated();
     // This will create the DB schema if the DB does not exist

     // Any change in the data entities will not change the DB

     // You should update the DB by hand
     // or drop and re-create the DB after each entity change!
  …
}
```

CRUD in ASP.NET Core MVC with EF

The "ShoppingList" App

The "ShoppingList" App

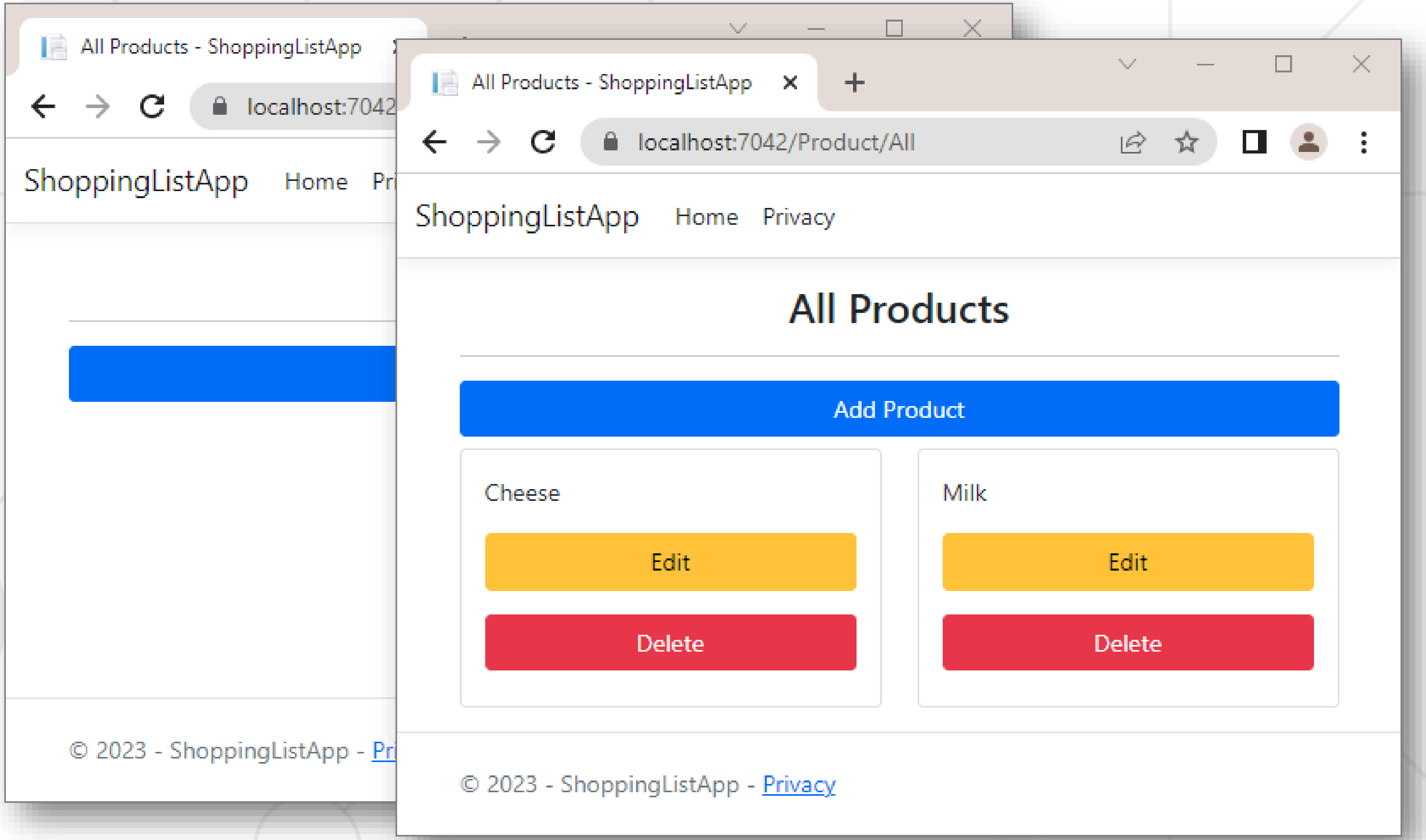
- Create an MVC app with the **models** and **db context** from the previous slides
- Perform **CRUD operations** on the database to create the following functionalities
  - Display all products
  - Add a product
  - Edit a product
  - Delete a product



```
Solution 'ShoppingListApp' (1 of 1 project)
◢ ShoppingListApp
  ▷ Connected Services
  ▷ Dependencies
  ▷ Properties
  ▷ wwwroot
  ▷ Controllers
  ◢ Data
    ▷ Migrations
    ◢ Models
      ▷ C# Product.cs
    ▷ C# ShoppingListAppDbContext.cs
  ▷ Models
  ▷ Views
  ▷ appsettings.json
  ▷ C# Program.cs
```

The "All Products" Page (Reading Data)

- It should display **all added products** with their **content** + **[Edit]** and **[Delete]** buttons + **[Add Product]** button


All Products - ShoppingListApp
localhost:7042/Product/All
ShoppingListApp
Home
Privacy
All Products
Add Product
Cheese
Edit
Delete
Milk
Edit
Delete
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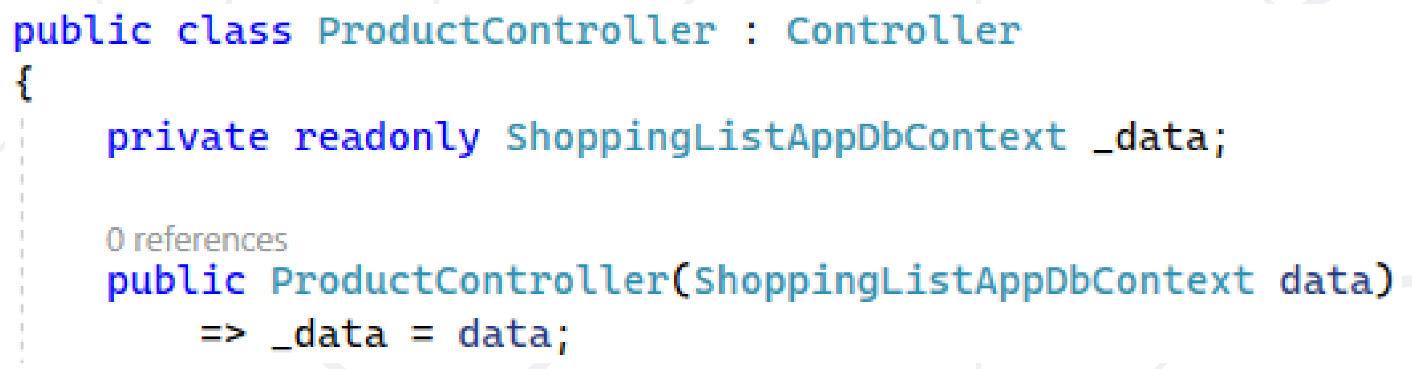
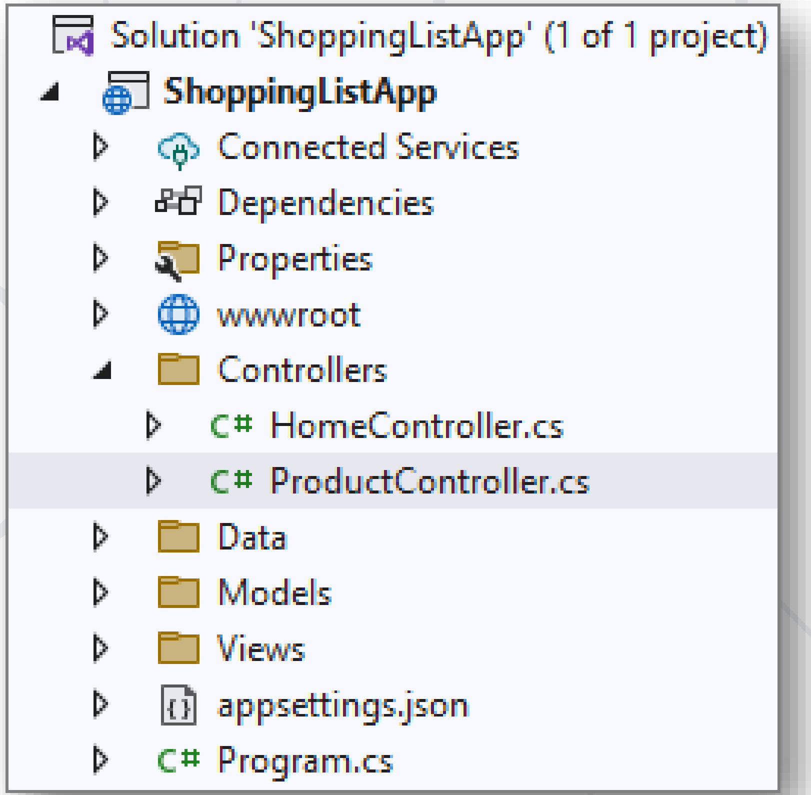
ProductController Class

- Create a new **ProductController** in the "**Controllers**" folder
- Inject the **ShoppingListAppDbContext** through the **constructor**
  - And assign it to a **variable** to use it



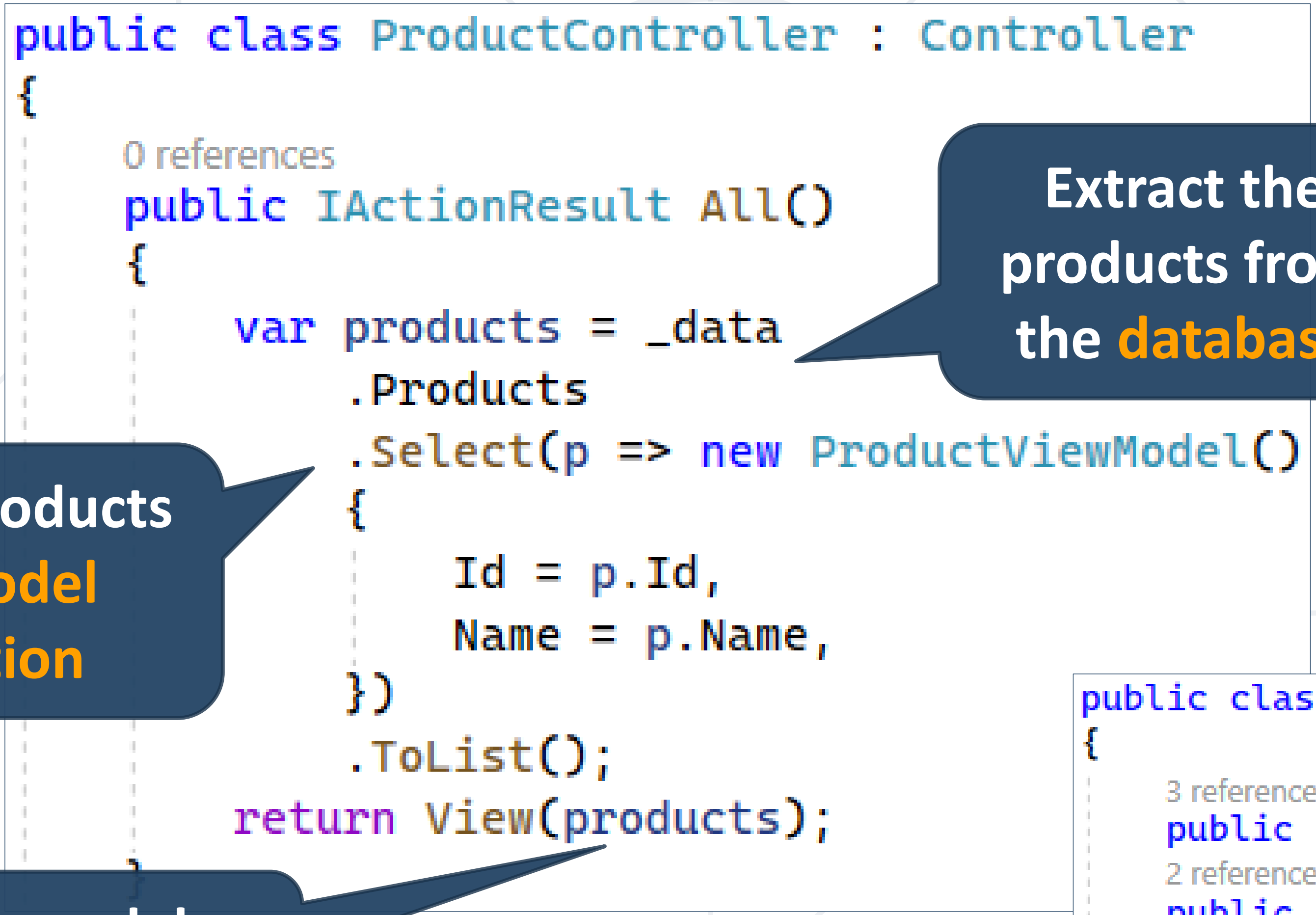
```
public class ProductController : Controller
{
    private readonly ShoppingListAppDbContext _data;

    0 references
    public ProductController(ShoppingListAppDbContext data)
        => _data = data;
```



```
Solution 'ShoppingListApp' (1 of 1 project)
◢ ShoppingListApp
    ▷ Connected Services
    ▷ Dependencies
    ▷ Properties
    ▷ wwwroot
    ◢ Controllers
        ▷ C# HomeController.cs
        ▷ C# ProductController.cs
    ▷ Data
    ▷ Models
    ▷ Views
    ▷ appsettings.json
    ▷ C# Program.cs
```

Reading Data (Controller + Model)

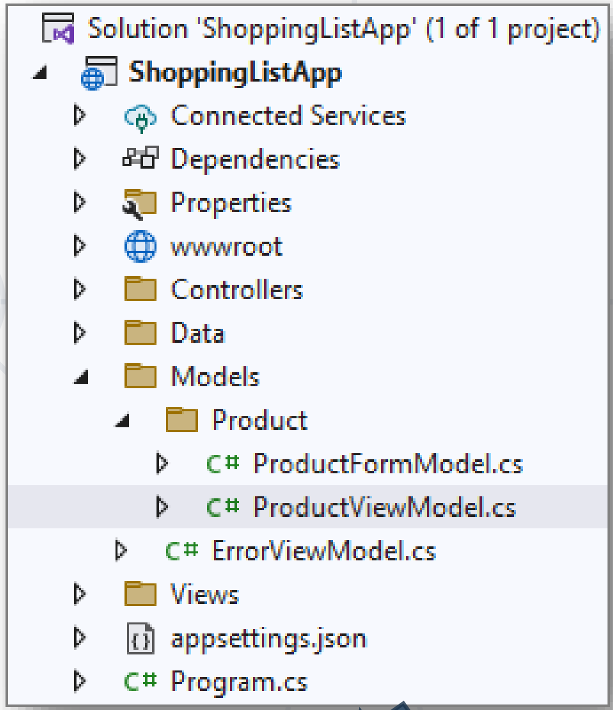


```
public class ProductController : Controller
{
    0 references
    public IActionResult All()
    {
        var products = _data
            .Products
            .Select(p => new ProductViewModel()
            {
                Id = p.Id,
                Name = p.Name,
            })
            .ToList();
        return View(products);
    }
```

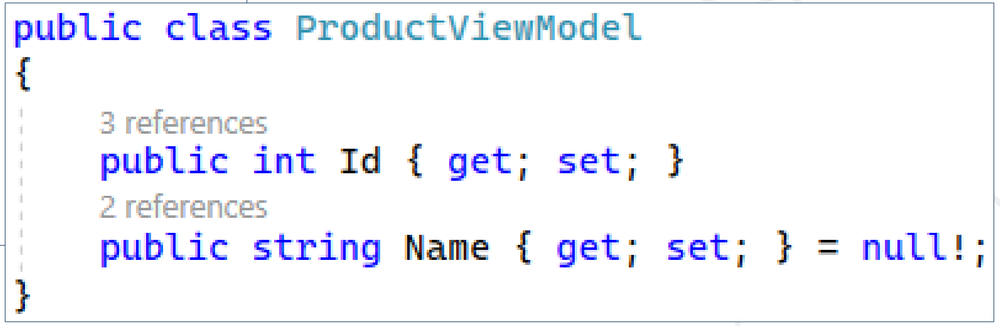
Extract the products from the database

Project products to a model collection

Passes the model collection to a view

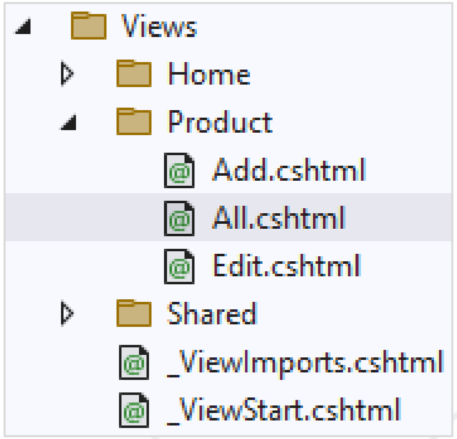


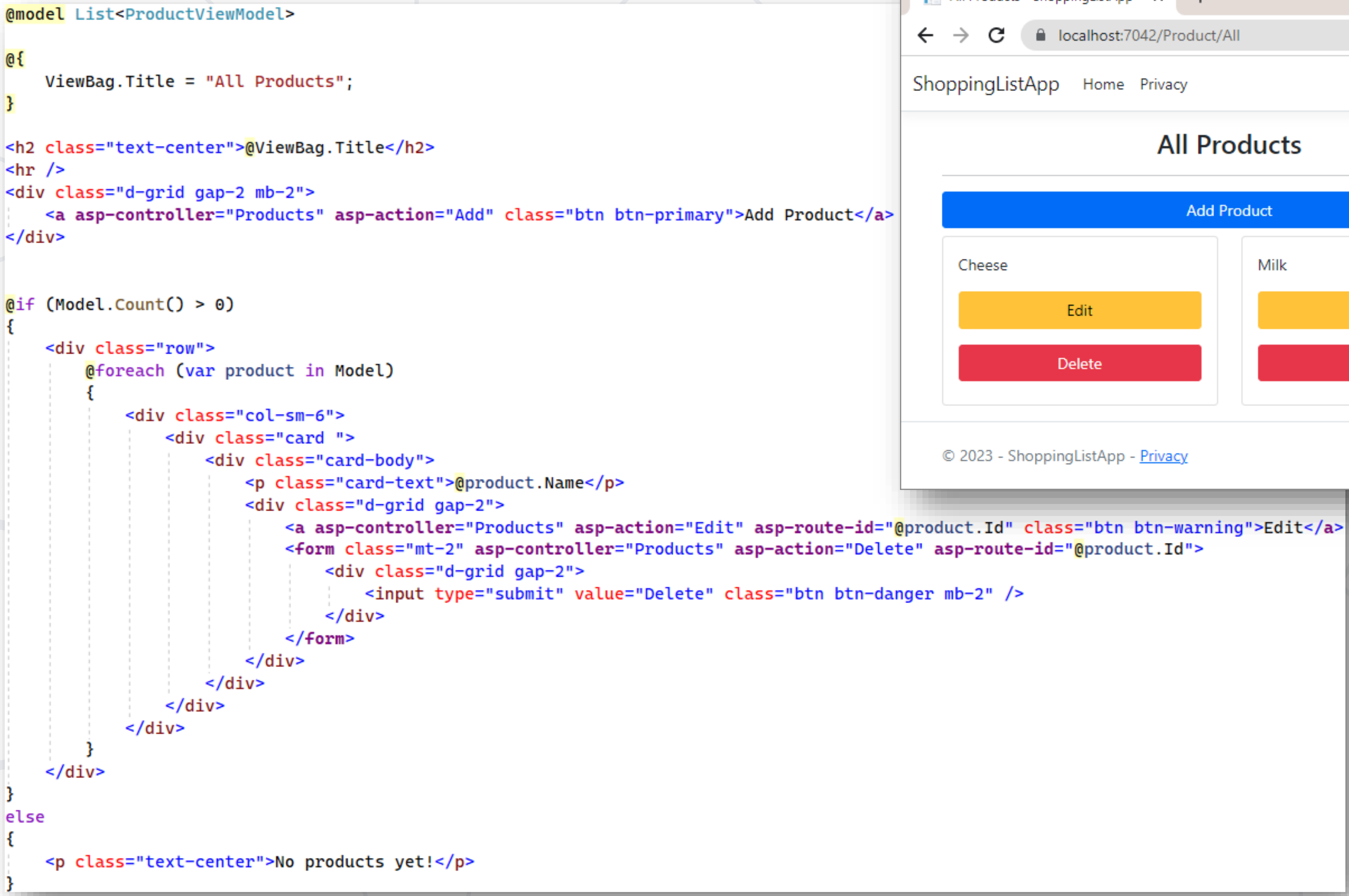
```
Solution 'ShoppingListApp' (1 of 1 project)
◢ ShoppingListApp
    ▷ Connected Services
    ▷ Dependencies
    ▷ Properties
    ▷ wwwroot
    ▷ Controllers
    ▷ Data
    ◢ Models
        ◢ Product
            ▷ C# ProductFormModel.cs
            ▷ C# ProductViewModel.cs
        ▷ C# ErrorViewModel.cs
    ▷ Views
    ▷ appsettings.json
    ▷ C# Program.cs
```



```
public class ProductViewModel
{
    3 references
    public int Id { get; set; }
    2 references
    public string Name { get; set; } = null!;
}
```

Reading Data (View)



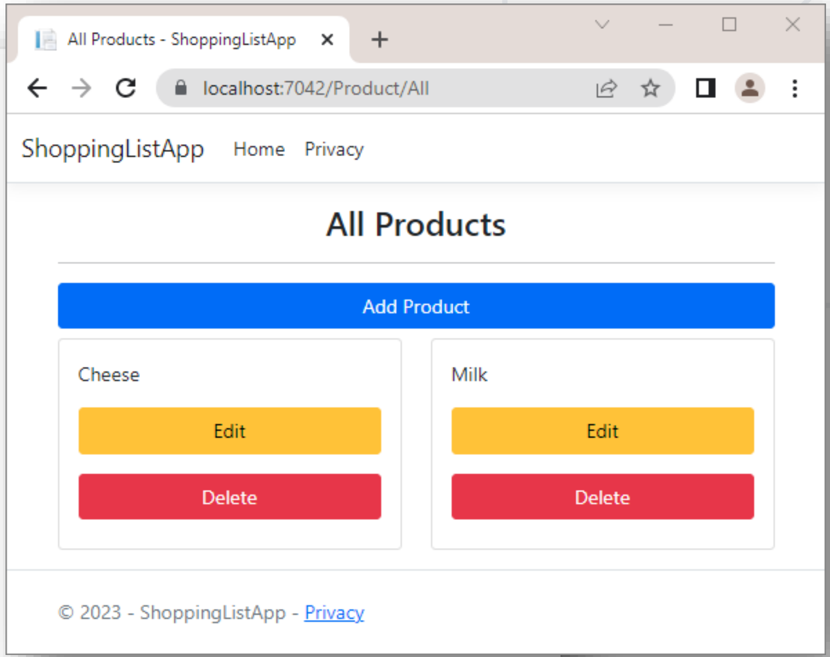


```
@model List<ProductViewModel>

@{
    ViewBag.Title = "All Products";
}

<h2 class="text-center">@ViewBag.Title</h2>
<hr />
<div class="d-grid gap-2 mb-2">
    <a asp-controller="Products" asp-action="Add" class="btn btn-primary">Add Product</a>
</div>


@if (Model.Count() > 0)
{
    <div class="row">
        @foreach (var product in Model)
        {
            <div class="col-sm-6">
                <div class="card ">
                    <div class="card-body">
                        <p class="card-text">@product.Name</p>
                        <div class="d-grid gap-2">
                            <a asp-controller="Products" asp-action="Edit" asp-route-id="@product.Id" class="btn btn-warning">Edit</a>
                            <form class="mt-2" asp-controller="Products" asp-action="Delete" asp-route-id="@product.Id">
                                <div class="d-grid gap-2">
                                    <input type="submit" value="Delete" class="btn btn-danger mb-2" />
                                </div>
                            </form>
                        </div>
                    </div>
                </div>
            </div>
        }
    </div>
}
else
{
    <p class="text-center">No products yet!</p>
}
```



All Products - ShoppingListApp
localhost:7042/Product/All
ShoppingListApp
Home
Privacy
All Products
Add Product
Cheese
Edit
Delete
Milk
Edit
Delete
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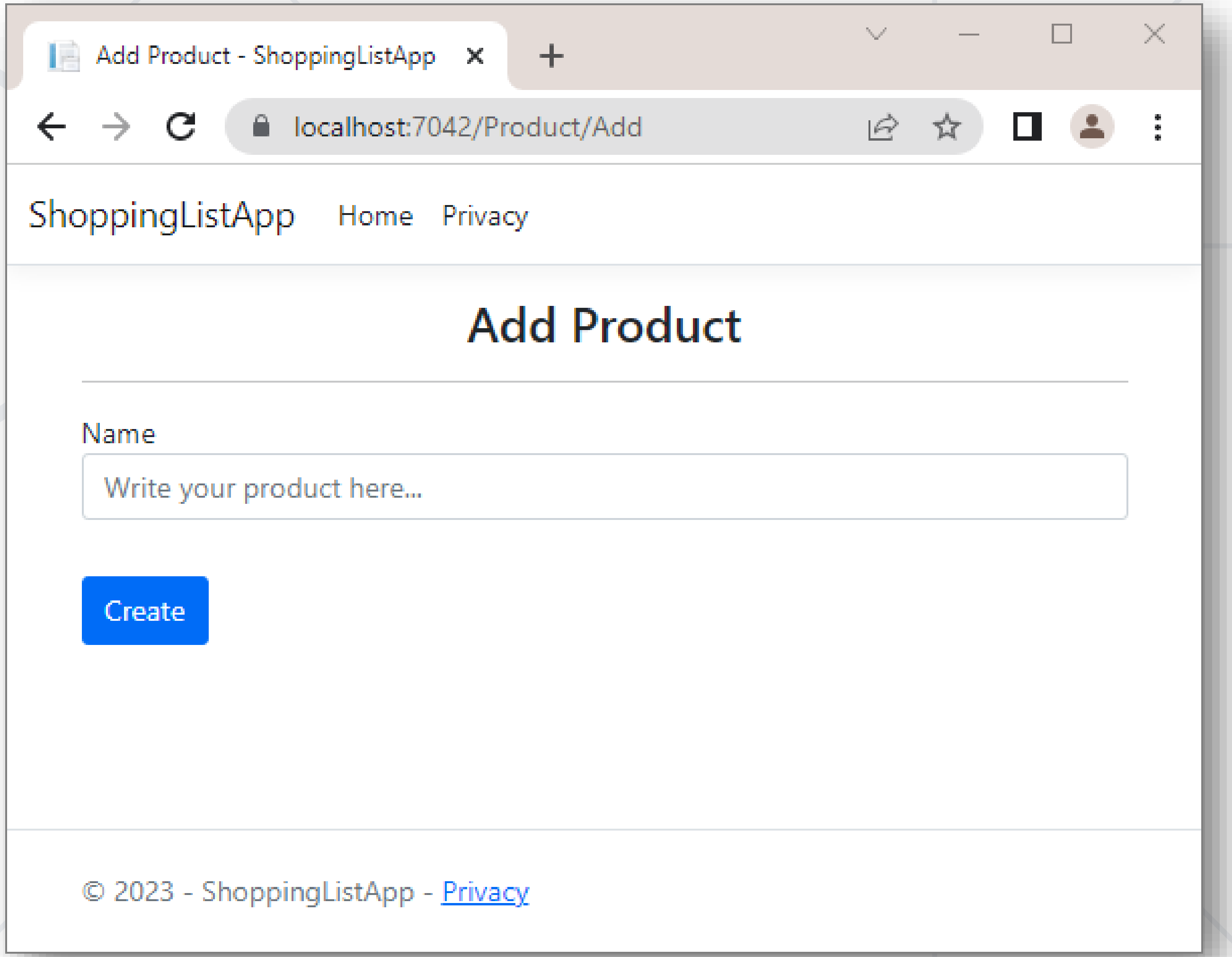
The "Add Product" Page (Creating New Data)

- It should display a **form** for **adding a product**



Add Product - ShoppingListApp

localhost:7042/Product/Add

ShoppingListApp Home Privacy

Add Product

Name

Write your product here...

Create

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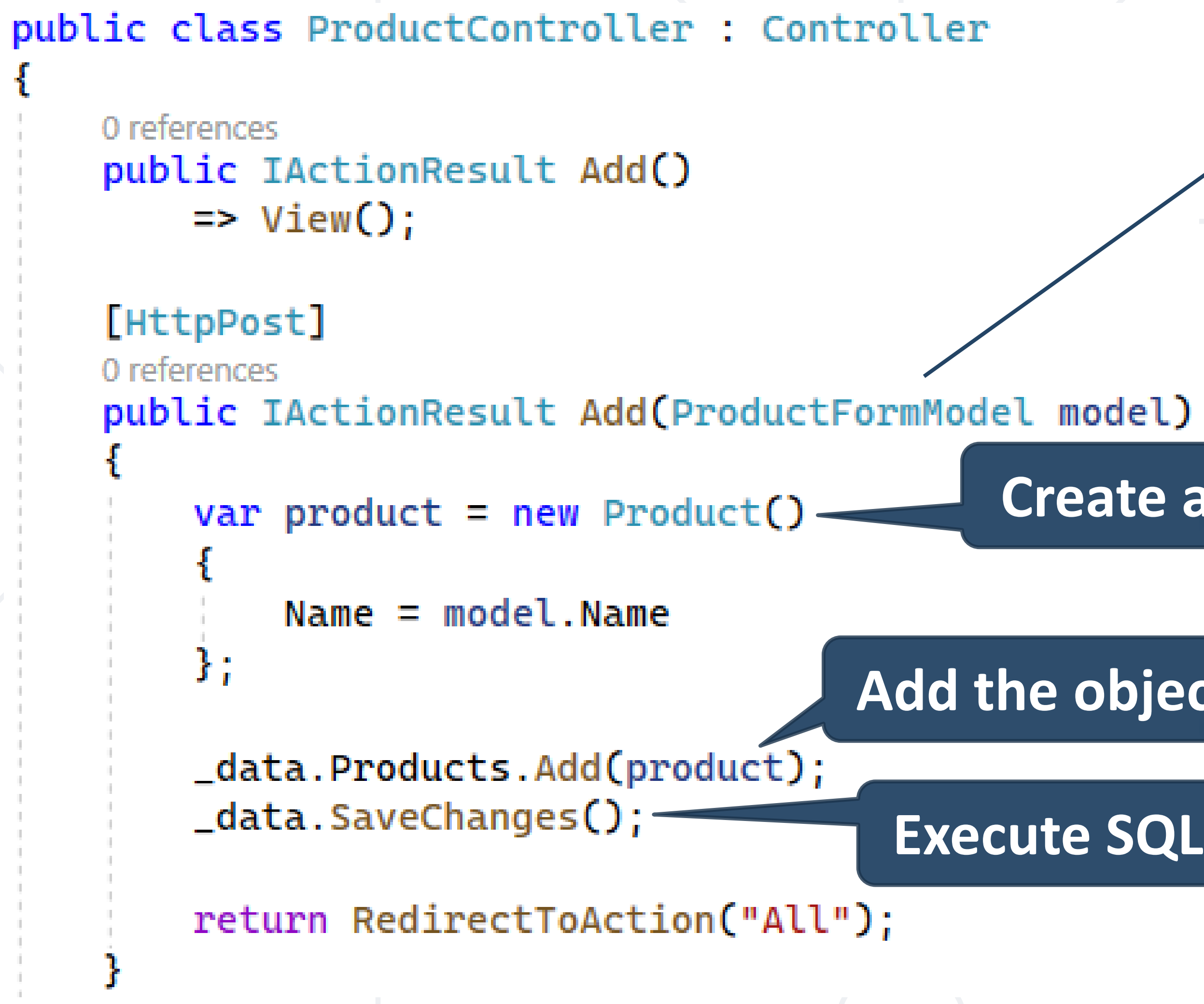
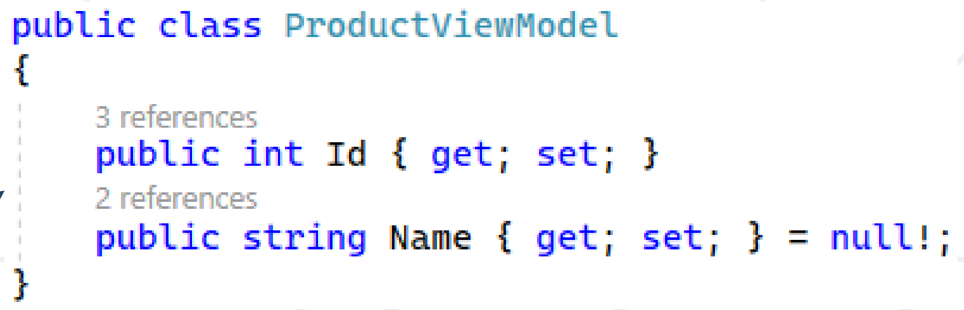
Creating New Data (Controller + Model)



```
public class ProductController : Controller
{
    0 references
    public IActionResult Add()
        => View();

    [HttpPost]
    0 references
    public IActionResult Add(ProductFormModel model)
    {
        var product = new Product()
        {
            Name = model.Name
        };

        _data.Products.Add(product);
        _data.SaveChanges();

        return RedirectToAction("All");
    }
```



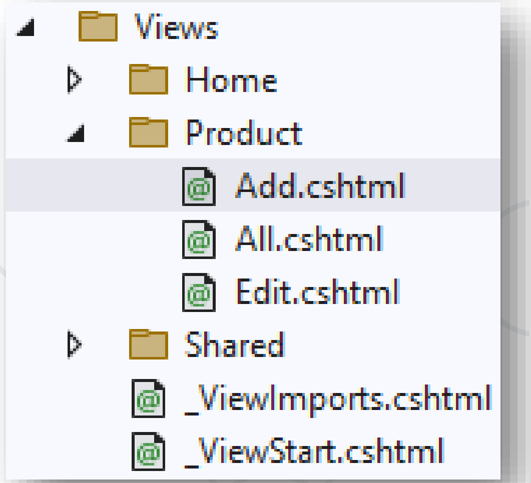
```
public class ProductViewModel
{
    3 references
    public int Id { get; set; }
    2 references
    public string Name { get; set; } = null!;
}
```

Create a new **Product** object

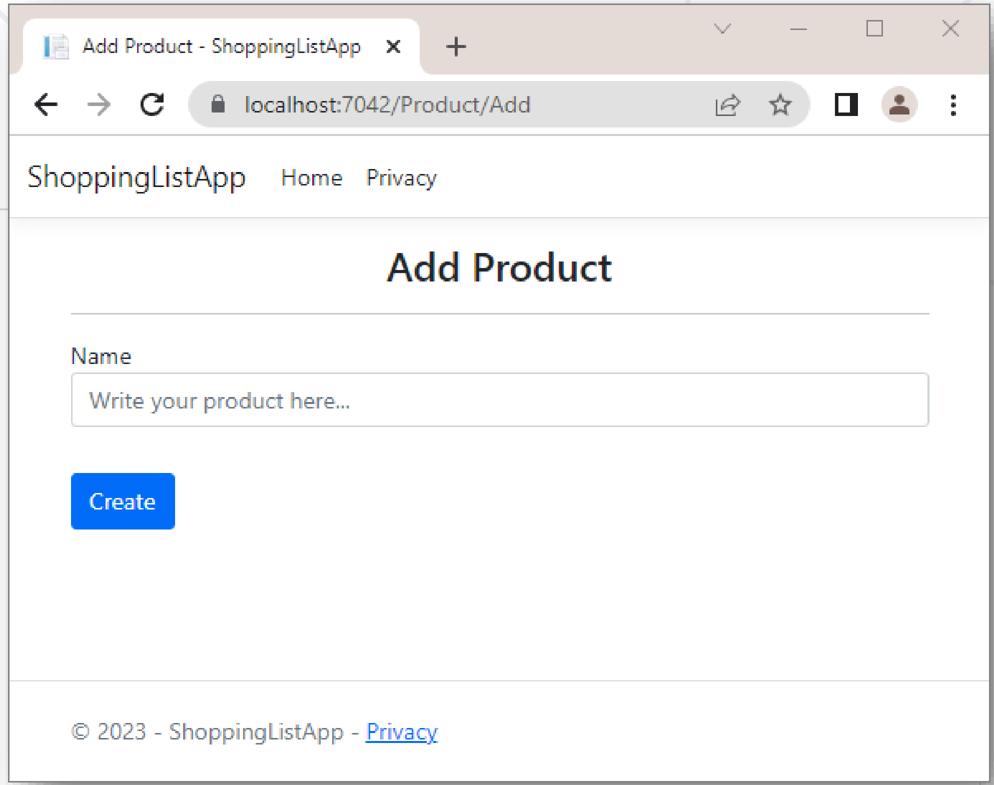
Add the object to the **DbSet**

Execute SQL statements

Creating New Data (View)

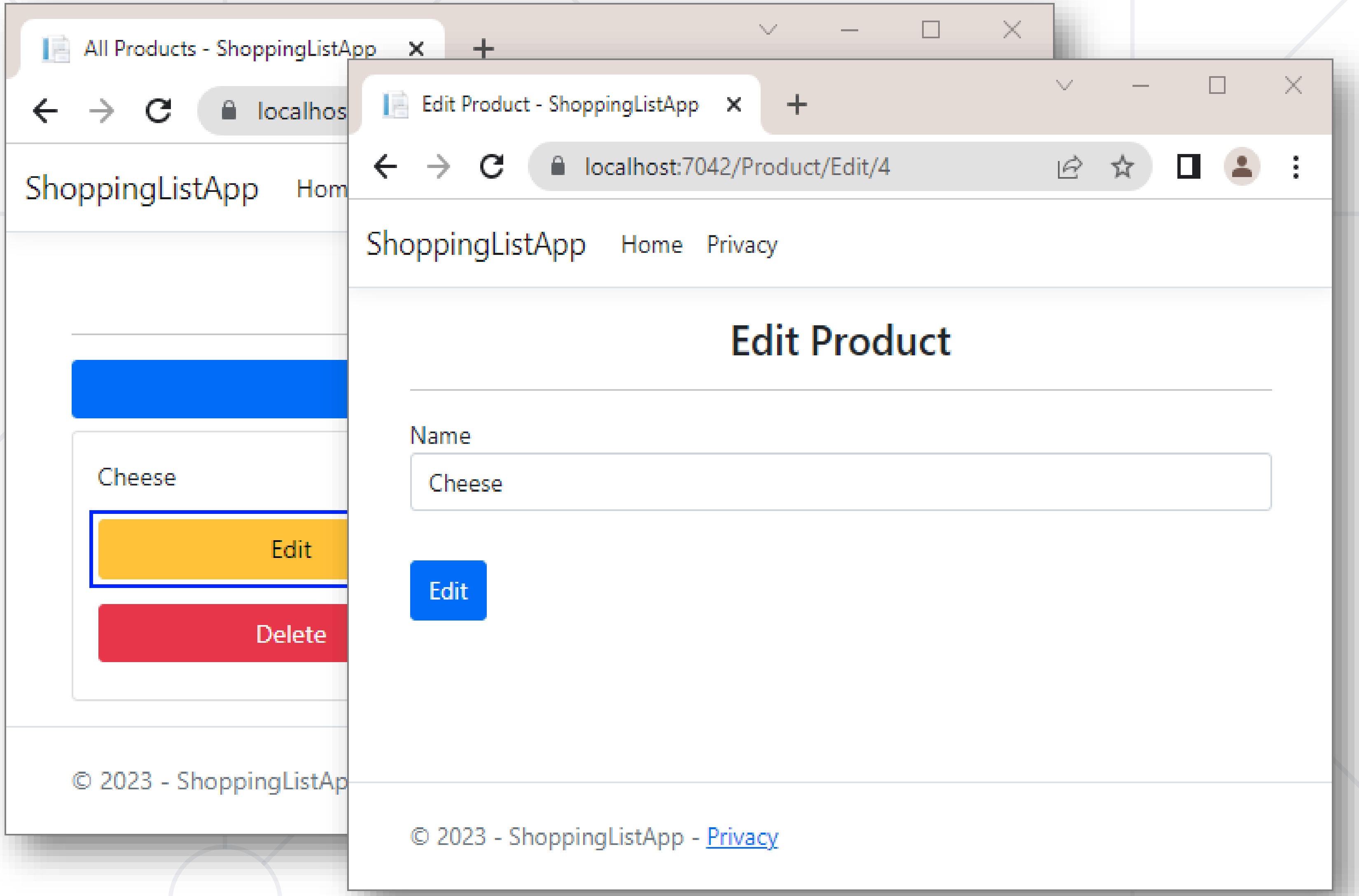


```
@model ProductFormModel

@{
    ViewBag.Title = "Add Product";
}

<h2 class="text-center">@ViewBag.Title</h2>
<hr />

<div class="row">
    <form method="post">
        <div class="form-group">
            <div class="mb-3">
                <label asp-for="Name"></label>
                <input asp-for="Name" class="form-control" placeholder="Write your product here...">
                <span asp-validation-for="Name" class="small text-danger"></span>
            </div>
        </div>
        <input class="btn btn-primary mt-3" type="submit" value="Create" />
    </form>
</div>
```


Add Product - ShoppingListApp
localhost:7042/Product/Add
ShoppingListApp
Home
Privacy
Add Product
Name
Write your product here...
Create
© 2023 - ShoppingListApp - Privacy

The "Edit Product" Page (Updating Existing Data)

- To **edit a product**, click on its **[Edit]** button
- It should display a **form for editing a product** with the product data in the fields



Edit Product

Name

Cheese

Edit

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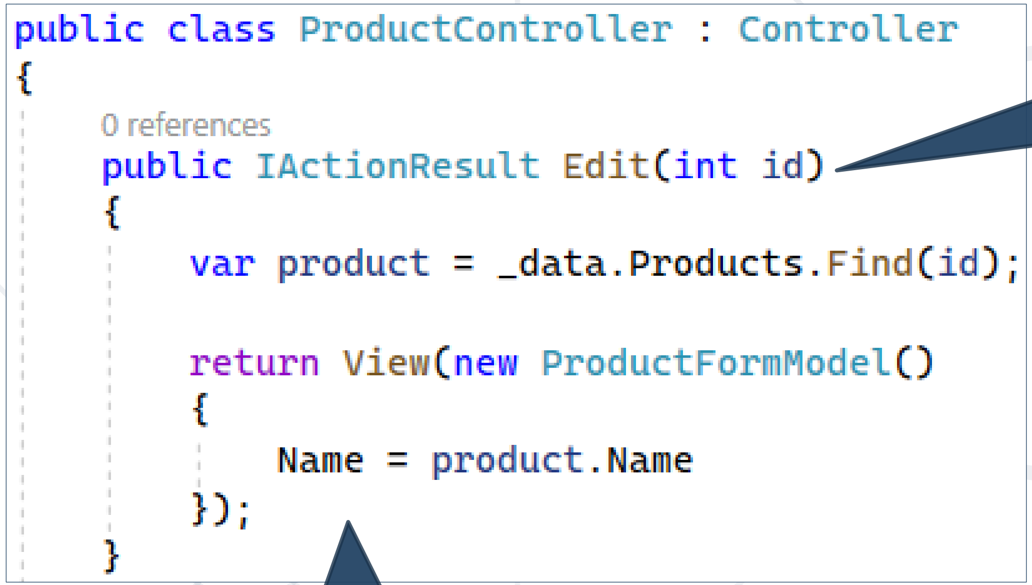
Updating Existing Data (Controller)



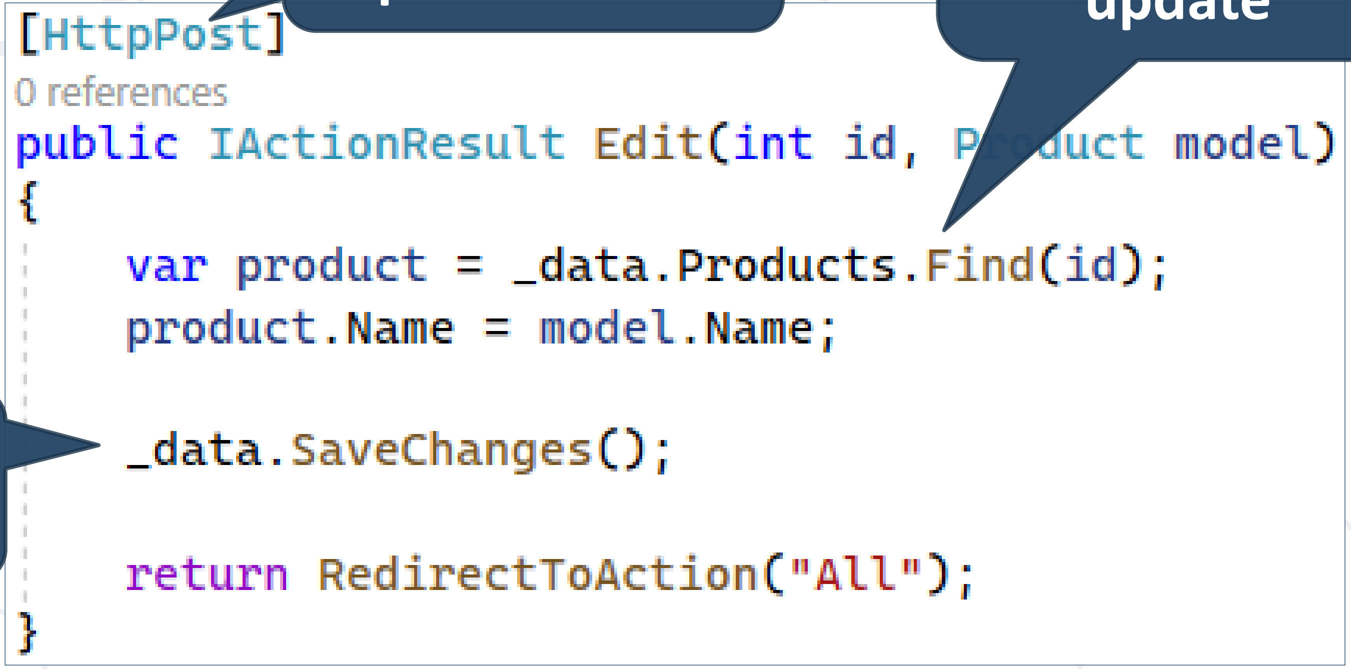
```
public class ProductController : Controller
{
    0 references
    public IActionResult Edit(int id)
    {
        var product = _data.Products.Find(id);

        return View(new ProductFormModel()
        {
            Name = product.Name
        });
    }
```

HTTP **GET** → display the edit form

Pass a product **model** to a **view**

HTTP **POST** → update the DB

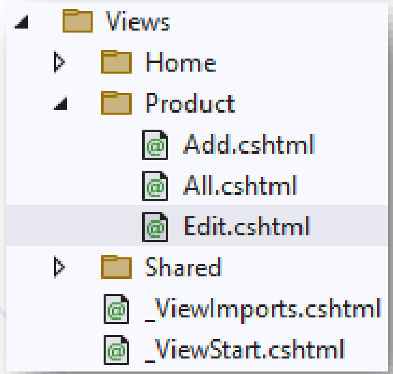
SELECT the product for update



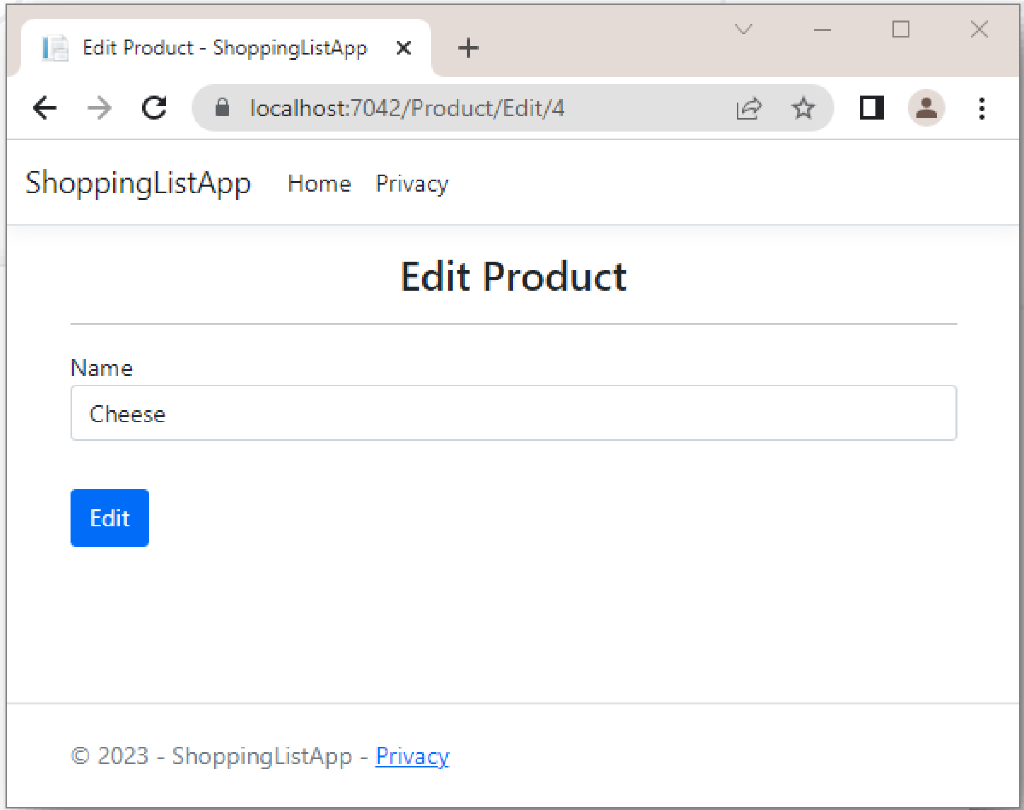
```
[HttpPost]
0 references
public IActionResult Edit(int id, Product model)
{
    var product = _data.Products.Find(id);
    product.Name = model.Name;

    _data.SaveChanges();

    return RedirectToAction("All");
}
```

Execute an **SQL UPDATE**

Updating Existing Data (View)



```
@model ProductFormModel

@{
    ViewBag.Title = "Edit Product";
}

<h2 class="text-center">@ViewBag.Title</h2>
<hr />

<div class="row">
    <form method="post">
        <div class="form-group">
            <div class="mb-3">
                <label asp-for="Name"></label>
                <input asp-for="Name" class="form-control" placeholder="Write your product here...">
                <span asp-validation-for="Name" class="small text-danger"></span>
            </div>
        </div>
        <input class="btn btn-primary mt-3" type="submit" value="Edit" />
    </form>
</div>
```


Edit Product - ShoppingListApp
localhost:7042/Product/Edit/4
ShoppingListApp
Home
Privacy
Edit Product
Name
Cheese
Edit
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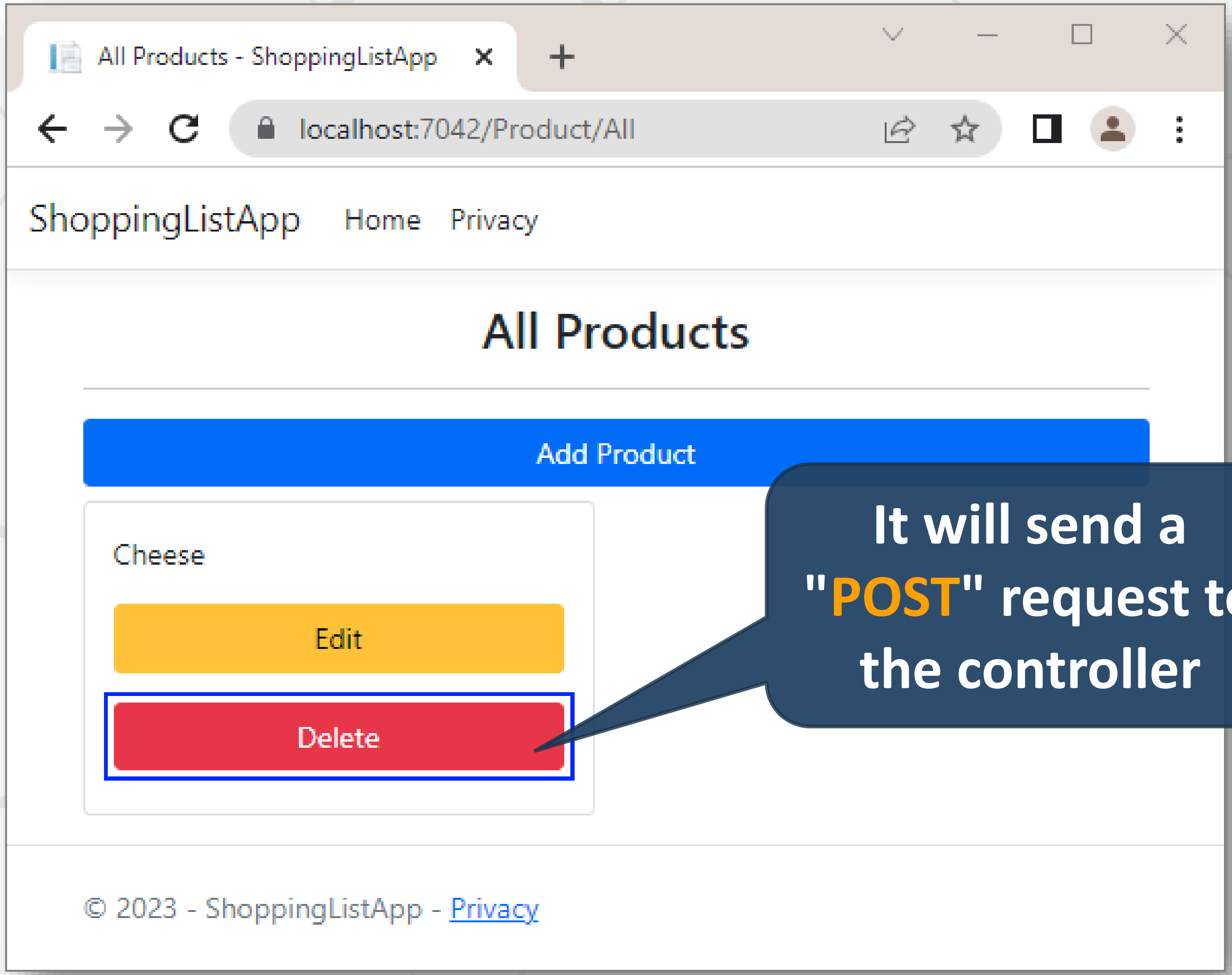
Deleting Existing Data

- To **delete a product**, press its **[Delete]** button


All Products - ShoppingListApp
localhost:7042/Product/All
ShoppingListApp
Home
Privacy
All Products
Add Product
Cheese
Edit
Delete
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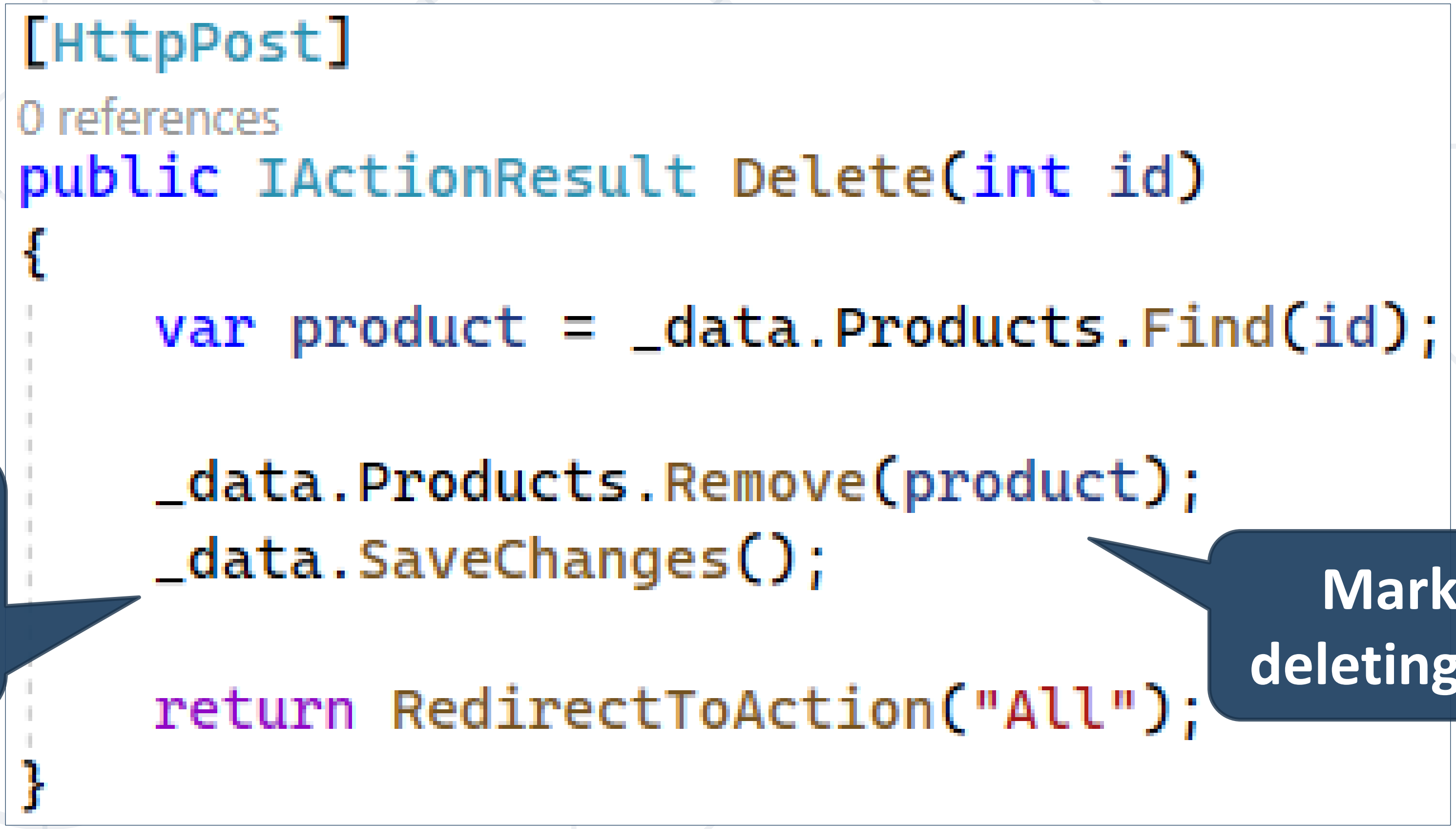
It will send a "**POST**" request to the controller

Deleting Existing Data (Controller)



```
[HttpPost]
0 references
public IActionResult Delete(int id)
{
    var product = _data.Products.Find(id);

    _data.Products.Remove(product);
    _data.SaveChanges();

    return RedirectToAction("All");
}
```

Execute the SQL **DELETE** command

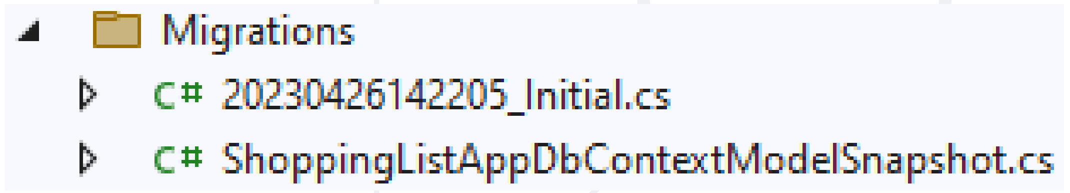
Mark the entity for deleting at the next save

Database Migrations

Scripts for Modifying Table Structure in the DB

What Are Database Migrations?

- Updating database schema **without losing data**
  - Adding/dropping tables, columns, etc.
- **Migrations** in EF Core keep their **history**
  - Entity Classes, DB Context versions are all **preserved**
- **Automatically** generated by certain EF tools



```
◢ Migrations
  ▷ C# 20230426142205_Initial.cs
  ▷ C# ShoppingListAppDbContextModelSnapshot.cs
```

Migrations in EF Core

- To **add a migration** in EF Core
  - Use the **EF CLI Tools** `dotnet ef migrations add {MigrationName}`
  - Use the **Package Manager Console** `Add-Migration {MigrationName}`
- To **undo a migration**, use one of the two ways

```
dotnet ef migrations remove {MigrationName}
```

```
Remove-Migration
```

Removes the last migration

- **Commit changes** to the database

```
dotnet ef database update
```

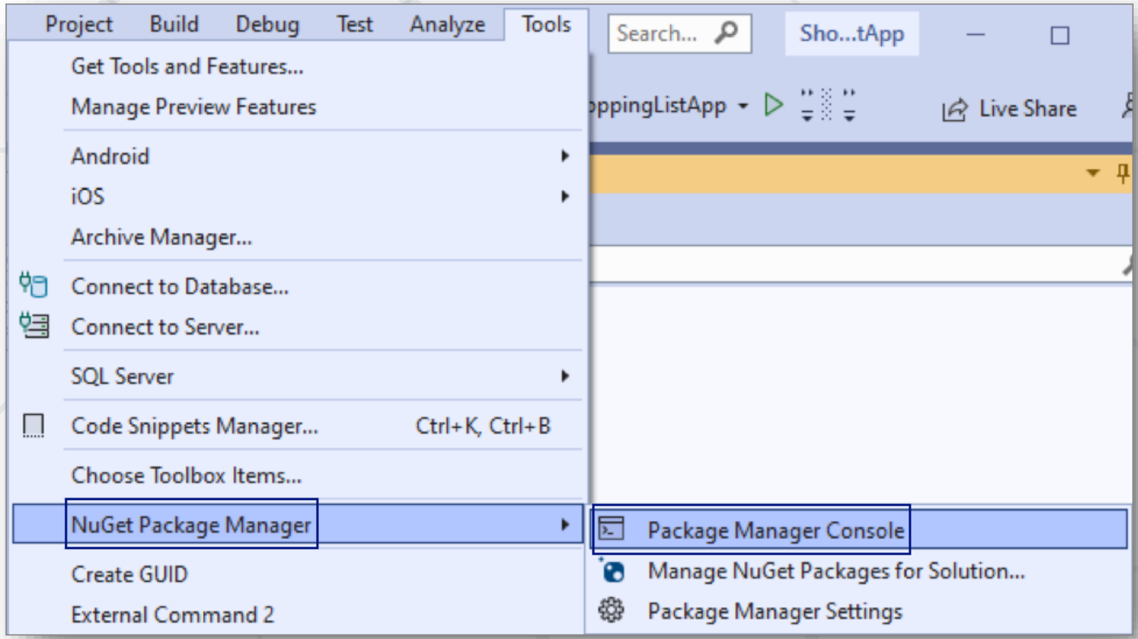
```
Update-Database
```

```
db.Database.Migrate(); // Auto migrate at start
```

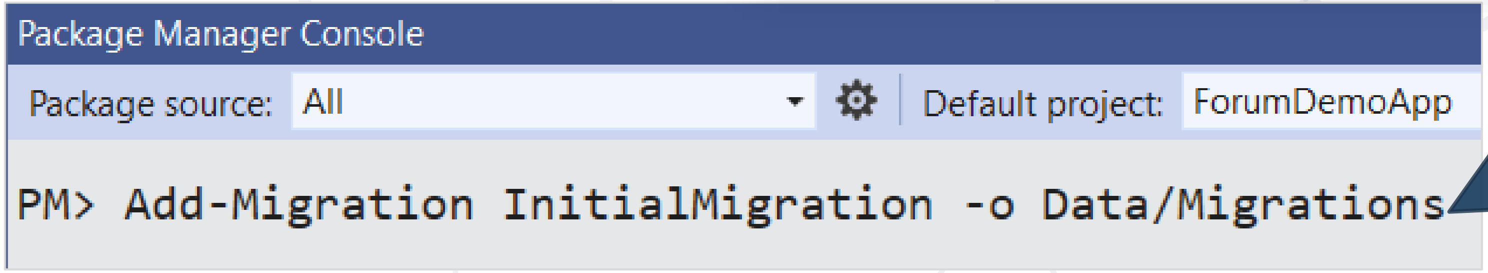
Migrates any DB changes on startup

Migrate the "ShoppingListDemo" App

- Install the `Microsoft.EntityFrameworkCore.Tools` package
- Open the **Package Manager Console**



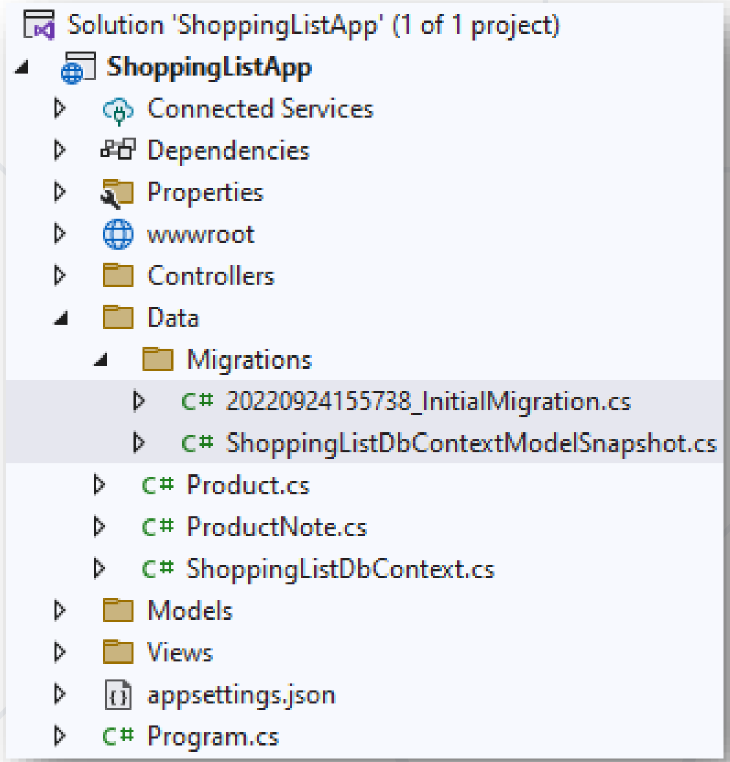
- Create a **migration**



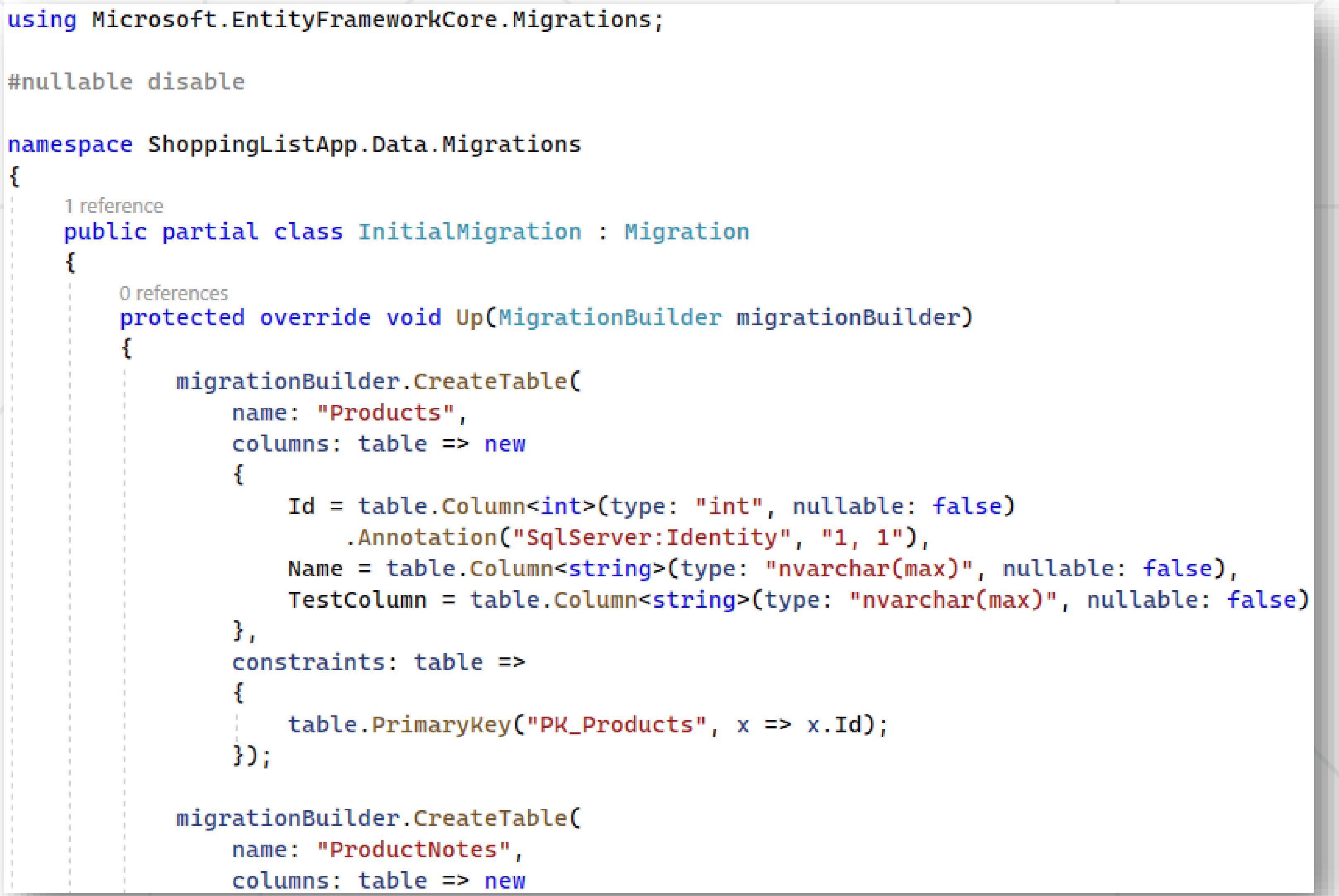
```
PM> Add-Migration InitialMigration -o Data/Migrations
```

Migration will be created in the "`Data/Migrations`" folder

Migrate the "ShoppingListDemo" App



Solution 'ShoppingListApp' (1 of 1 project)
- ShoppingListApp
  - Connected Services
  - Dependencies
  - Properties
  - wwwroot
  - Controllers
  - Data
    - Migrations
      - 20220924155738_InitialMigration.cs
      - ShoppingListDbContextModelSnapshot.cs
    - Product.cs
    - ProductNote.cs
    - ShoppingListDbContext.cs
  - Models
  - Views
  - appsettings.json
  - Program.cs



```
using Microsoft.EntityFrameworkCore.Migrations;

#nullable disable

namespace ShoppingListApp.Data.Migrations
{
    1 reference
    public partial class InitialMigration : Migration
    {
        0 references
        protected override void Up(MigrationBuilder migrationBuilder)
        {
            migrationBuilder.CreateTable(
                name: "Products",
                columns: table => new
                {
                    Id = table.Column<int>(type: "int", nullable: false)
                        .Annotation("SqlServer:Identity", "1, 1"),
                    Name = table.Column<string>(type: "nvarchar(max)", nullable: false),
                    TestColumn = table.Column<string>(type: "nvarchar(max)", nullable: false)
                },
                constraints: table =>
                {
                    table.PrimaryKey("PK_Products", x => x.Id);
                });

            migrationBuilder.CreateTable(
                name: "ProductNotes",
                columns: table => new
```

Auto Run Migration Scripts at Startup

```
public class ShoppingListDbContext : DbContext
{
  public ShoppingListDbContext(
    DbContextOptions<ShoppingListDbContext> options) :
          base(options)
          => Database.Migrate();
}
```

- This will **apply the migration scripts** (if not yet applied)
- Simple, but **can cause problems** → not recommended in production
- Recommended approach: migrate the database by hand

```
dotnet ef database update
```

Summary

- **EF Core** maps database objects to database schema
- **Code First approach** creates a database, based on C# classes that we create
- LINQ can be used to **query the DB** through the DB context
- **Database migrating** updates the database schema to match app data models

Questions?

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