EF Core Migrations

Sync Db Schemas and Applications

SoftUni Team

Technical Trainers

Software University

SoftUni

Software University

https://about.softuni.bg/

Have a Question?

Software University

sli.do

#csharp-db

Table of Contents

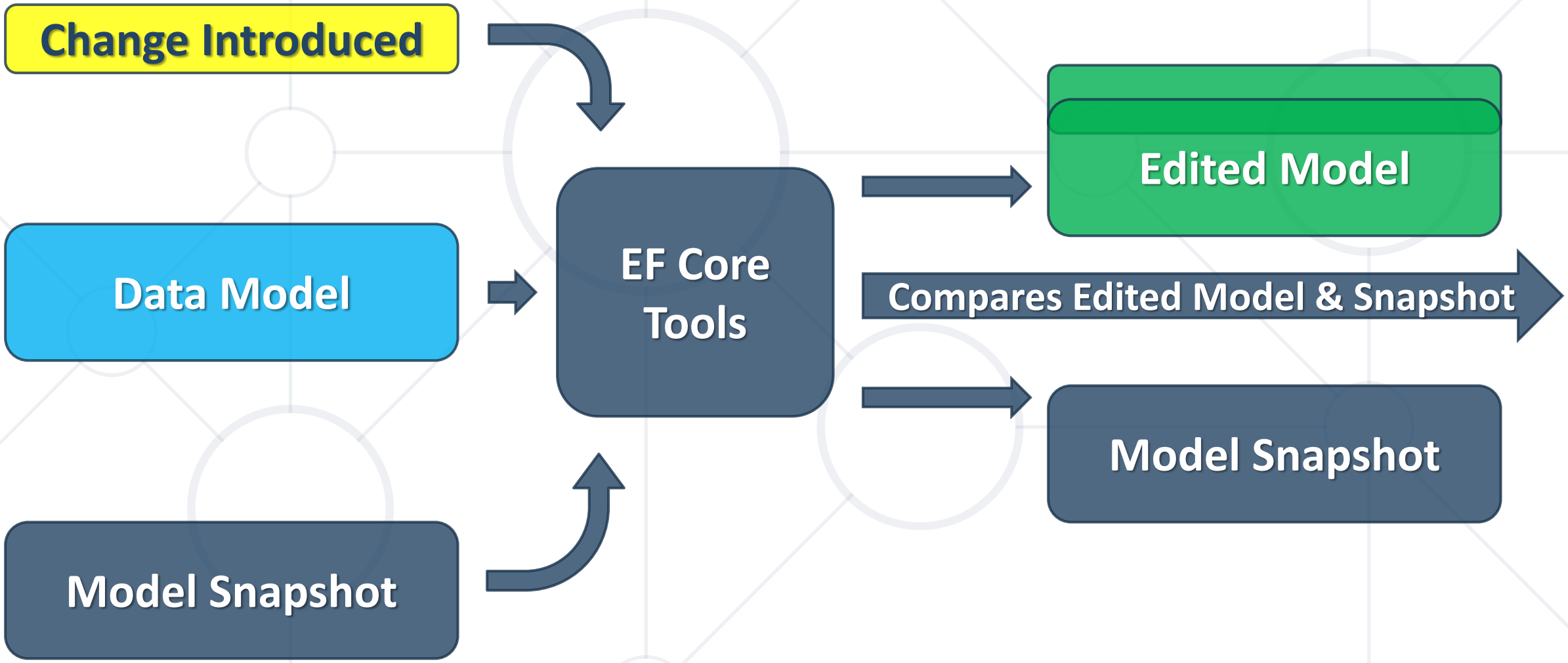
Migrations Overview

First Steps with Migrations

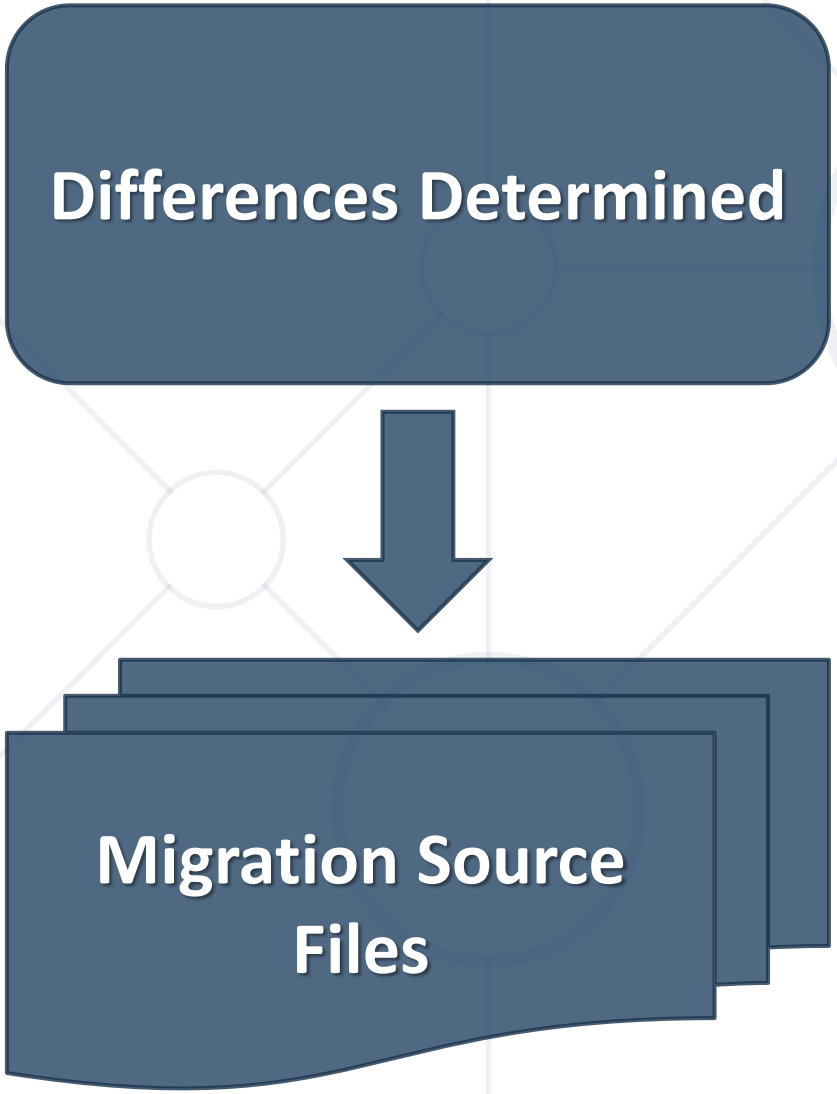
Migrations in EF Core

- **Data models change** as features get implemented
  - **Add new entities** or **properties**
  - **Remove** entities, properties
- Migrations feature in EF Core:
  - Allows to **update** the **db schema**
  - Keeps the db schema in **sync with the data model**
  - **Protects** the **existing data** in the database

How do Migrations Function



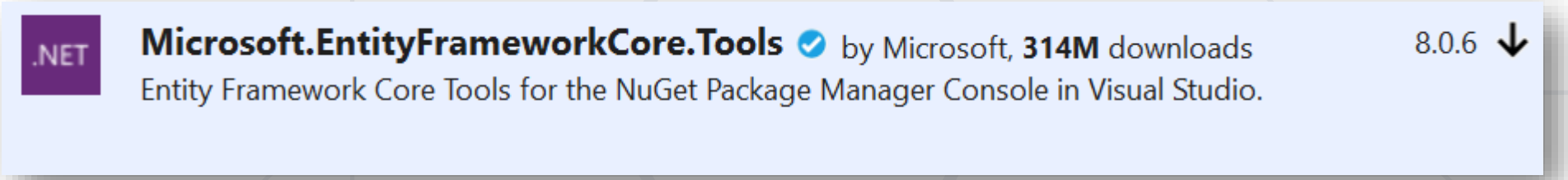
How do Migrations Function



- **Migrations Source Files**
  - Can be tracked in the project's **source control** like any other source file
- Once a **Migration** has been **generated**, it can be **applied** to a database in various ways
- EF Core **records all applied migrations** in a **history table**

EntityFrameworkCore.Tools

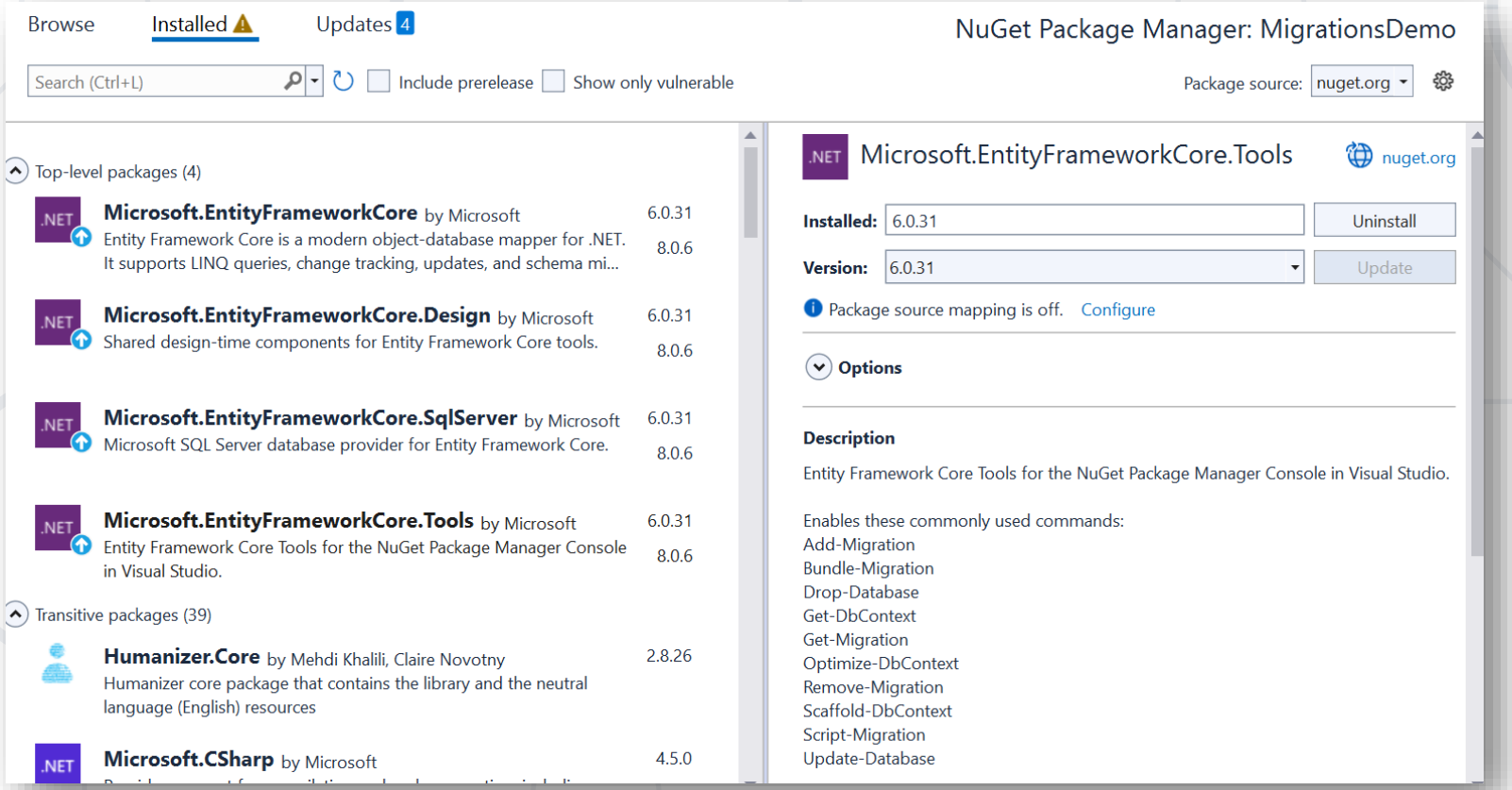
- Manage **NuGet Packages** ⟶ EntityFrameworkCore.Tools



- Create a conceptual **model from an existing database**
  - Then graphically visualize and edit your conceptual model
- Graphically create a conceptual **model first**
  - Then generate a database that supports your model

Create Migration – NuGet Packages

- **Start the MigrationsDemo** project in Visual Studio
- **EFCore.Tools is added** to your **MigrationsDemo** project



Create Migration – Package Manager Console

- **Add a migration** to the project
- Run the command shown
  - A migration will be **created** and **applied**

Package Manager Console

Package source: All Default project:

```
Each package is licensed to you by its owner. NuGet is not responsible
package source (feed) URL to determine any dependencies.

Package Manager Console Host Version 6.9.1.3

Type 'get-help NuGet' to see all available NuGet commands.

PM> add-migration InitialMigration
```

82 %

Output Package Manager Console Error List Git Changes

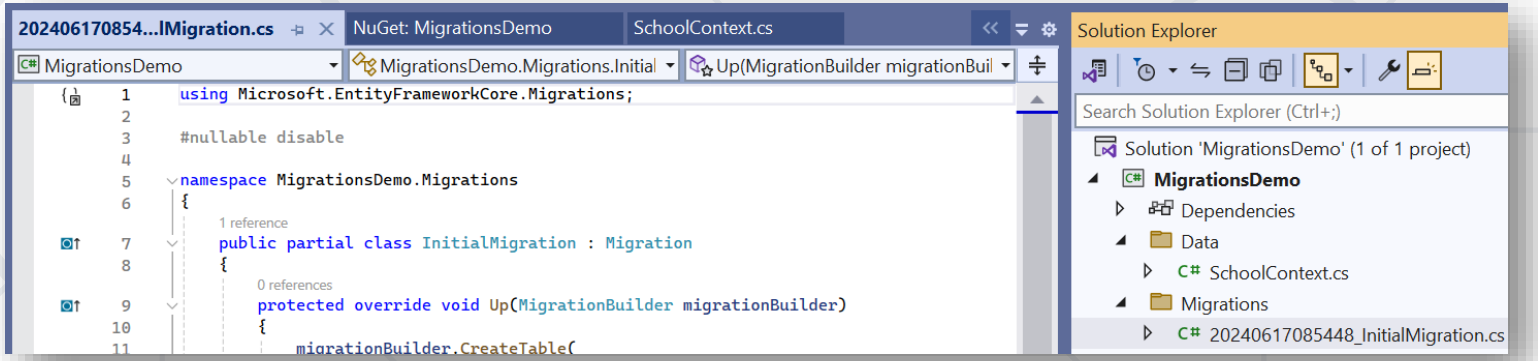
Package Manager Console

Package source: All Default project:

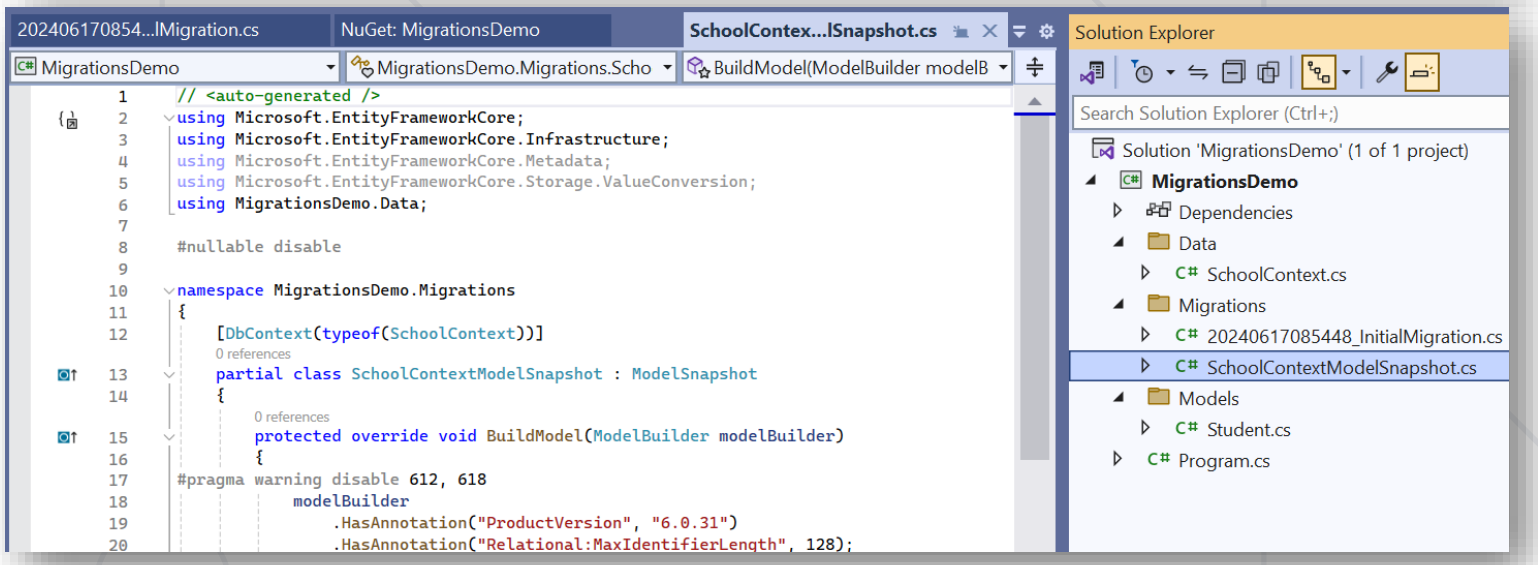
```
Package Manager Console Host Version 6.9.1.3

Type 'get-help NuGet' to see all available NuGet commands.

PM> add-migration InitialMigration
Build started...
Build succeeded.
To undo this action, use Remove-Migration.
PM>
```

Create Migration – Migration Source Files

- Each Migration typically **generates two main files:**
  - Migration Class File



  - Model Snapshot



Applying Migrations

Database Update

Database Update

- What is '**update-database**' ?
  - The '**update-database**' command in Entity Framework Core **applies any pending migrations** to the database
  - It ensures that the **database schema** **matches the current state** of the **EF Core model**

How It Works?

- **Checks Migration History**
  - Compares the **applied migrations** (recorded in '__EFMigrationsHistory' table) with **available migrations**
- **Generates SQL**
  - Creates SQL scripts based on the 'Up' **methods** in **pending migrations**
- **Executes SQL**
  - Runs the SQL scripts to **update the database** schema
- **Updates History**
  - **Records the applied migrations** in the '__EFMigrationsHistory' table to **avoid reapplying** them

Understanding the Connection String

- A **Connection String** is a string that specifies information about a data source and the means of connecting to it
- It includes details such as the **database server**, **database name**, **authentication credentials**, and other configuration settings…

Standard Security

```
Server=myServerAddress; Database=myDataBase; User Id=myUsername; Password=myPassword;
```

Db Server

Db Name

Credentials

Connection String Components

- **Server**
  - The **name or network address** of the **SQL Server** instance (e.g., (localhost)\\mssqllocaldb)
- **Database**
  - The **name of the database** to connect to (e.g., School)
- **Authentication Details**
  - Specify the **use of Authentication**
- **Other settings** to **communicate** with the db server

Configuring the Connection String

- The **Connection String** could be defined in the **'OnConfiguring' method** of the **DbContext** class
- Example:

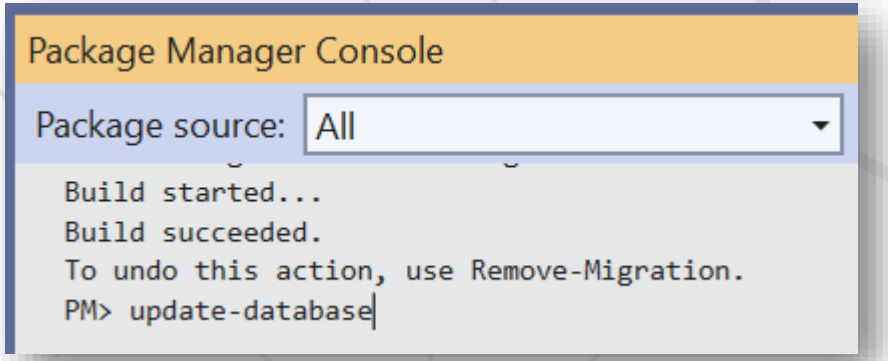
```
public class SchoolContext : DbContext
{
    0 references
    public DbSet<Student> Students { get; set; } = null!;

    0 references
    protected override void OnConfiguring(DbContextOptionsBuilder optionsBuilder)
    {
        optionsBuilder.UseSqlServer("Server=localhost;Database=School;Trusted_Connection=True;");
    }
}
```

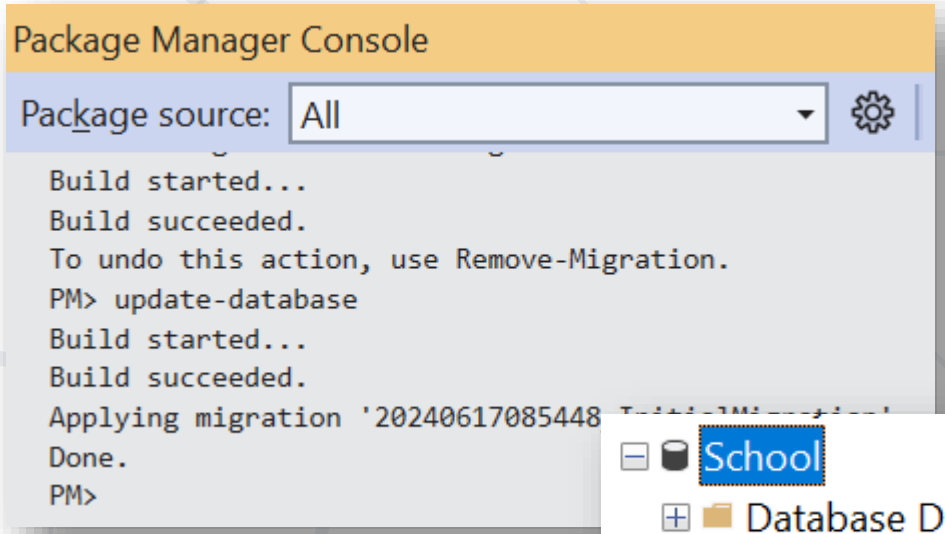
Trusted Connection

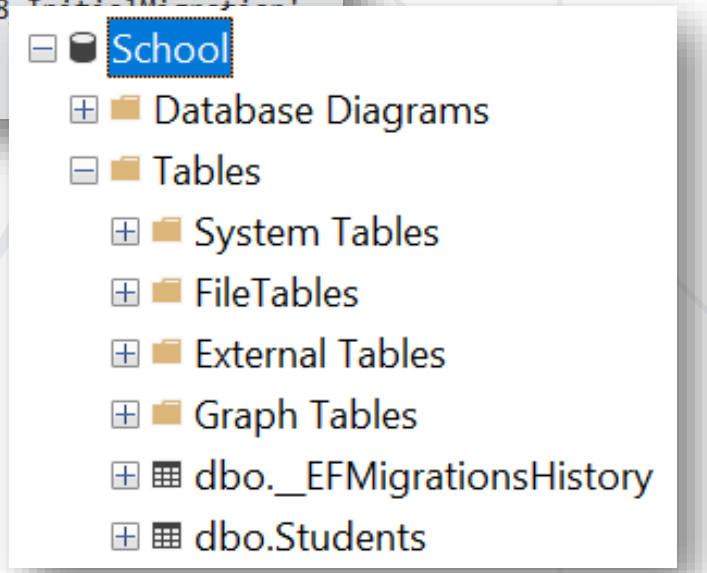
```
Server=myServerAddress; Database=myDataBase; Trusted_Connection=True;
```

Running the 'Update-Database' Command

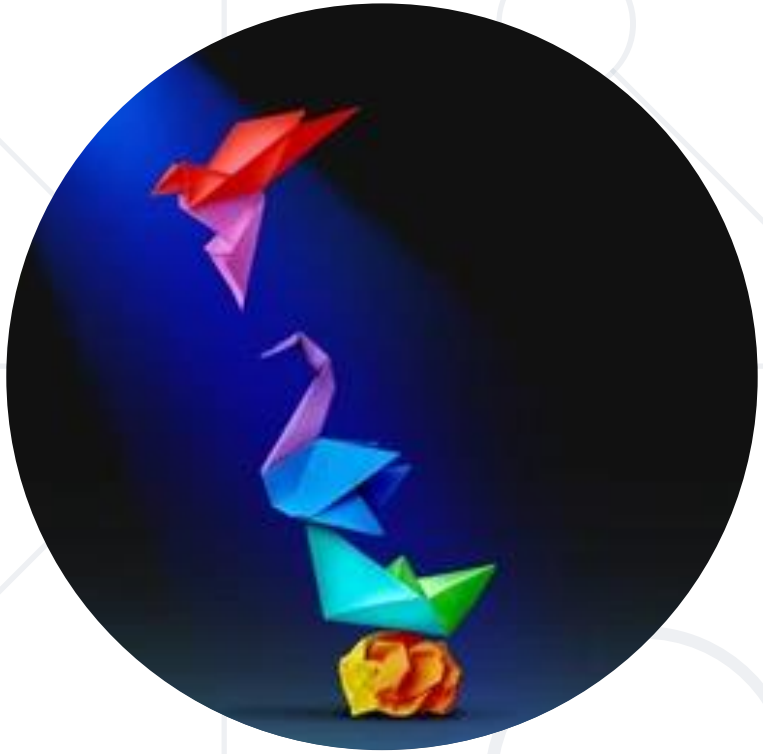
- Type the '**update-database**' command (case insensitive)
- Press '**Enter**'







- This will **apply any pending migrations** to the database



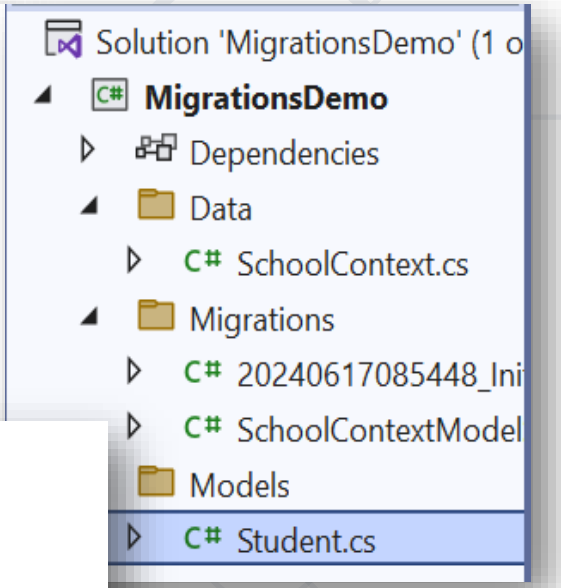
Managing Migrations

Evolving the Models

Evolving the Model

- Evolve the **Student** model **by adding a new property**:
  - Open the Student class file

```
public class Student
{
    0 references
    public int Id { get; set; }

    0 references
    public string Name { get; set; } = null!;

    0 references
    public int Age { get; set; }
}
```



  - Add a **new property Email**

```
public class Student
{
    0 references
    public int Id { get; set; }

    0 references
    public string Name { get; set; } = null!;

    0 references
    public int Age { get; set; }

    0 references
    public string Email { get; set; } = null!;
}
```

Creating a New Migration

- Open the Package Manager Console in Visual Studio
- Run the command to create a new migration

Package Manager Console

Package source: All

```
PM> add-migration AddStudentEmail
```

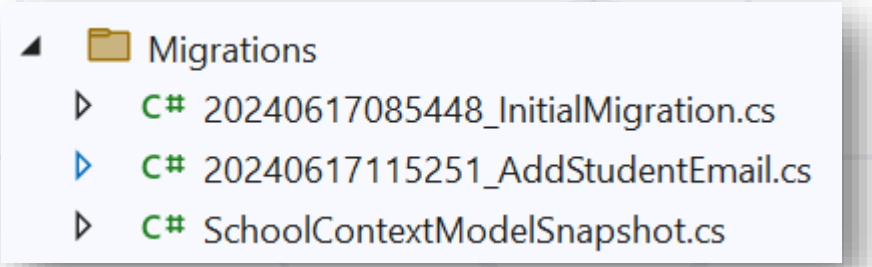
Package Manager Console

Package source: All

```
PM> add-migration AddStudentEmail
Build started...
Build succeeded.
To undo this action, use Remove-Migration.
PM>
```

Migration File

- **EF Core** generates a **new migration file** in the '**Migrations**' folder
- **Up Method**
  - **Adds the Email** column to the 'Students' table
- **Down Method**
  - **Removes the Email** column if the migration is **rolled back**



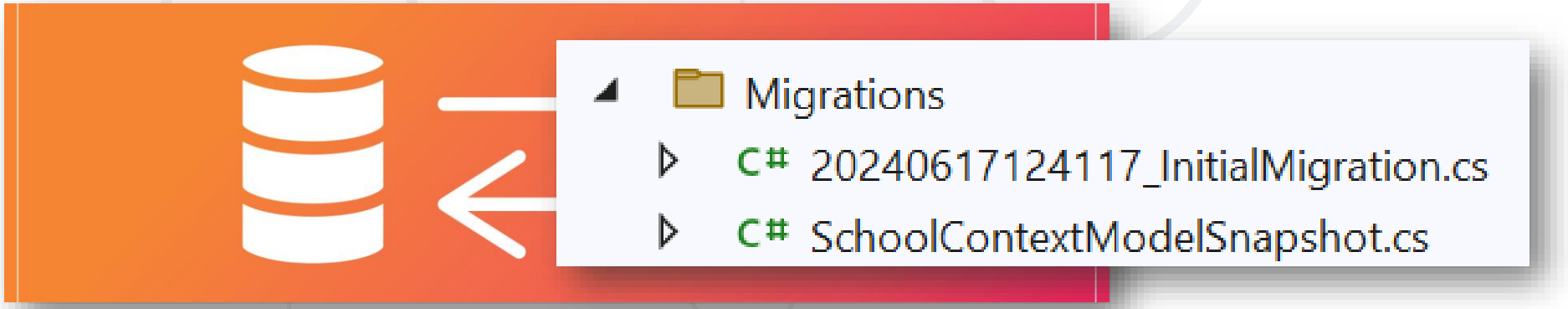

```
namespace MigrationsDemo.Migrations
{
    1 reference
    public partial class AddStudentEmail : Migration
    {
        0 references
        protected override void Up(MigrationBuilder migrationBuilder)
        {
            migrationBuilder.AddColumn<string>(
                name: "Email",
                table: "Students",
                type: "nvarchar(max)",
                nullable: false,
                defaultValue: "");
        }

        0 references
        protected override void Down(MigrationBuilder migrationBuilder)
        {
            migrationBuilder.DropColumn(
                name: "Email",
                table: "Students");
        }
    }
}
```

Remove a Migration Before Applying It

- How to **remove a migration before applying it to the database**
  - Open the **Package Manager Console**
  - **Run** the '**remove-migration**' **command**
- Why Remove a Migration?
  - Realized **there's an error in the migration**
  - Need to **make additional changes** to the model
  - Created a migration **accidentally**

Remove-Migration

- The command **removes the last migration** that **has not been applied** to the database
- It **deletes the migration file** from the '**Migrations**' folder
- **No Database Changes**
  - Since the **migration has not been applied yet**, there are **no changes made** to the database



Practical Example

- After creating the '**AddStudentEmail**' migration, you realize you **forgot to set** the '**Email**' property **as required**
- **Instead of applying the migration**, you **remove it**, update the model, and **create a new migration**

```
public class Student
{
    0 references
    public int Id { get; set; }

    0 references
    public string Name { get; set; } = null!;

    0 references
    public int Age { get; set; }

    [Required]
    0 references
    public string Email { get; set; } = null!;
}
```

Package Manager Console

Package source: All

```
PM> remove-migration
Build started...
Build succeeded.
Removing migration '20240617124221_AddStudentEmail'.
Reverting the model snapshot.
Done.
PM> add-migration AddStudentEmail
Build started...
Build succeeded.
To undo this action, use Remove-Migration.
PM>
```

Applying the Migration

- **Updating** the database
  - Run the '**update-database**' command
- **Verifying** the changes
  - Using **SQL Server Management Studio** (SSMS)
    - Open SSMS and **connect to the SQL Server instance**
    - Navigate to the '**School**' database and **refresh the tables**
    - Verify that the '**Students**' table now **includes the updated 'Email' column**

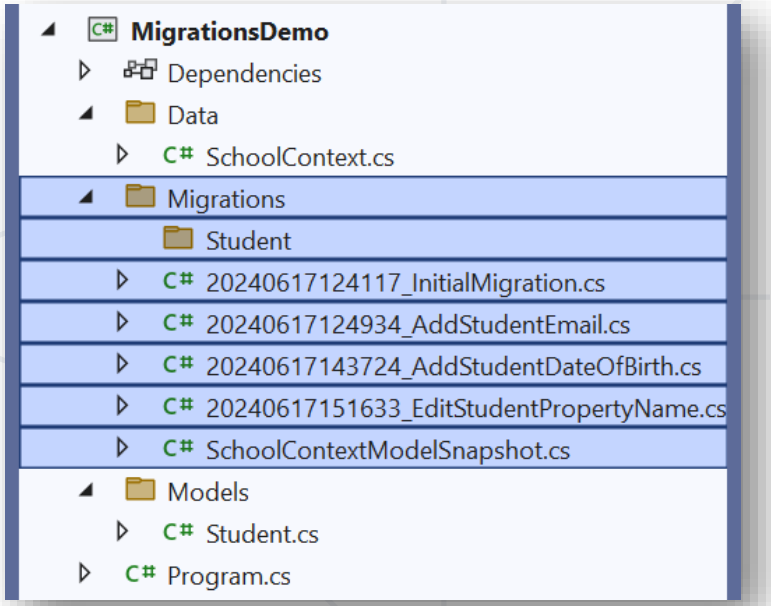
Listing All Migrations

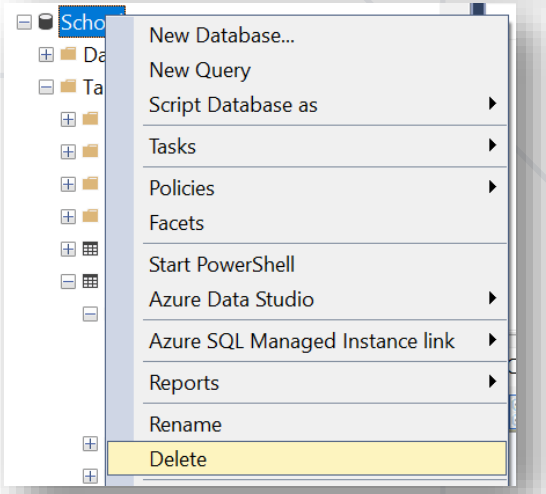
- All existing Migrations could be listed by executing '**Get-Migration**' command

```
PM> Get-Migration
Build started...
Build succeeded.

id                                      name                    safeName                applied
--                                      ----                    --------                -------
20240617124117_InitialMigration         InitialMigration        InitialMigration           True
20240617124934_AddStudentEmail          AddStudentEmail         AddStudentEmail           False
20240617143724_AddStudentDateOfBirth    AddStudentDateOfBirth   AddStudentDateOfBirth     False
20240617151633_EditStudentPropertyName  EditStudentPropertyName EditStudentPropertyName   False
```

Resetting All Migrations

- In some **extreme cases**, it may be necessary to **remove all migrations** and start over
- This can be easily done by **deleting** your '**Migrations**' folder and **dropping your database**
- At that point you **can create a new initial migration**, which will contain your entire current schema





Customize Migration Code

Review Migration Files

Why Customize Migrations

- **Real-World Requirements**
  - Default migration code may **not always meet specific** business or technical **requirements**
  - Customizing migrations allows for **more precise control** over the database schema changes
- **Complex Operations**
  - Perform **complex data transformations** or ensure data integrity during schema changes

How to Customize Migrations

- **After creating a migration**, EF Core generates code in the **Up** and **Down methods**
- You can **modify this code** to suit your **specific needs**
- One **example where customizing migrations is required** is when **renaming a property**

```
public class Student
{
    0 references
    public int Id { get; set; }

    0 references
    public string FullName { get; set; } = null!;

    0 references
    public int Age

    [Required]
    0 references
    public string

    0 references
    public DateTime DateOfBirth { get; set; }
}
```

FullName

Rename will update 5 references in 5 files.

☐ Include comments

☑ Include strings

Enter to rename, Shift+Enter to preview

Create Custom Migration

- **EF Core** is **unable to know when the intention is to drop a column and create a new one**, and when a column should be renamed
- If the above migration is applied as-is, all your student **names will be lost**
- To rename a column, **replace the above generated migration** with the following

```
migrationBuilder.DropColumn(
    name: "Name",
    table: "Students");

migrationBuilder.AddColumn<string>(
    name: "Name",
    table: "Students",
    nullable: false,
    defaultValue: "");
```

```
migrationBuilder.RenameColumn(
    name: "Name",
    table: "Students",
    newName: "FullName");
```

Tip

- The **migration scaffolding process warns** when an operation might result in **data loss** (like dropping a column)
- If you see that warning, be especially sure to **review the migrations** code for accuracy

What Else Could Be Customized?

- Adding / Altering Indexes
- Custom SQL commands
- Adding / Altering Constraints
  - Adding a Unique Constraint
  - Adding a Foreign Key Constraint
- Data Seeding
- Advanced Column Types and Computed Columns

Multiple Providers

Does Db Matter?

Multiple Db Providers

- The **EF Core Tools** only scaffold migrations for the **active provider**
- It is possible to maintain **multiple sets of migrations**
  - One for each provider
  - Adding a **migration to each**, for **every model change**
- Using **multiple context** types
- Using **one context** type

Reasons to Work With Multiple Providers

- Maybe you are **building an application** distributed as a **Software-as-a-Service** (**SaaS**) product
  - And a standalone **product your customers** can install in their data center
- **SaaS** may use **PostgreSQL**
- Customers may have standardized on **Microsoft SQL Server**
- Some customers prefer to use **Windows Server** and **SQL Server** database and others prefer to use **Linux** and **MySQL**

PostgreSQL in EF Core

- Add the **PotgreSQL provider** to your project

Npgsql.EntityFrameworkCore.PostgreSQL by Shay R 6.0.29
PostgreSQL/Npgsql provider for Entity Framework Core. 8.0.4

- **Updating** the **DbContext**

```
protected override void OnConfiguring(DbContextOptionsBuilder optionsBuilder)
{
    var provider = Environment.GetEnvironmentVariable("PROVIDER");

    if (provider == "PostgreSQL")
    {
        optionsBuilder.UseNpgsql("Host=localhost;Database=School;Username=postgres;Password=postgres");
    }
    else
    {
        optionsBuilder.UseSqlServer("Server=localhost;Database=School;Trusted_Connection=True;");
    }
}
```

Creating Migrations

- Create subfolders
  - In your project, create a '**Migrations**' folder if it doesn't already exist
  - Within the '**Migrations**' folder, create subfolders for each provider, for example:
    - '**SqlServerMigrations**'
    - '**PostgreSqlMigrations**'

Setting Up Environment Variables

- **Environment variables** store configuration settings outside the codebase
- Setting Environment Variables:
  - For **SQL Server**
    - `$env:PROVIDER="SqlServer"`
  - For **PostgreSQL**
    - `$env:PROVIDER="PostgreSQL"`

Setting Up Environment Variables

- **Environment Variable** can be easily checked through the **Package Manager Console**:
  - `echo $env:PROVIDER`

```
PM> $env:PROVIDER="PostgreSQL"
PM> echo $env:PROVIDER
PostgreSQL
PM>
```

- The Environment Variable value can be **switched** through the PM Console:

```
PM> $env:PROVIDER="PostgreSQL"
PM> echo $env:PROVIDER
PostgreSQL
PM> $env:PROVIDER="SqlServer"
PM> echo $env:PROVIDER
SqlServer
PM>
```

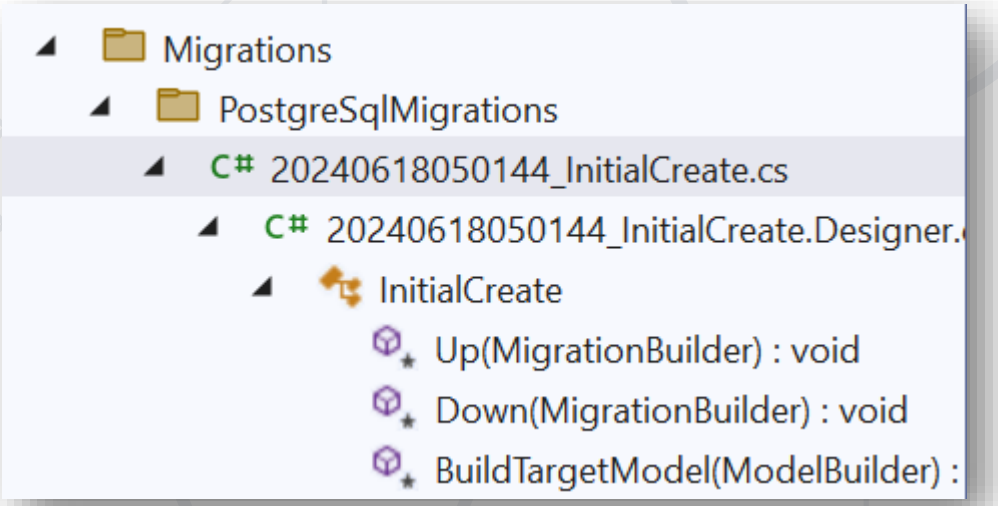
Creating a Migration for PostgreSQL

- Set the **correct Environment Variable value**
  - **`$env:PROVIDER="PostgreSQL"`**
- Create the migration and specify the output directory:
  - **`add-migration InitialCreate -o Migrations/PostgreSqlMigrations`**

```
PM> add-migration InitialCreate -o Migrations/PostgreSqlMigrations
Build started...
Build succeeded.
```

PostgreSQL Migration File

- The migration files are located in the specified subfolder




```
namespace MigrationsDemo.Migrations.PostgreSqlMigrations
{
    1 reference
    public partial class InitialCreate : Migration
    {
        0 references
        protected override void Up(MigrationBuilder migrationBuilder)
        {
            migrationBuilder.AlterColumn<string>(
                name: "FullName",
                table: "Students",
                type: "text",
                nullable: false,
                oldClrType: typeof(string),
                oldType: "nvarchar(max)");

            migrationBuilder.AlterColumn<string>(
                name: "Email",
                table: "Students",
                type: "text",
                nullable: false,
                oldClrType: typeof(string),
                oldType: "nvarchar(max)");

            migrationBuilder.AlterColumn<DateTime>(
                name: "DateOfBirth",
                table: "Students",
                type: "timestamp with time zone",
                nullable: false,
                oldClrType: typeof(DateTime),
                oldType: "datetime2");
```

Error Handling

Common Errors and Good Practices

Model and Database Schema Mismatch

- Occurs when the **model and the database are out of sync**
  - `System.InvalidOperationException: The model backing the 'DbContext' context has changed since the database was created.`
- Ensure all migrations are applied using '**Update-Database**'

Migration Conflicts

- Conflicts between migrations **created by different team members**
- Migration **conflicts can also happen locally**
  - This can occur if you make **multiple changes** to your model and generate **migrations without applying them in sequence**
  - **`System.Data.SqlClient.SqlException: There is already an object named 'TableName' in the database.`**

Migration Conflicts

- Solutions:
  - **Apply migrations in sequence** to keep the local database schema in sync with the model
  - Communicate and **coordinate migration creation** within the team
  - **Merge conflicting migrations manually** if necessary

SQL Syntax Errors

- **Errors in the SQL commands** generated by EF Core
  - `System.Data.SqlClient.SqlException: Incorrect syntax near 'keyword’.`
- Solution:
  - Review and **customize the migration code to correct SQL syntax**
  - Use 'migrationBuilder.Sql' to execute raw SQL if needed

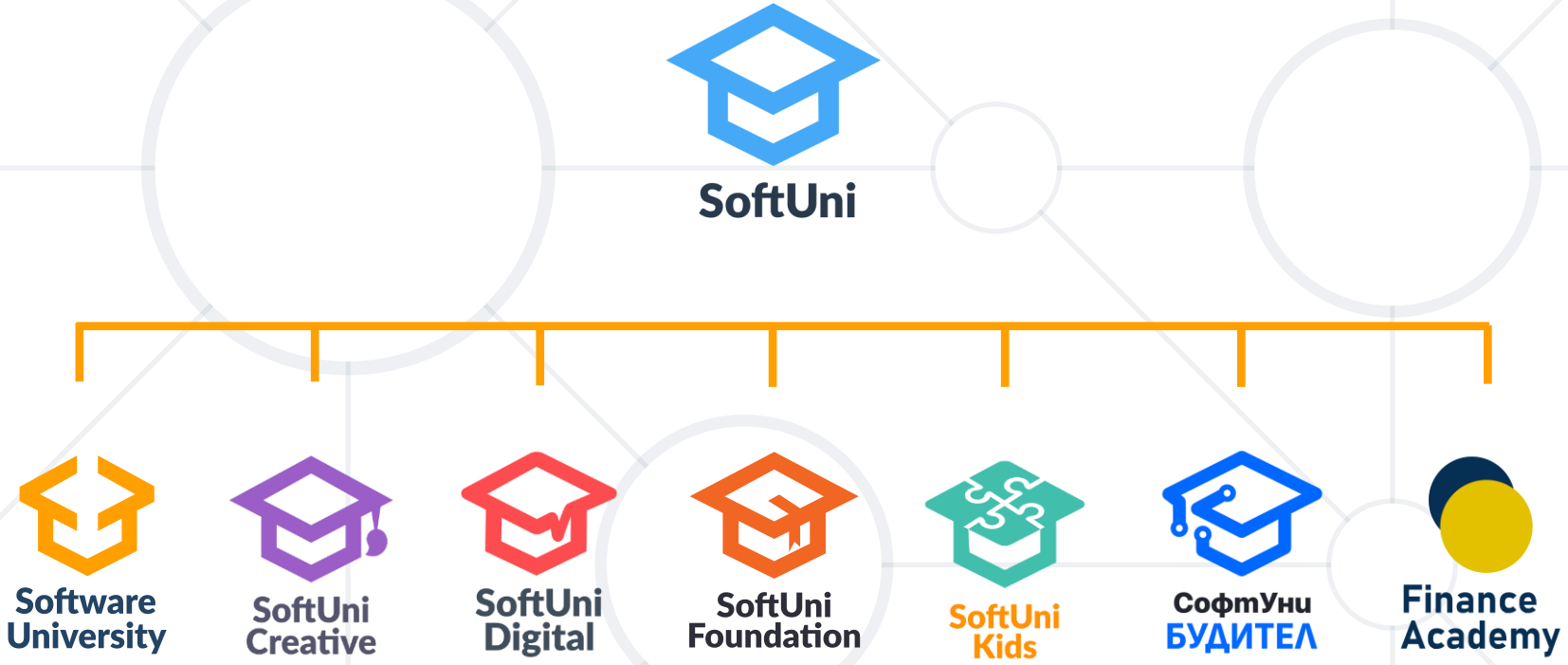
Data Loss Issues

- Risk of **data loss when dropping or renaming** columns incorrectly
- No specific error, but **data may be lost**
- Solution:
  - Use '**RenameColumn**' instead of dropping and adding columns
  - **Backup data** before applying risky migrations

Summary

- Purpose and benefits of migrations in EF Core
- Essential commands
- Creating and applying migrations
- Customizing migration code
- Configuring and managing connection strings
- Organizing migrations and applying them in sequence
- Error Handling

Questions?



SoftUni Diamond Partners

Software University

SmartIT

Coca-Cola HBC Bulgaria

SUPER HOSTING .BG

createX

Postbank

top EMPLOYER България Bulgaria 2024 FOR A BETTER WORLD OF WORK

DRAFT KINGS

THE CROWN IS YOURS

VIVACOM

INDEAVR

Serving the high achievers

AMBITIONED

PHAR VISION

Trainings @ Software University (SoftUni)

- Software University – High-Quality Education, Profession and Job for Software Developers
  - softuni.bg, about.softuni.bg
- Software University Foundation
  - softuni.foundation
- Software University @ Facebook
  - facebook.com/SoftwareUniversity

License

- This course (slides, examples, demos, exercises, homework, documents, videos and other assets) is **copyrighted content**
- Unauthorized copy, reproduction or use is illegal
- © SoftUni – https://about.softuni.bg
- © Software University – https://softuni.bg