Bern University of Applied Sciences | BFH

Department of Engineering and Information Technology

Bachelor's Thesis (BTI7321) Autumn Semester 2020/21

"Planning of the Assignments for Lecturers(PLANA)" Web Application

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Contents

Acknowledgments

Abstract

1 Introduction

The aim of this work is to develop a web based information system that enables assignment planning for lecturers in our school at the Department of Technology and Computer Science. The challenge we face is to create effective planning by involving the teachers themselves in this process. We decided to make a web application that will meet all the requirements and will be created using suitable modern technologies. Technologies such as ASP.NET Core Blazor Server with Entity Framework Core (EFCore) and MS SQL (Microsoft Structured Query Language) for the database were chosen. ASP.NET Core Blazor is a new framework that is gaining popularity. Interestingly, thanks to it, it becomes possible to do the entire application in C# without using JavaScript.

In project 2, we created a prototype. In this work, the system will be detailed and expanded. In particular, the following goals are pursued:

- **Involvement of teachers in the planning process.** Teachers are able to create and manage their own medium- and long-term deployment plans.
- **Grouping of lecturers.** It should be possible to schedule several lecturers for the same module.
  - Teachers who join a group can independently manage their assignments related to their common module.
  - Each teacher can make a group with another lecturers.
- **Grouping of the modules.** The group of lecturers can choose the group of modules and set themselves to it. This can be done in the form of a proposal for the definitive plan, which is then approved by the person responsible for the planning.

1.1 Acronyms

Acronyms	Words
EF	Entity Framework
CSS	Cascading Style Sheet
KKK	345

Table 1: Caption2

1.2 Glossary

- **FURPS+eeles2005capturing** is a system for classifying requirements.
  - Functionality
  - Usability
  - Reliability
  - Performance
  - Supportability
- **SignalIR** is a free and open-source software library for Microsoft ASP.NET that allows server code to send asynchronous notifications to client-side web applications.
- **Blazor** is a free and open-source web framework that enables developers to create web apps using C# and HTML. It is being developed by Microsoft.
- **EF Core**
- **HTML** HyperText Markup language
- **SQL** Structured Query Language
- **JS** JavaScript
- **CRUD** Create, read, update and delete
- **UI** User Interface
- **API** Application Programming Interface
- **MS** Microsoft
- **BPMN** Business Process Model and Notation

2 Project Management

2.1 Effort Estimation

The Bachelor's Thesis is designed as a 12 ECTS module. This corresponds to a workload of 360 hours. When we are working on a project, we always record our hours of work in an Excel table. At the end of the project, we will compare this time with the time allotted for the project.

2.2 Scrum

The foundation of the project organization was Scrum. Some principles of Scrum could not be achieved since they need a group of more than two people. Our work was based on the principles of Scrum like the Empirical Process of Control, the core of Scrum, self-organization, value-based prioritization, etc. The Empirical Process of Control includes three main ideas, namely transparency, inspection, and adaptation.
Transparency: The work is carried out in full trust of all parties involved. Everyone has the courage to keep each other up to date with both good and bad news.
Inspection: Inspection is carried out by every one in the Scrum Team. The team openly shows the product at the end of each Sprint.
Adaptation: The team asks constant questions about the progress of work, whether we are on the right way. Depending on this, we can adapt an existing product.

At the beginning of the project, we have discussed and estimated all the work that needs to be done. Meetings between supervisor and developer are weekly and sometimes bi-weekly. Each meeting includes a discussion about what has been achieved since the tasks have been assigned, what can be improved, and scheduling of future tasks.

Scrum Roles

- Product Owner: Mr. Pfahrer
- Development Team: Shiryagina Kristina
- Scrum Master: Shiryagina Kristina

Scrum Plan

To discuss the project, were weekly and biweekly meetings held . They included personal meetings or meetings using Microsoft Teams. The meetings consisted of:

- Sprint Review. It includes a show of work and its discussion.
- Sprint Planning. It includes the scheduling of future tasks.
- Sprint Retrospective. It includes discussion about what went well and what went wrong, what we should do differently.

Scrum Artifacts

Sprints

3 System Requirements

3.1 Product Backlog and user stories

Epic	User Story	Acceptance Criteria
As a Lecturer I want to be able to create and manage my own medium and long-term assignment plans so that it will be possible a mutual development of the main assignment plan.	As a Lecturer, I want to see the list of modules for concrete semester, so that I can choose the modules I want to plan in my own plan.	User is able to: • have his own plan page • navigate to his own plan page • able to see the module list
	As a Lecturer, I want to be able to add the modules to my assignment plan I want to teach in specific semester or remove it from my plan so that I can participate in the main planning by making a suggestions or requests.	User is able to: • have his own plan page • navigate to his own plan page • able to select a module and set himself to it • able to remove himself from the module he has added himself • able modify a data of his own planning
	As a Lecturer, I want to be able to manage my plan, so I can modify my plan as I like.	User is able to: • have his own plan page • navigate to his own plan page • able to select a module and set himself to it • able to remove himself from the module he has added himself • able modify a data of his own planning

Table 2: Product Backlog

Epic	**User Story**	**Acceptance Criteria**
As a Study Director, I want to be able to make group of lecturers and attach it to a specific module,and also make group of modules so this will increase planning flexibility . As a Study Director, I want to be able to attach a specific group of modules to a specific group of teachers so that further joint planning of these modules will be easier	As a Study Director, I want to see teachers' suggestions for group work and also their proposal for the selected modules so that it will be easier to approve specific groups.	User is able to: • open the main planning matrix with suggestions for group work and teacher suggestions for teaching modules. • manage matrix page, making the necessary adjustments
	As a Study Director, I want to be able to make groups of lecturers in the assignment plan.	User is able to: • open the main planning page • select list of teachers • select several teachers and save them as a group. • open module view and attach a specific group of lecturers to a specific module.
	As a Study Director, I want to be able to make groups of modules in the assignment plan.	User is able to: • open the main planning page • select list of modules • select several modules and save them as a group.
	As a Study Director, I want to be able attach lecturer or group of lecturers to the specific module in the assignment plan.	User is able to: • open the main planning page • select list of modules • click add lecturer button or add group of lecturer button • select lecturer or group of lecturer and save it

Table 3: Product Backlog

Epic	User Story	Acceptance Criteria
	As a Study Director, I want to be able attach a group of lecturers to the group of modules in the assignment plan.	User is able to: • open the main planning page • select list of modules • select a specific group of modules • click add group of lecturer button • select group of lecturer and save it
	As a Lecturer, I can join a group with another lecturers, so that we can use a system as a group.	User is able to: • •
	As a Lecturer, who joins a group, I want to be able to independently manage the tasks related to the common module	User is able to: • •

Table 4: Product Backlog

3.2 Functional Requirements

4 System Architecture and System Design

In project 2 we have started with describing of System architecture and design. In this work we want go deeper into this topic.

5 Domain Analysis

6 Technologies

7 Creating the Projects

7.1 Structure of Projects and Folders

7.2 Data Models

7.3 Entity Framework Core Packages

7.4 Connection String

7.5 Creating the Database Context Class

7.6 Entity Framework Core Configuration

7.7 Database and Entity Framework Core

Entity Framework(EF) Core is an object-relational mapper (O /RM). It is designed to make writing code for accessing a database quick and intuitive. There are many good reasons to use EF Core. It supports LINQ queries, change tracking, updates, and schema migrations. EF Core works with many databases, including SQL Database, SQLite, MySQL, PostgreSQL, and Azure Cosmos DB. book **efa ef**

7.8 The PLANA App's Relational Database

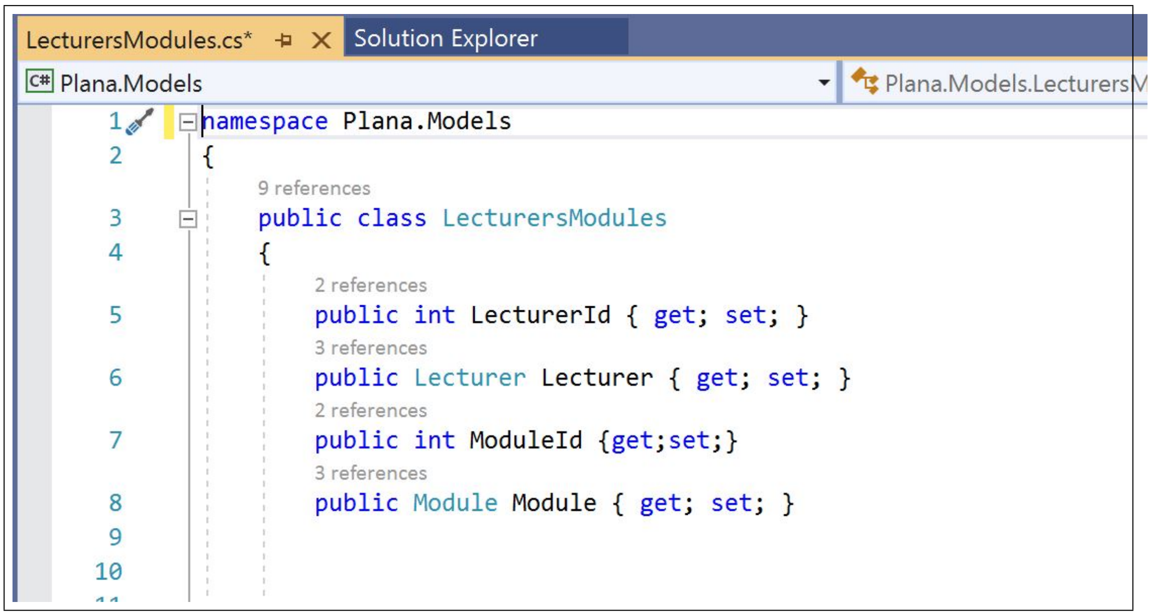
Our database has many types of relationships we can have in EF Core. The types are: One-to-many: Lecturer Many-to-many: One-To-Many Relationship : Lecturer to an Additional Assignment Semester to a Additional Assignment Semester to a Module Run Module to a Module Run Study Branch to a Module Many-To-Many Relationship : Lecturers to Semester Lecturers to Module Lecturers to Module Run

7.9 Modeling Types of Database Relationships

Many-to-many Relationship

Creating many-to-many relationship is little bit different from the one-to-many and one-to-one. We will take as example relation between Lecturer and Module.

In EF Core database doesn't directly implement this kind of relationships. First we have to create class Lecturer and class Module. Then we have to create one more class, we call it LecturersModules. This class links lecturers to their modules.
At the LecturerModules class there are two properties, LecturerId and ModuleId. There are both - primary keys and foreign keys, known as a composite key.**efa**



```
namespace Plana.Models
{
    9 references
    public class LecturersModules
    {
        2 references
        public int LecturerId { get; set; }
        3 references
        public Lecturer Lecturer { get; set; }
        2 references
        public int ModuleId {get;set;}
        3 references
        public Module Module { get; set; }
```

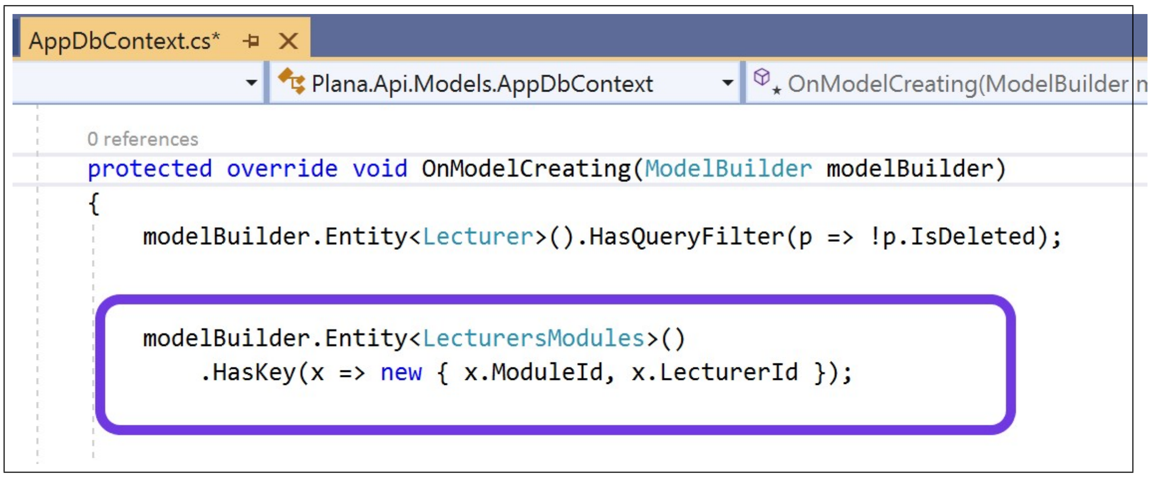
Figure 1: The LecturersModules entity class

The next step is adding necessary code to the AppDbContext class. We add

- **DbSet<Lecturer>**
- **DbSet<Module>**
- **DbSet<LecturersModules>**

The Figure 2 below shows this process. In the OnModelCreating method we add

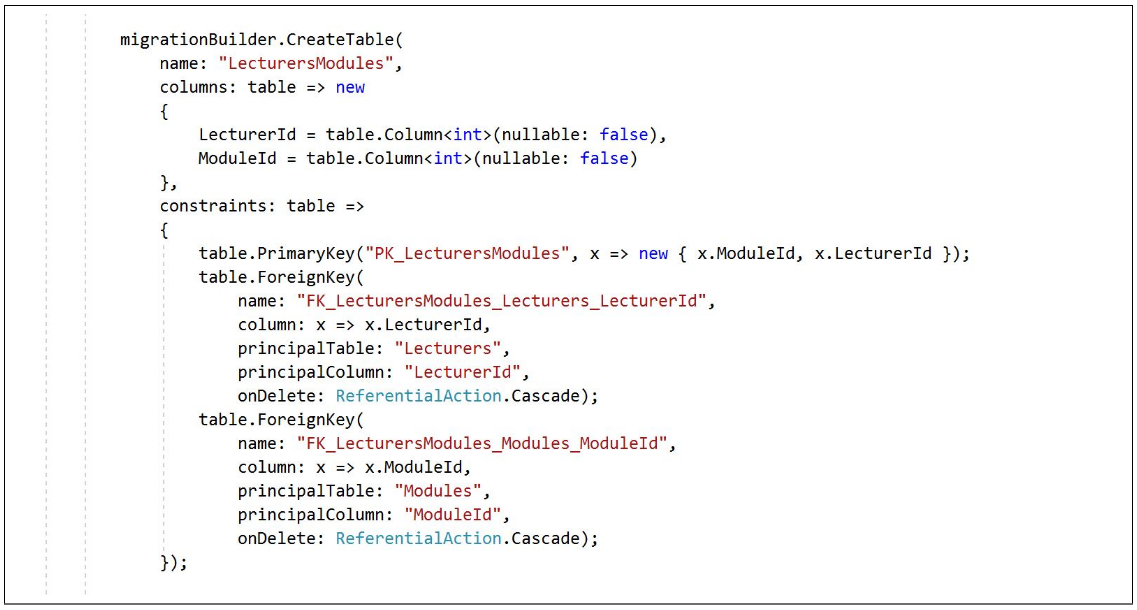
- **modelBuilder.Entity<LectuerersModules>().HasKey(x=> new x.LecturerId, x.ModuleId**;



```
0 references
protected override void OnModelCreating(ModelBuilder modelBuilder)
{
    modelBuilder.Entity<Lecturer>().HasQueryFilter(p => !p.IsDeleted);

    modelBuilder.Entity<LecturersModules>()
        .HasKey(x => new { x.ModuleId, x.LecturerId });
```

Figure 2: Adding Entity LecturersModules to the AppDbContext class

We need write just this and Entity Framework Core will do the correct implementation that we can see then in the migration files. **patrick**



```
migrationBuilder.CreateTable(
    name: "LecturersModules",
    columns: table => new
    {
        LecturerId = table.Column<int>(nullable: false),
        ModuleId = table.Column<int>(nullable: false)
    },
    constraints: table =>
    {
        table.PrimaryKey("PK_LecturersModules", x => new { x.ModuleId, x.LecturerId });
        table.ForeignKey(
            name: "FK_LecturersModules_Lecturers_LecturerId",
            column: x => x.LecturerId,
            principalTable: "Lecturers",
            principalColumn: "LecturerId",
            onDelete: ReferentialAction.Cascade);
        table.ForeignKey(
            name: "FK_LecturersModules_Modules_ModuleId",
            column: x => x.ModuleId,
            principalTable: "Modules",
            principalColumn: "ModuleId",
            onDelete: ReferentialAction.Cascade);
    });
```

Figure 3: Initial Migration File

From Figure 3 we can see that one many-to-many relationship has transformed in two one-to-many and many-to-one relationships.

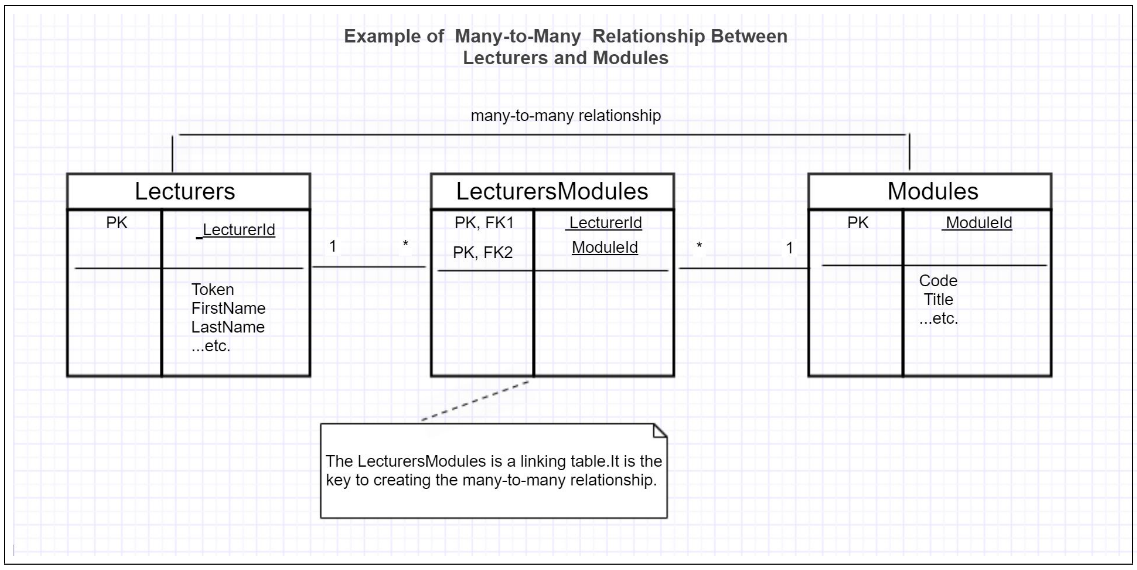

Example of Many-to-Many Relationship Between Lecturers and Modules
many-to-many relationship
Lecturers
PK
LecturerId
Token
FirstName
LastName
...etc.
1
*
LecturersModules
PK, FK1
PK, FK2
LecturerId
ModuleId
*
1
Modules
PK
ModuleId
Code
Title
...etc.
The LecturersModules is a linking table.It is the key to creating the many-to-many relationship.

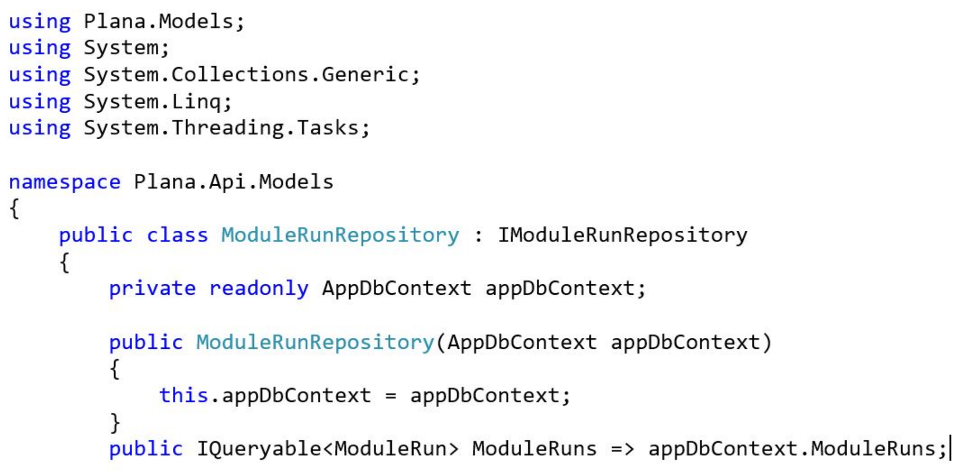
Figure 4: Creating Many-To-Many Relationship

7.10 Creating Database

7.11 Creating a Repository

todo: photo of repository

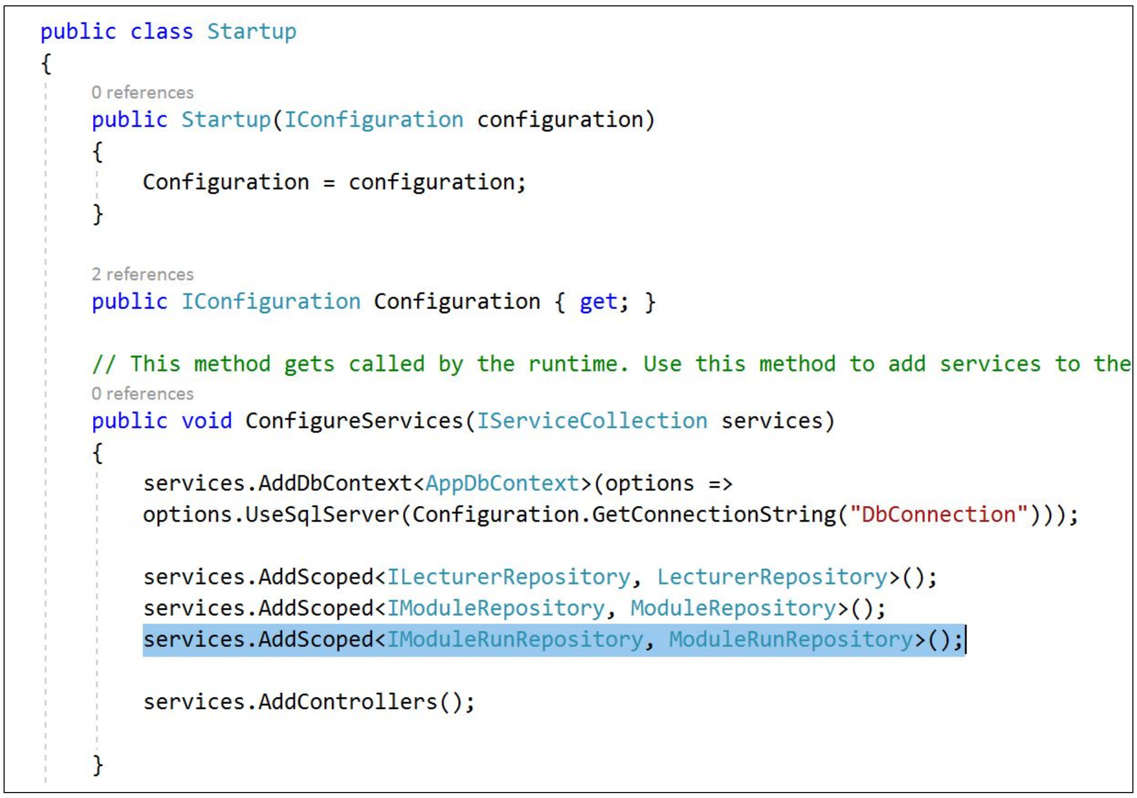
In our project we create a repository interfaces and implementation classes.
We use **IQueryable<T> and IEnumarable<T>** interfaces. With IQueryable<T> interface the objects can be queried in more efficient way.
For example: **public IQueryable<ModuleRun> ModuleRuns => appDbContext.ModuleRuns;** the ModuleRuns property in the context class returns a DbSet<ModuleRun> object, which implements the IQueryable<T> interface.



```
using Plana.Models;
using System;
using System.Collections.Generic;
using System.Linq;
using System.Threading.Tasks;

namespace Plana.Api.Models
{
    public class ModuleRunRepository : IModuleRunRepository
    {
        private readonly AppDbContext appDbContext;

        public ModuleRunRepository(AppDbContext appDbContext)
        {
            this.appDbContext = appDbContext;
        }
        public IQueryable<ModuleRun> ModuleRuns => appDbContext.ModuleRuns;
```

Figure 5: The ModuleRunRepository.cs file in the Plana.Api/Models folder

Then we create the Repository Service in the Startup.cs file.



```
public class Startup
{
    0 references
    public Startup(IConfiguration configuration)
    {
        Configuration = configuration;
    }

    2 references
    public IConfiguration Configuration { get; }

    // This method gets called by the runtime. Use this method to add services to the
    0 references
    public void ConfigureServices(IServiceCollection services)
    {
        services.AddDbContext<AppDbContext>(options =>
        options.UseSqlServer(Configuration.GetConnectionString("DbConnection")));

        services.AddScoped<ILecturerRepository, LecturerRepository>();
        services.AddScoped<IModuleRepository, ModuleRepository>();
        services.AddScoped<IModuleRunRepository, ModuleRunRepository>();

        services.AddControllers();

    }
```

Figure 6: Creating Services in Startup.cs File

core3

Creating the Database Migration, Code-First Migration

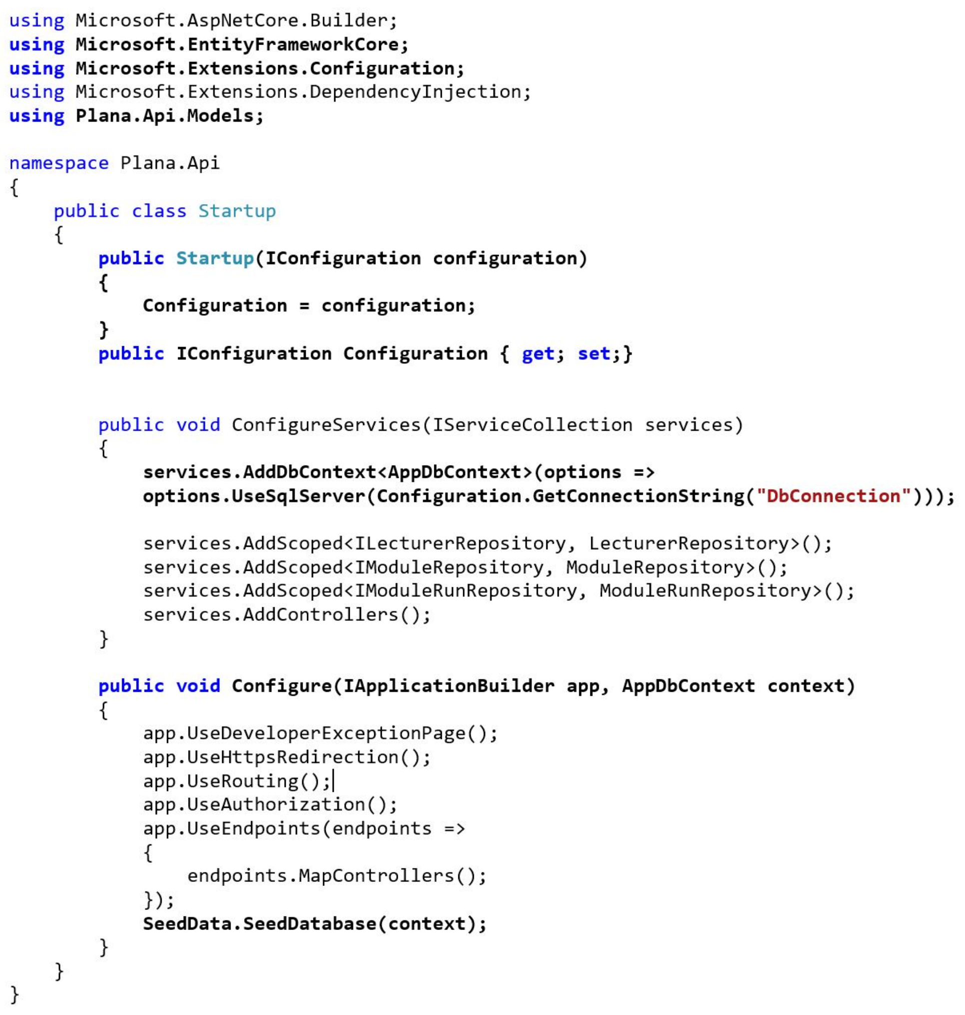
Entity Framework Core makes it possible to generate schema for the database from the data model classes using **migrations dotnet em migrations add Initial core3**

7.12 Creating Seed Data

The seed data is the data that is used to populate the database. For seed data we add class SeedData.cs in the Models folder in Plana.Api project **core3**. By default, Entity Framework Core uses cascade deletes for depend relationships with non-nullable foreign keys. **efa**
..add photo of seed class (give it name The contents of the SeedData.cs class

Configuration of Core Services and Entity Framework

It is necessary to make changes in Startup.cs class in Plana.Api project - configure Entity Framework Core and set up the services that will be used to access the database **efa**. The figure below shows all these configurations.



```
using Microsoft.AspNetCore.Builder;
using Microsoft.EntityFrameworkCore;
using Microsoft.Extensions.Configuration;
using Microsoft.Extensions.DependencyInjection;
using Plana.Api.Models;

namespace Plana.Api
{
    public class Startup
    {
        public Startup(IConfiguration configuration)
        {
            Configuration = configuration;
        }
        public IConfiguration Configuration { get; set;}


        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<AppDbContext>(options =>
            options.UseSqlServer(Configuration.GetConnectionString("DbConnection")));

            services.AddScoped<ILecturerRepository, LecturerRepository>();
            services.AddScoped<IModuleRepository, ModuleRepository>();
            services.AddScoped<IModuleRunRepository, ModuleRunRepository>();
            services.AddControllers();
        }

        public void Configure(IApplicationBuilder app, AppDbContext context)
        {
            app.UseDeveloperExceptionPage();
            app.UseHttpsRedirection();
            app.UseRouting();
            app.UseAuthorization();
            app.UseEndpoints(endpoints =>
            {
                endpoints.MapControllers();
            });
            SeedData.SeedDatabase(context);
        }
    }
}
```

Figure 7: Startup.cs in the Plana.Api project.Preparing Services and Middleware

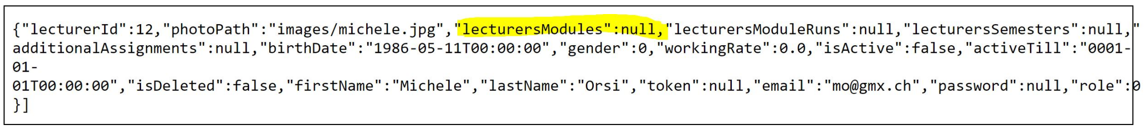
7.13 Create an Controller

Complex Data Model

in this section I would like to highlight more complex features of coding and data model structure in asp .net core.

```
public async Task<IEnumerable<Lecturer>> GetLecturers()
        {
               return await appDbContext.Lecturers.ToListAsync();

        }
```

Figure 8: LecturerRepository.cs file in the Plana.Api project's folder

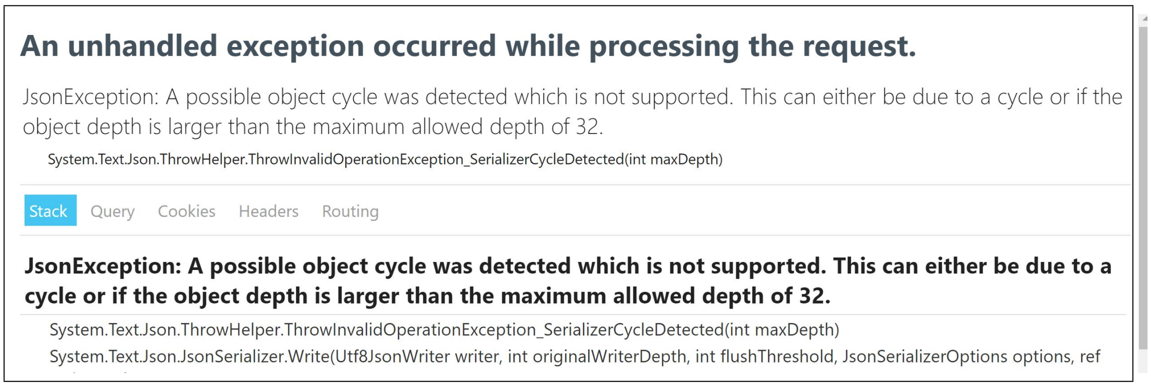


```
{"lecturerId":12,"photoPath":"images/michele.jpg","lecturersModules":null,"lecturersModuleRuns":null,"lecturersSemesters":null,"
additionalAssignments":null,"birthDate":"1986-05-11T00:00:00","gender":0,"workingRate":0.0,"isActive":false,"activeTill":"0001-
01-
01T00:00:00","isDeleted":false,"firstName":"Michele","lastName":"Orsi","token":null,"email":"mo@gmx.ch","password":null,"role":0
}]
```

Figure 9

```
public async Task<IEnumerable<Lecturer>> GetLecturersModules()
        {
            return await appDbContext.Lecturers
                .Include(m => m.LecturersModules)
                .ThenInclude(mo => mo.Module).ToListAsync();
        }
```

Figure 10: ...



An unhandled exception occurred while processing the request.

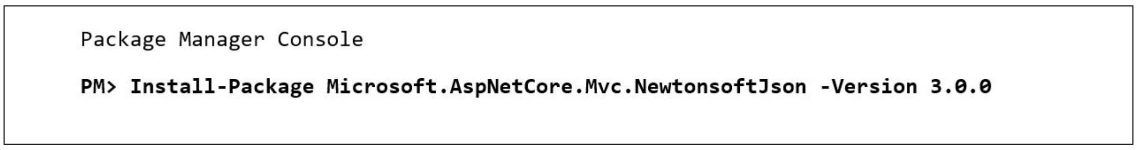
JsonException: A possible object cycle was detected which is not supported. This can either be due to a cycle or if the object depth is larger than the maximum allowed depth of 32.

System.Text.Json.ThrowHelper.ThrowInvalidOperationException_SerializerCycleDetected(int maxDepth)

JsonException: A possible object cycle was detected which is not supported. This can either be due to a cycle or if the object depth is larger than the maximum allowed depth of 32.

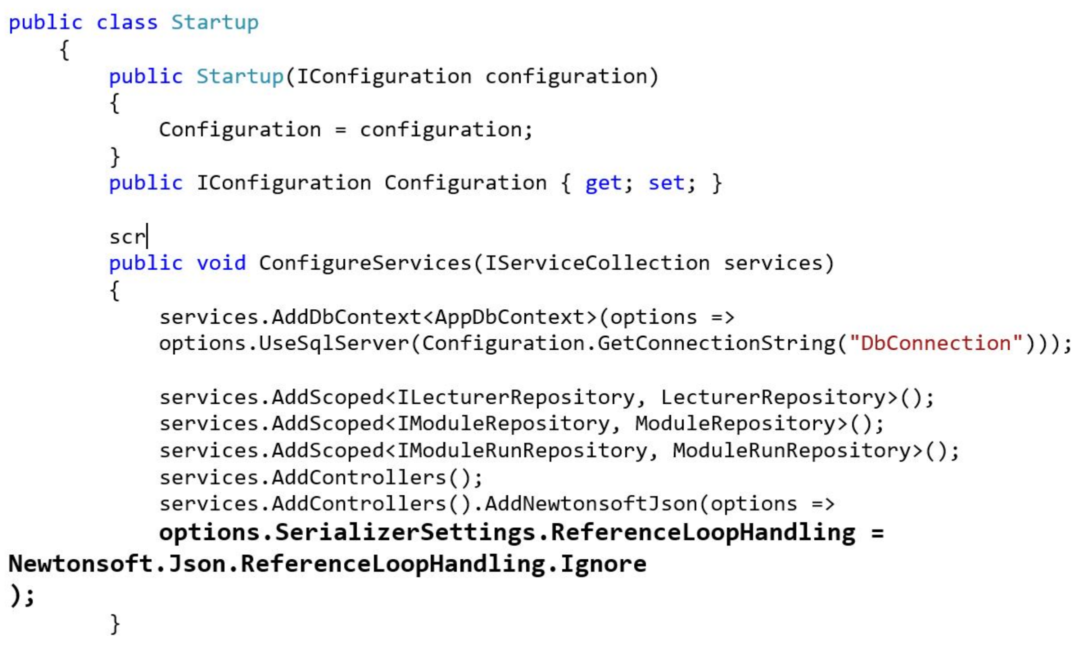
```
System.Text.Json.ThrowHelper.ThrowInvalidOperationException_SerializerCycleDetected(int maxDepth)
System.Text.Json.JsonSerializer.Write(Utf8JsonWriter writer, int originalWriterDepth, int flushThreshold, JsonSerializerOptions options, ref
```

Figure 11



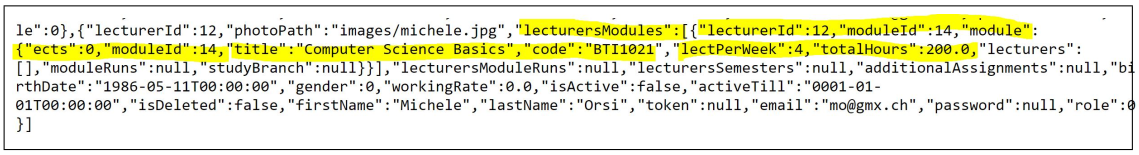
```
Package Manager Console

PM> Install-Package Microsoft.AspNetCore.Mvc.NewtonsoftJson -Version 3.0.0
```

Figure 12



```
public class Startup
    {
        public Startup(IConfiguration configuration)
        {
            Configuration = configuration;
        }
        public IConfiguration Configuration { get; set; }

        scr
        public void ConfigureServices(IServiceCollection services)
        {
            services.AddDbContext<AppDbContext>(options =>
            options.UseSqlServer(Configuration.GetConnectionString("DbConnection")));

            services.AddScoped<ILecturerRepository, LecturerRepository>();
            services.AddScoped<IModuleRepository, ModuleRepository>();
            services.AddScoped<IModuleRunRepository, ModuleRunRepository>();
            services.AddControllers();
            services.AddControllers().AddNewtonsoftJson(options =>
            options.SerializerSettings.ReferenceLoopHandling =
Newtonsoft.Json.ReferenceLoopHandling.Ignore
);
        }
```

Figure 13: ...



```
le":0},{"lecturerId":12,"photoPath":"images/michele.jpg","lecturersModules":[{"lecturerId":12,"moduleId":14,"module":
{"ects":0,"moduleId":14,"title":"Computer Science Basics","code":"BTI1021","lectPerWeek":4,"totalHours":200.0,"lecturers":
[],"moduleRuns":null,"studyBranch":null}}],"lecturersModuleRuns":null,"lecturersSemesters":null,"additionalAssignments":null,"bi
rthDate":"1986-05-11T00:00:00","gender":0,"workingRate":0.0,"isActive":false,"activeTill":"0001-01-
01T00:00:00","isDeleted":false,"firstName":"Michele","lastName":"Orsi","token":null,"email":"mo@gmx.ch","password":null,"role":0
}]
```

Figure 14

Blazor Server

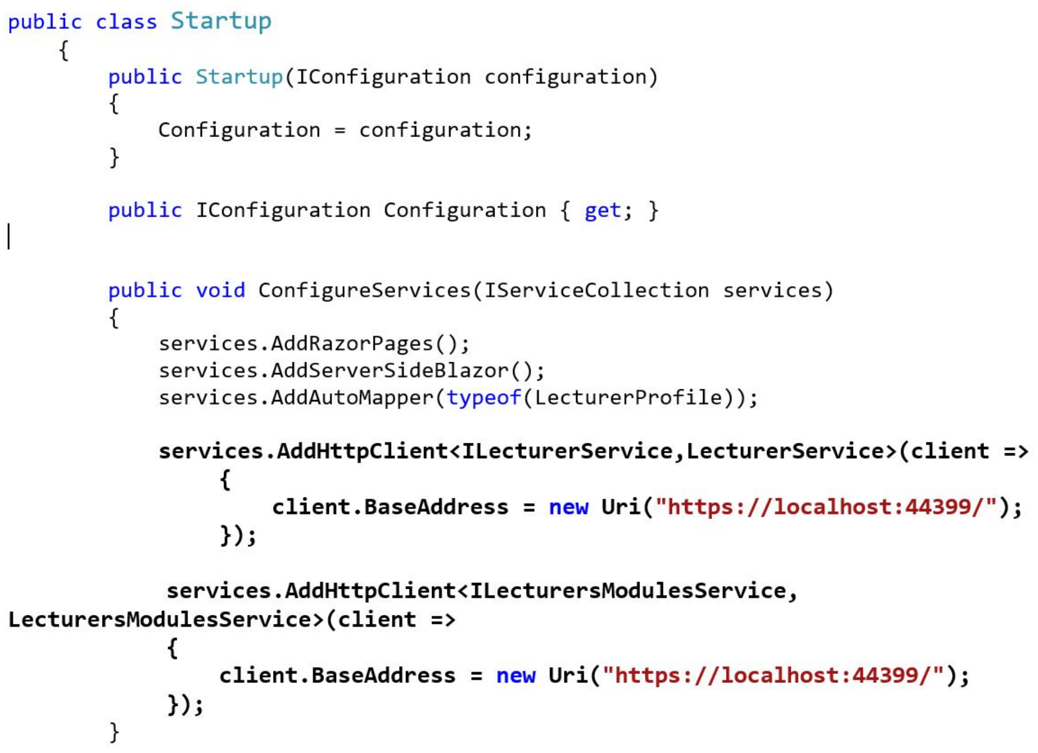
Configuring ASP.NET Core for Blazor Server

Call the API from Asp.net Core Blazor

.. add picture with a blazor page

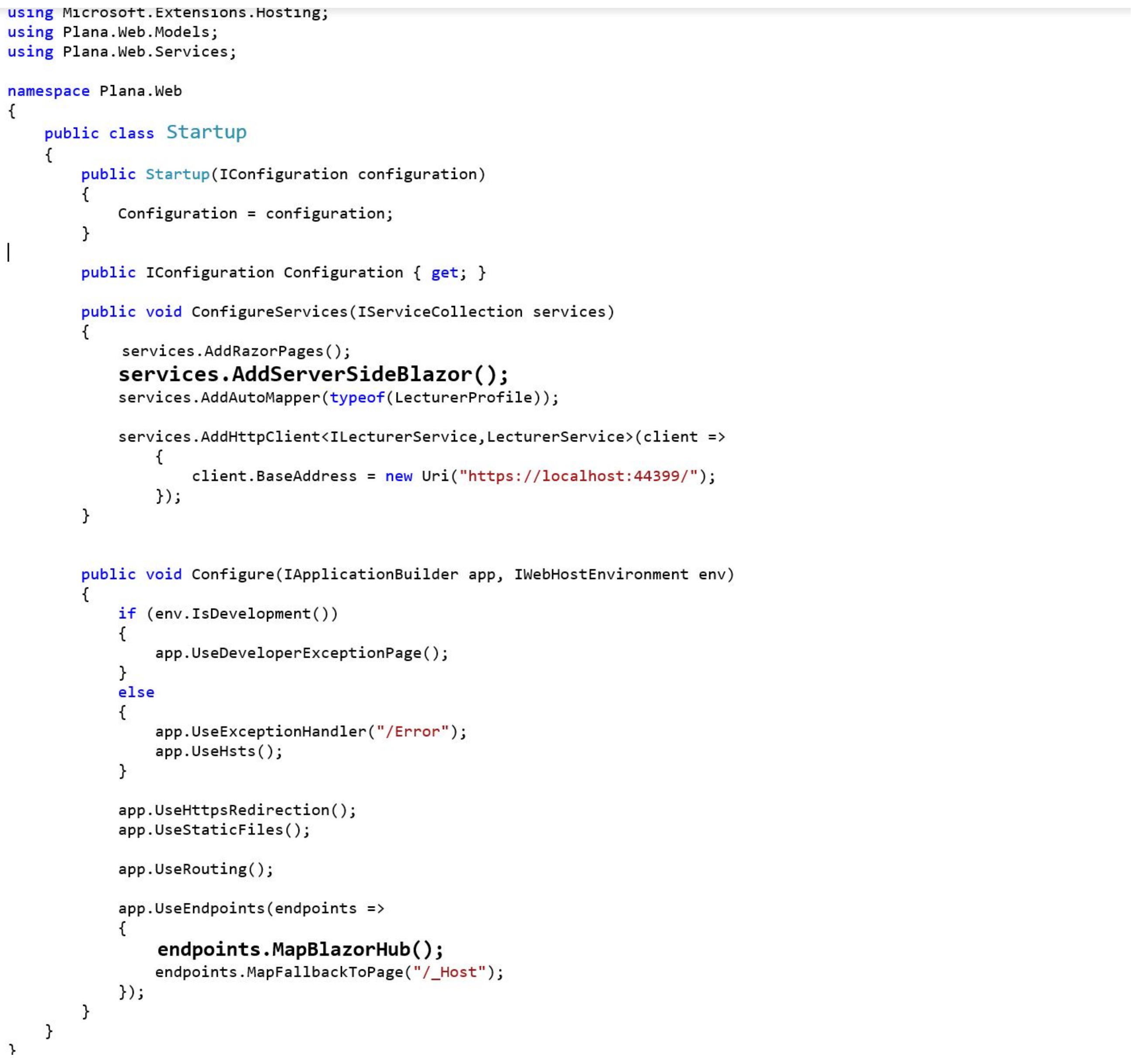
...write about imports

... write about registration of http client services



```
public class Startup
    {
        public Startup(IConfiguration configuration)
        {
            Configuration = configuration;
        }

        public IConfiguration Configuration { get; }


        public void ConfigureServices(IServiceCollection services)
        {
            services.AddRazorPages();
            services.AddServerSideBlazor();
            services.AddAutoMapper(typeof(LecturerProfile));

            services.AddHttpClient<ILecturerService,LecturerService>(client =>
                {
                    client.BaseAddress = new Uri("https://localhost:44399/");
                });

             services.AddHttpClient<ILecturersModulesService,
LecturersModulesService>(client =>
             {
                 client.BaseAddress = new Uri("https://localhost:44399/");
             });
        }
```

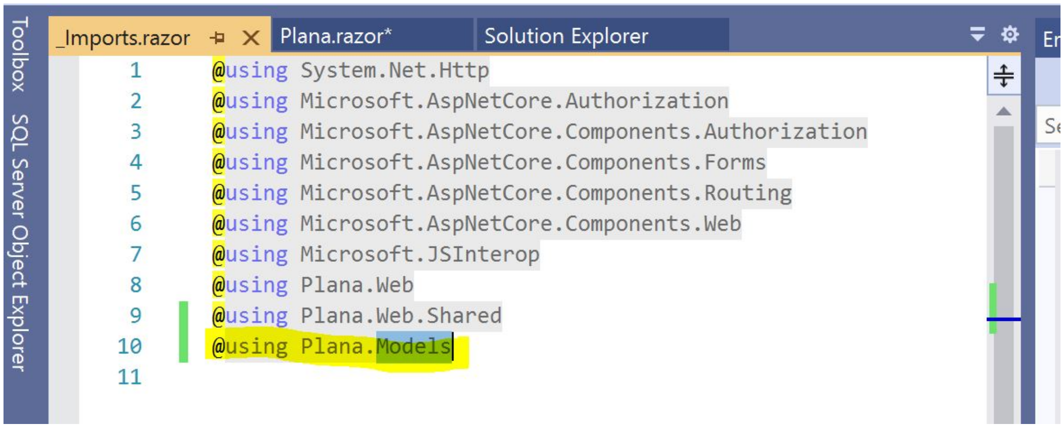
Figure 15: Registration of Http Client Services in Startup File in Plana.Web Project folder



```
using Microsoft.Extensions.Hosting;
using Plana.Web.Models;
using Plana.Web.Services;

namespace Plana.Web
{
    public class Startup
    {
        public Startup(IConfiguration configuration)
        {
            Configuration = configuration;
        }

        public IConfiguration Configuration { get; }

        public void ConfigureServices(IServiceCollection services)
        {
            services.AddRazorPages();
            services.AddServerSideBlazor();
            services.AddAutoMapper(typeof(LecturerProfile));

            services.AddHttpClient<ILecturerService,LecturerService>(client =>
                {
                    client.BaseAddress = new Uri("https://localhost:44399/");
                });
        }


        public void Configure(IApplicationBuilder app, IWebHostEnvironment env)
        {
            if (env.IsDevelopment())
            {
                app.UseDeveloperExceptionPage();
            }
            else
            {
                app.UseExceptionHandler("/Error");
                app.UseHsts();
            }

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

            app.UseRouting();

            app.UseEndpoints(endpoints =>
            {
                endpoints.MapBlazorHub();
                endpoints.MapFallbackToPage("/_Host");
            });
        }
    }
}
```

Figure 16: Adding Services and Middleware in the Startup.cs File in the Plana.Web project folder

When we need to use some data from other folders in a blazor files like Razor files(.razor) all necessary imports we include in the partial class **_Imports.razor** using the **@using** directives.



```
@using System.Net.Http
@using Microsoft.AspNetCore.Authorization
@using Microsoft.AspNetCore.Components.Authorization
@using Microsoft.AspNetCore.Components.Forms
@using Microsoft.AspNetCore.Components.Routing
@using Microsoft.AspNetCore.Components.Web
@using Microsoft.JSInterop
@using Plana.Web
@using Plana.Web.Shared
@using Plana.Models
```

Figure 17: Adding required namespaces to the _Imports.razor file in Plana.Web project folder

7.14 Setup for Blazor

To use the Blazor framework it is necessary to install :

- **.NET Core SDK 3.1 or later** from `http://dotnet.microsoft.com/download`
- **Visual Studio 2019** from `https://visualstudio.microsoft.com/downloads/`

The sprints covered a one three-four weeks period. At the end of each sprint, there was a discussion with the supervisor.

8 Testing

9 Summary

9.1 Conclusions

9.2 Future Work

9.3 Lessons Learned

10 List of illustrations

11 Contents of the table

12 Appendix

13 Declaration of Authorship

I hereby certify that I composed this work completely unaided, and without the use of any other sources or resources other than those specified in the bibliography. All text sections not of my authorship are cited as quotations, and accompanied by an exact reference to their origin.

Place, date:

Signature:

14 Protocol

Frequency: (weekly)
Meeting length: (60 minutes)

Agenda

- Demo and Discuss Deliverable(Demo)
- Planning next Goals(Plan)
- Lessons learned (Lessons)
- Date, time of the next meeting(next meeting)

Report from
Plan
Future goals are:

-
-

Lessons learned

Next Meeting: .....