DB Apps Introduction

Intro to ADO.NET

SoftUni Team

Technical Trainers

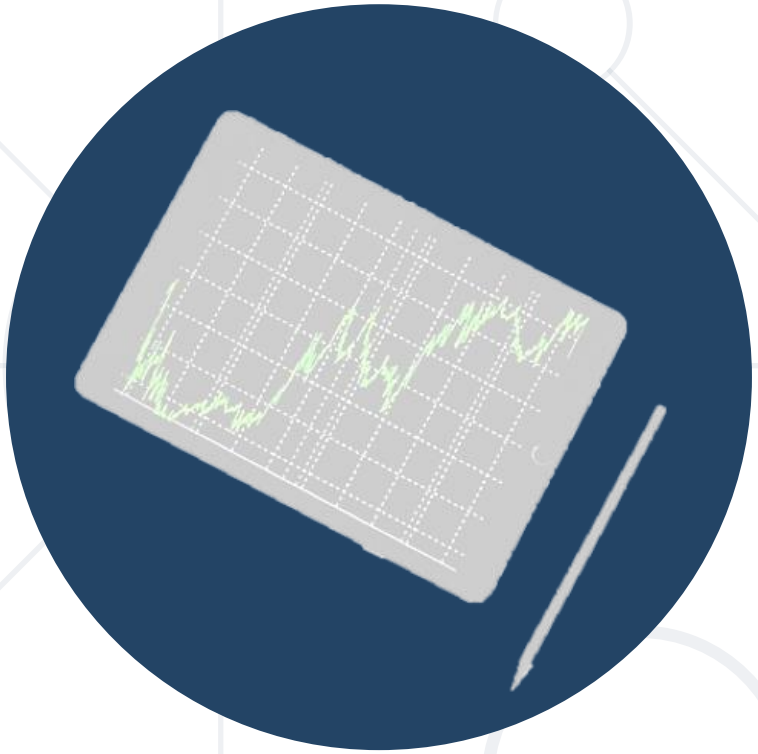
Software University

SoftUni Foundation

Software University

http://softuni.bg

Table of Contents

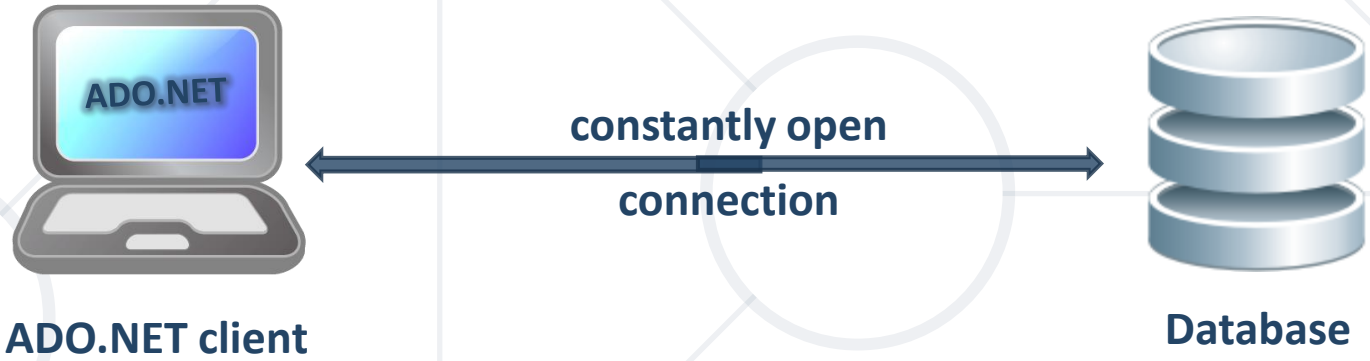


Data Access Models

Connecting to a DB through C#

Connected Model

- **Connected data access model**
  - Applicable to an environment where the database is constantly available



Connected Model: Benefits and Drawbacks

SoftUni Foundation

- **Connected data access model (SqlClient)**
  - **Benefits**:
    - Concurrency control is easier to maintain
    - Better chance to work with the most recent version of the data
  - **Drawbacks**:
    - Needs a constant reliable network
    - Problems when scalability is an issue

ADO.NET Architecture

What Is ADO.NET?

SoftUni Foundation

- ADO.NET is a standard **.NET class library** for accessing databases, processing data and XML
- Supports connected, disconnected and ORM data access models
  - Excellent integration with **LINQ**
  - Allows executing SQL in **RDBMS** systems
  - Allows accessing data in the **ORM** approach

Data Providers in ADO.NET

SoftUni Foundation

- Data Providers are collections of classes that provide access to various databases
  - For different RDBMS systems different **Data Providers** are available
- Several common objects are defined
  - **Connection** – to connect to the database
  - **Command** – to run an SQL command
  - **DataReader** – to retrieve data

Data Providers in ADO.NET (2)

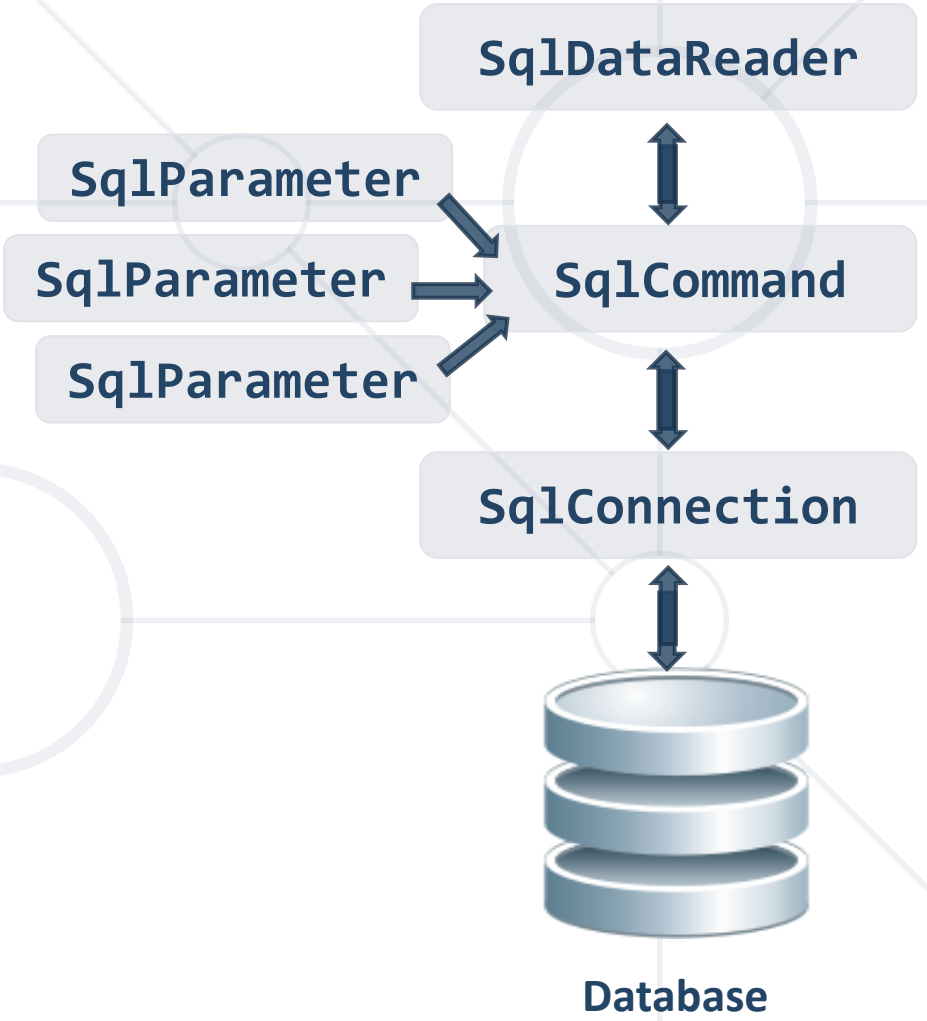
SoftUni Foundation

- Several standard ADO.NET Data Providers come as part of .NET Framework
  - **SqlClient** – accessing **SQL Server**
  - **OleDB** – accessing standard **OLE DB** data sources
  - **Odbc** – accessing standard **ODBC** data sources
  - **Oracle** – accessing **Oracle** databases
- Third party Data Providers are available for:
  - **MySQL**, **PostgreSQL**, **Interbase**, **DB2**, **SQLite**
  - Other RDBMS systems and data sources
    - SQL Azure, Salesforce CRM, Amazon SimpleDB, …

SqlClient and ADO.NET Connected Model

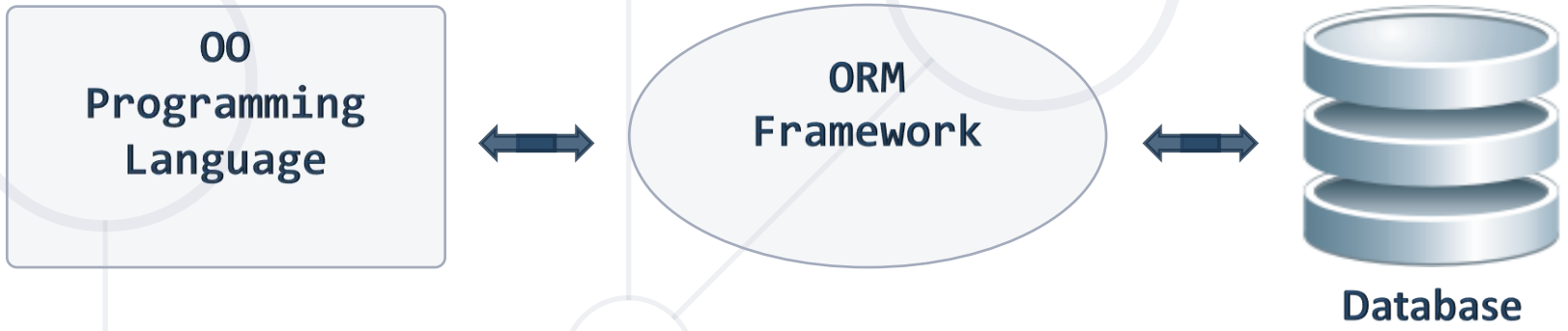
SoftUni Foundation

- Retrieving data in connected model
  - Open a connection (**SqlConnection**)
  - Execute command (**SqlCommand**)
  - Process the result set of the query by using a reader (**SqlDataReader**)
  - Close the reader
  - Close the connection



ORM Model

- **ORM data access model** (Entity Framework Core)
  - Maps **database tables** to **classes** and **objects**
  - Objects can be **automatically persisted** in the database
  - Can operate in both connected and disconnected modes



ORM Model – Benefits and Problems

SoftUni Foundation

- **ORM** model benefits
  - Less code
  - Use objects with **associations** instead of tables and SQL
  - Integrated object query mechanism
- ORM model drawbacks:
  - Less flexibility
    - SQL is automatically generated
  - Performance issues (sometimes)

ADO.NET: Entity Framework Core

SoftUni Foundation

- **Entity Framework Core** is a generic **ORM** framework
  - Create entity data model mapping the database
  - Open an object context
  - Retrieve data with LINQ / modify the tables in the object context
  - Persist the object context changes into the DB
  - Connection is automatically managed

SQL Client Data Provider

SqlClient Data Provider

- **SqlConnection**
  - Establish database connection to SQL Server
- **SqlCommand**
  - Executes SQL commands on the SQL Server through an established connection
  - Could accept parameters (**SQLParameter**)
- **SqlDataReader**
  - Retrieves data (record set) from SQL Server as a result of SQL query execution

The SqlConnection Class

- **SqlConnection** establishes a connection to SQL Server database
  - Requires a valid connection string
- Connection string example:

```
Data Source=(local)\SQLEXPRESS;Initial
Catalog=SoftUni;Integrated Security=true;
```

- Connecting to SQL Server:

```
SqlConnection con = new SqlConnection(
 @"Server=.;
   Database=SoftUni;
   Integrated Security=true");
con.Open();
```

SqlConnection – Example

- Creating and opening connection to SQL Server (database **SoftUni**)

```
SqlConnection dbCon = new SqlConnection(
    "Server=.\\SQLEXPRESS; " +
    "Database=SoftUni; " +
    "Integrated Security=true");
dbCon.Open();
using (dbCon)
{
 //TODO: Use the connection to execute SQL commands here …
}
```

DB Connection String

- **Database connection string**
  - Defines the parameters needed to establish the connection to the database
- Settings for **SQL Server connections**:
  - **Data Source** / **Server** – server name / IP address + database instance name
  - **Database** / **Initial Catalog** – database name
  - **User ID** / **Password** – credentials
  - **Integrated Security** – false if credentials are provided

Working with SqlConnection

SoftUni Foundation

- Explicitly opening and closing a connection
  - **Open()** and **Close()** methods
  - Works through the connection pool
- DB connections are **IDisposable** objects
  - Always use the **using** construct in C#!

The SqlCommand Class

SoftUni Foundation

- More important methods
  - **ExecuteScalar()**
    - Returns a single value - the value in the first column of the first row of the result set (as **System.Object**)
  - **ExecuteReader()**
    - Returns a **SqlDataReader**
      - It is a cursor over the returned records (result set)
    - **CommandBehavior** – assigns some options
  - **ExecuteNonQuery()**
    - Used for non-query SQL commands, e.g. **INSERT**
    - Returns the number of affected rows (**int**)

SqlCommand – Example


```
SqlConnection dbCon = new SqlConnection(
  "Server=.; " +
  "Database=SoftUni; " +
  "Integrated Security=true");
dbCon.Open();
using(dbCon)
{
  SqlCommand command = new SqlCommand(
    "SELECT COUNT(*) FROM Employees", dbCon);
  int employeesCount = (int) command.ExecuteScalar();
  Console.WriteLine("Employees count: {0} ", employeesCount);
}
```

The SqlDataReader Class

- **SqlDataReader** retrieves a sequence of records (cursor) returned as result of an SQL command
  - Data is available for reading only (can't be changed)
  - Forward-only row processing (no move back)
- Important properties and methods:
  - **Read()** – moves the cursor forward and returns false if there is no next record
  - **Indexer[]** – retrieves the value in the current record by given column name or index
  - **Close()** – closes the cursor and releases resources

SqlDataReader – Example

SoftUni Foundation

```
SqlConnection dbCon = new SqlConnection(…);
dbCon.Open();
using(dbCon)
{
  SqlCommand command = new SqlCommand("SELECT * FROM Employees", dbCon);
  SqlDataReader reader = command.ExecuteReader();
  using (reader)
  {
    while (reader.Read())
    {
      string firstName = (string)reader["FirstName"];
      string lastName = (string)reader["LastName"];
      decimal salary = (decimal)reader["Salary"];
      Console.WriteLine("{0} {1} - {2}", firstName, lastName, salary);
    }
  }
}
```

Fetch more rows until finished

SQL Injection

What is SQL Injection? How to Prevent It?

What is SQL Injection? (1)

SoftUni Foundation

```
bool IsPasswordValid(string username, string password)
{
  string sql =
    $"SELECT COUNT(*) FROM Users " +
    $"WHERE UserName = '{username}' AND" +
    $"PasswordHash = '{CalcSHA1(password)}'";
  SqlCommand cmd = new SqlCommand(sql, dbConnection);

  int matchedUsersCount = (int)cmd.ExecuteScalar();
  return matchedUsersCount > 0;
}
```

What is SQL Injection? (2)

SoftUni Foundation

```
bool normalLogin =
  IsPasswordValid("peter", "qwerty123"); // true

bool sqlInjectedLogin =
  IsPasswordValid(" ' or 1=1 --", "qwerty123"); // true

bool evilHackerCreatesNewUser =
  IsPasswordValid("' INSERT INTO Users VALUES('hacker','') --",
  "qwerty123");
```

How Does SQL Injection Work?

SoftUni Foundation

- The following SQL commands are executed:
  - Usual password check (no SQL injection):

```
SELECT COUNT(*) FROM Users WHERE UserName = 'peter’
AND PasswordHash = 'XOwXWxZePV5iyeE86Ejvb+rIG/8='
```

  - SQL-injected password check:

```
SELECT COUNT(*) FROM Users WHERE UserName = ' ' or 1=1
-- ‘ AND PasswordHash = 'XOwXWxZePV5iyeE86Ejvb+rIG/8='
```

  - SQL-injected INSERT command:

```
SELECT COUNT(*) FROM Users WHERE UserName = ''
INSERT INTO Users VALUES('hacker','')
--’ AND PasswordHash = 'XOwXWxZePV5iyeE86Ejvb+rIG/8='
```

Preventing SQL Injection

SoftUni Foundation

- Ways to prevent the SQL injection:
  - SQL-escape all data coming from the user:

```
string escapedUsername = username.Replace("'", "''");
string sql =
    "SELECT COUNT(*) FROM Users " +
    "WHERE UserName = '" + escapedUsername + "' and " +
    "PasswordHash = '" + CalcSHA1(password) + "'";
```

    - Not recommended: use as last resort only!
  - Preferred approach:
    - Use **parameterized queries**
    - Separate the SQL command from its arguments

The SqlParameter Class

- What are **SqlParameters**?
  - SQL queries and stored procedures can have input and output parameters
  - Accessed through the **Parameters** property of the **SqlCommand** class
- Properties of **SqlParameter**:
  - **ParameterName** – name of the parameter
  - **DbType** – SQL type (**NVarChar**, **Timestamp**, …)
  - **Size** – size of the type (if applicable)
  - **Direction** – input / output

Parameterized Commands – Example

SoftUni Foundation

```
void InsertProject(string name, string description, DateTime startDate)
{
  SqlCommand cmd = new SqlCommand(
    "INSERT INTO Projects " +
    "(Name, Description, StartDate, EndDate) VALUES " +
    "(@name, @desc, @start, @end)", dbCon);

  cmd.Parameters.AddWithValue("@name", name);
  cmd.Parameters.AddWithValue("@desc", description);
  cmd.Parameters.AddWithValue("@start", startDate);

  cmd.ExecuteNonQuery();
}
```

Connecting to Non-Microsoft Databases

Connecting to Non-Microsoft Databases

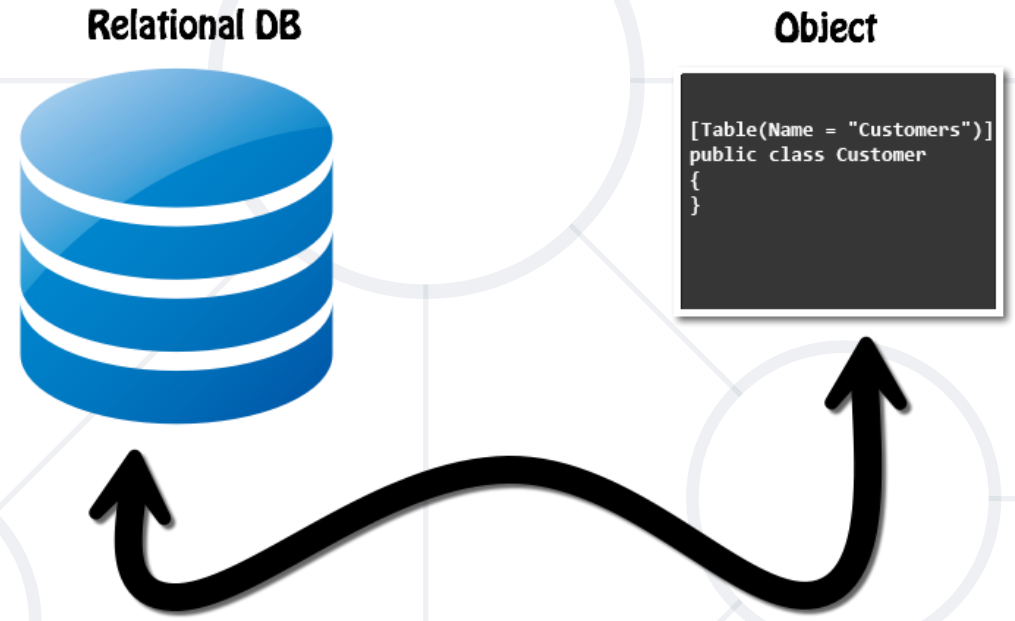
- ADO.NET supports accessing various databases via their Data Providers:
  - **OLE DB** – supported internally in ADO.NET
    - Access any OLE DB-compliant data source
    - E.g. MS Access, MS Excel, MS Project, MS Exchange, Windows Active Directory, text files
  - **Oracle** – supported internally in ADO.NET
  - **MySQL** – third party extension

Summary

- ADO.NET provides an interface between our apps and the database engine
- Different engines can be used with other data providers
- SQL commands must be parametrized to prevent malicious behavior

ORM Fundamentals

The ORM Concept, Config, CRUD Operations



SoftUni Team

Technical Trainers

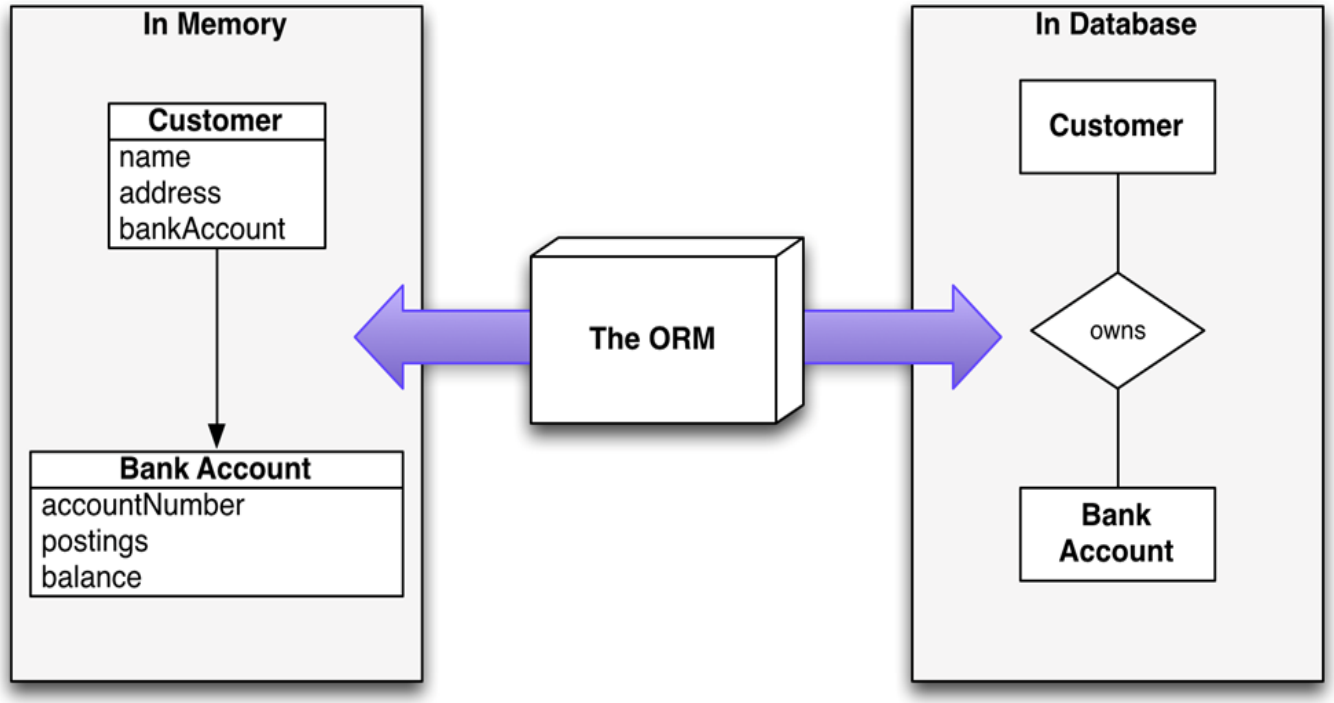
Software University

SoftUni Foundation

Software University

http://softuni.bg

Table of Contents

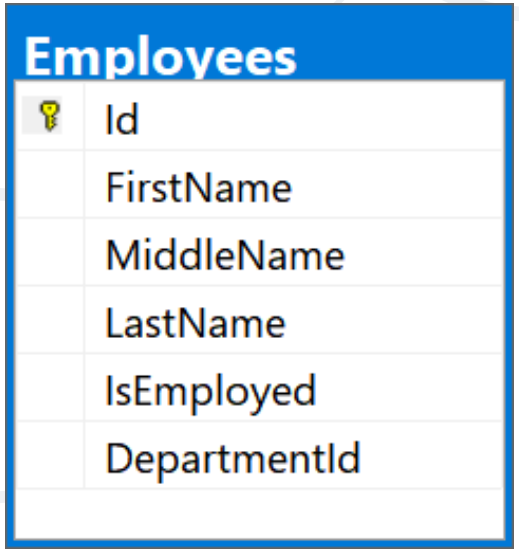


Introduction to ORM

Object-Relational Mapping

What is ORM?

- **Object-Relational Mapping** (ORM) allows manipulating databases **using common classes and objects**
  - **Database Tables → C#/Java/etc. classes**



```
public class Employee
{
    public int Id { get; set; }
    public string FirstName { get; set; }
    public string MiddleName { get; set; }
    public string LastName { get; set; }
    public bool IsEmployed { get; set; }
    public Department Department { get; set; }
}
```

ORM Frameworks: Features

- **ORM frameworks** typically **provide** the following functionality:
  - **Automatically generate SQL** to perform data operations

```
database.Employees.Add(new Employee
{
   FirstName = "Gosho",
   LastName = "Ivanov",
   IsEmployed = true    });
```

```
INSERT INTO Employees
(FirstName, LastName, IsEmployed)
VALUES
('Gosho', 'Ivanov', 1)
```

  - **Create object model from database schema** (DB First model)
  - **Create database schema from object model** (Code First model)
  - **Query data by object-oriented API** (e.g. LINQ queries)

ORM Advantages and Disadvantages

SoftUni Foundation

- Object-relational mapping (ORM) **advantages**:
  - Developer productivity: **writing less code**
  - Abstract from differences between object and relational world
  - **Manageability of the CRUD operations** for complex relationships
  - **Easier maintainability**
- **Disadvantages**:
  - **Reduced performance** (due to overhead or autogenerated SQL)
  - **Reduces flexibility** (some operations are hard to implement)

Custom ORM Framework

Overview and Features

MiniORM Core: Overview

- Designed after **Entity Framework Core**
- Provides **LINQ-based data queries** and **CRUD operations**
- **Change tracking** of in-memory objects
- Maps navigation properties
- Maps collections
  - **One-to-many**, **Many-to-many**, etc.

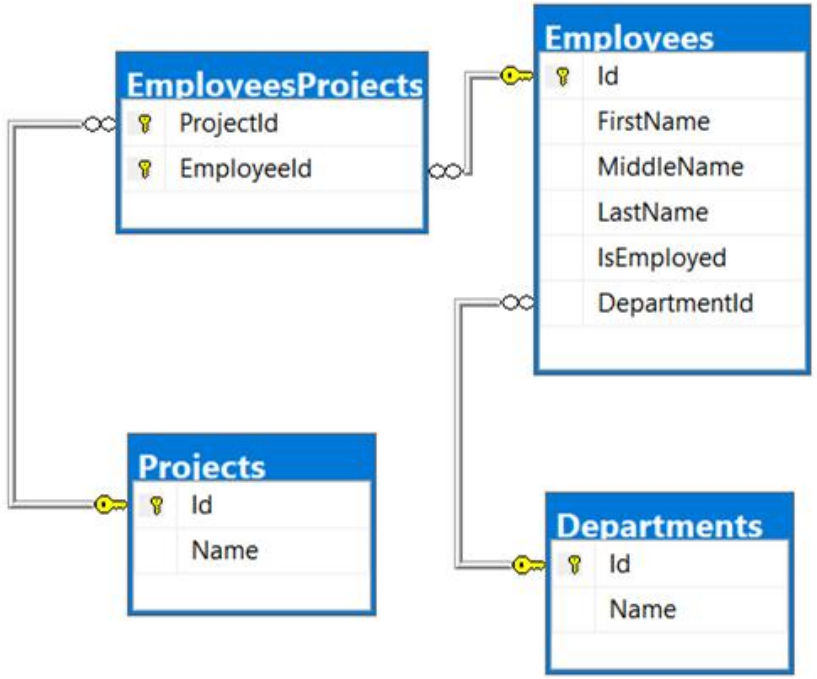
MiniORM Core Workflow: Overview

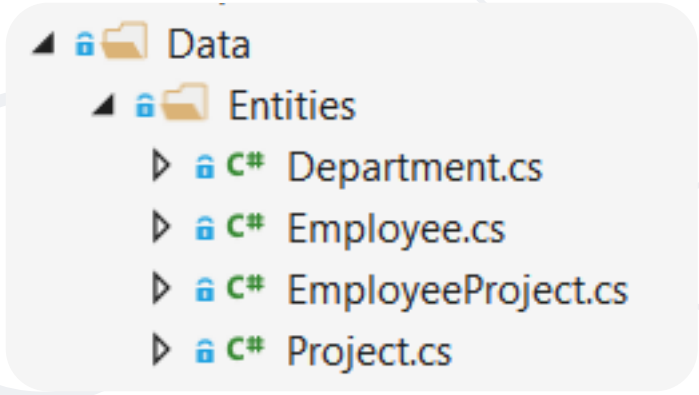
SoftUni Foundation

- **Define data model** (database-first)
  - Entity Classes
  - **DbContext** (with **DbSets**)
- Initialize **DbContext**
  - Using connection string
- Query data using context
- Manipulate data (add/remove/update entities)
- Context gets persisted into database

Database First Model

- **Database First model** - models the entity classes after the database





MiniORM Components

- The **DbContext** class
  - Holds the **database connection** and the **DB Sets**
  - Provides **LINQ-based** data access
  - Provides **change tracking**, and an API for **CRUD** operations
- **DB Sets**
  - Hold **entities** (objects with their attributes and relations)
  - Each database **table** is typically mapped to a single **C# class**

MiniORM Components (2)

- **Associations** (relationship mappings)
  - An association is **a primary key** / **foreign key**-based **relationship** between two entity classes
  - Allows **navigation** from one entity to another

```
var courses = student.Courses.Where(…);
```

  - MiniORM **supports one-to-one**, **one-to-many** and **many-to-many** relationships

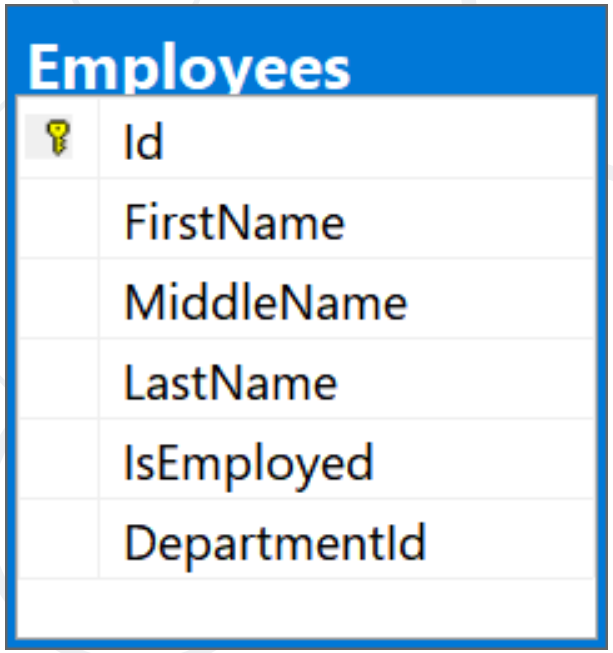
```
public class Employee
{
    public int Id { get; set; }
    public string FirstName { get; set; }
    public string MiddleName { get; set; }
    public string LastName { get; set; }
    public bool IsEmployed { get; set; }
    public Department Department { get; set; }
}
```

Entity Classes

Data Holders

Entity Classes

- **Entity classes** are regular **C# classes**
- Used for **storing** the **data** from the DB **in-memory**



```
public class Employee
{
    public int Id { get; set; }
    public string FirstName { get; set; }
    public string MiddleName { get; set; }
    public string LastName { get; set; }
    public bool IsEmployed { get; set; }
    public Department Department { get; set; }
}
```

Entity Classes: Navigation Properties

SoftUni Foundation

- Reference type properties
- Point to relevant object, connected by foreign key
- Set by the framework
- Example: Employee's Department:

```
public class Employee {
    public int Id { get; set; }
    ...
    [ForeignKey(nameof(Department))]
    public int DepartmentId { get; set; }
    public Department Department { get; set; }
}
```

Entity Classes: Navigation Properties (2)

SoftUni Foundation

- Navigation Properties can also be collections
- Usually of type **ICollection<T>**
- Holds all of the objects whose **foreign keys** are the same as the entity's **primary key**
- Set by the ORM framework

```
public class Department
{
  public int Id { get; set; }
  ...
  public ICollection<Employee> Employees { get; set; }
}
```

```
public class DbSet<TEntity> : ICollection<TEntity>
    where TEntity : class, new()
{
    internal DbSet([NotNull] IEnumerable<TEntity> entities)...

    internal ChangeTracker<TEntity> ChangeTracker { get; set; }

    internal IList<TEntity> Entities { get; set; }

    public void Add(TEntity item)...

    public void Clear()...

    public bool Contains(TEntity item) => this.Entities.Contains(item);
```

DbSet<T>

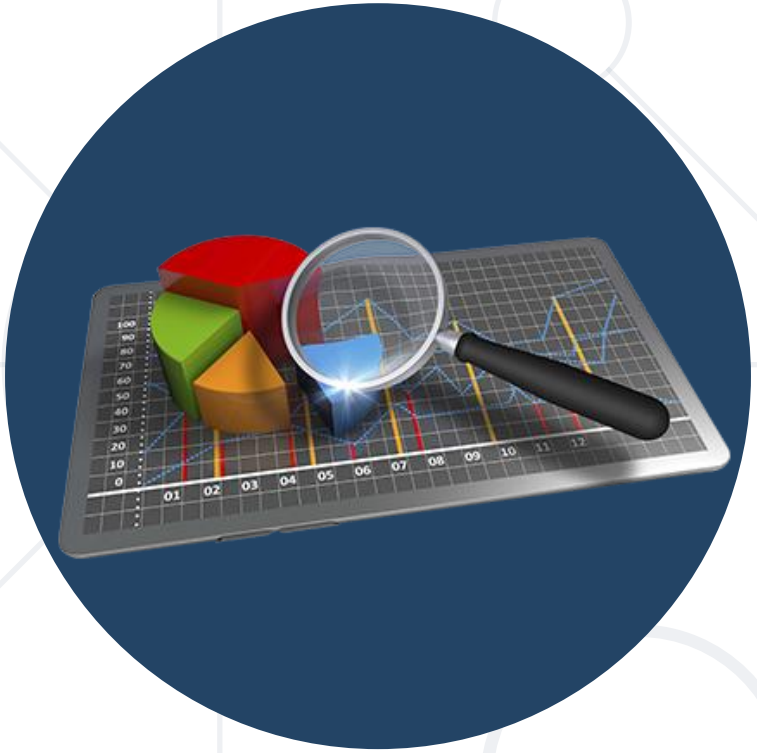
Specialized Collections

DbSet<T> Class

- Generic collection with additional features
- Each **DbSet<T>** corresponds to a single database table
- Inherits from **ICollection<T>**
  - **foreach**-able
  - Supports **LINQ** operations
- Usually several **DbSets** are part of a **DbContext**

DbSet<T> Features

- Each DbSet tracks its own entities through a change tracker
- Has every other feature of an ICollection<T>
  - **Adding**/**Updating** elements
  - **Removing** an entity/a range of entities
  - **Checking** for element **existence**
  - Accessing the **count** of elements



DbContext

DbContext Class

SoftUni Foundation

- Holds several **DbSet<T>**
- Responsible for **populating** the **DbSets**
- Users create a **DbContext**, which **inherits** from **DbContext**
  - Using one DbSet per database table

```
public class SoftUniDbContext : DbContext
{
   public DbSet<Employee> Employees { get; }
   public DbSet<Department> Departments { get; }
   public DbSet<Project> Projects { get; }
   public DbSet<EmployeeProject> EmployeesProjects { get; }
}
```

```
internal class ChangeTracker<T>
    where T: class, new()
{
    private readonly List<T> allEntities;

    private readonly List<T> added;

    private readonly List<T> removed;

    public ChangeTracker(IEnumerable<T> entities)...

    private static List<T> CloneEntities(IEnumerable<T> entities)...

    public IReadOnlyCollection<T> AllEntities => this.allEntities.AsReadOnly();

    public IReadOnlyCollection<T> Added => this.added.AsReadOnly();

    public IReadOnlyCollection<T> Removed => this.removed.AsReadOnly();
```

ChangeTracker<T>

Change Tracking Class

ChangeTracker<T>

- Container for tracking changes
- Holds 3 collections:
  - **All** entities
  - **Added** entities
  - **Removed** entities
- Also can track **modified entities**
  - Through **cloning entities** at initialization

ChangeTracker<T>: Cloning Entities

SoftUni Foundation

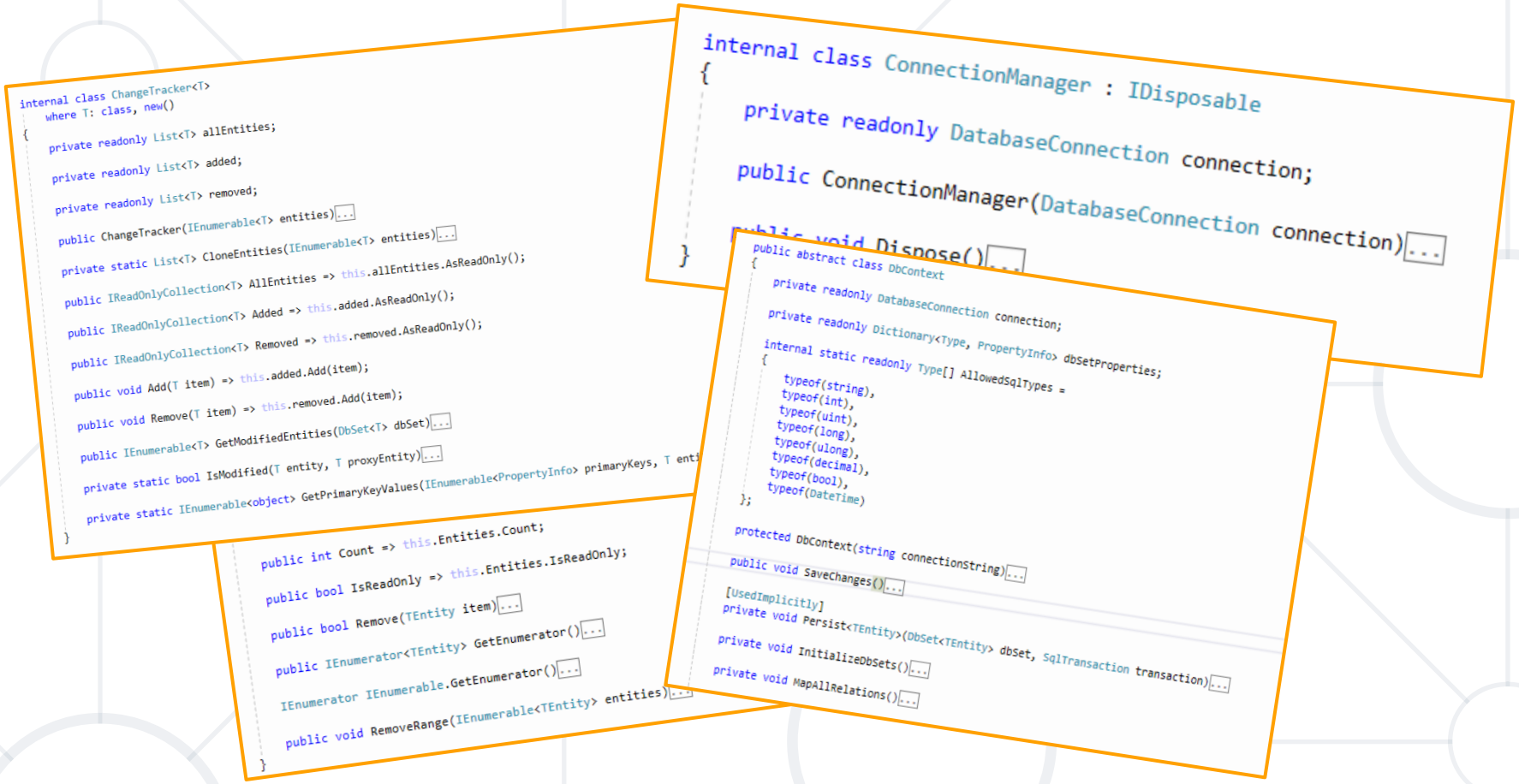
- In order to check for entity modification, the change tracker **clones** all entities on initialization
- Cloning process:
  - Create **new** blank **instance** of entity
  - Find all **properties**, which are valid SQL types
  - Set blank instance's property **values** to existing entity values

ChangeTracker<T>: Cloning Entities (2)

SoftUni Foundation

- Cloning Process:

```
private static List<T> CloneEntities(IEnumerable<T> entities)
{
  var clonedEntities = new List<T>();
  var propertiesToClone =
// TODO: get properties with SQL types

foreach (var entity in entities) {
    var clonedEntity = Activator.CreateInstance<T>();
    foreach (var property in propertiesToClone) {
      var value = property.GetValue(entity);
      property.SetValue(clonedEntity, value);
    }
    clonedEntities.Add(clonedEntity);
  }
  return clonedEntities;
}
```



Writing an ORM Framework

Live Demo

Reading Data

Querying the DB using MiniORM

Using DbContext Class

- First create instance of the **DbContext**:

```
var context = new SoftUniDbContext(connectionString);
```

- In the constructor you can pass a database connection string
- DbContext **properties**:
  - All **entity classes** (tables) are listed as **properties**
    - e.g. **DbSet<Employee> Employees { get;}**

Reading Data with LINQ Query

SoftUni Foundation

- Executing **LINQ-to-Entities** query over entity:

```
var context = new
SoftUniDbContext(connectionString)

var employees = context.Employees
  .Where(e => e.JobTitle == "Design Engineer")
  .ToArray();
```

- **Employees** property in the **DbContext**:

```
public class SoftUniDbContext : DbContext
{
  public DbSet<Employee> Employees { get; }
  public DbSet<Project> Projects { get; }
  public DbSet<Department> Departments { get; }
}
```

Reading Data with LINQ Query

SoftUni Foundation

- We can also use **extension methods** for constructing the query

```
var context = new
SoftUniDbContext(connectionString)
var employees = context.Employees
    .Where(c => c.JobTitle == "Design Engineering")
    .Select(c => c.FirstName)
    .ToList();
```

- Find element by **ID**

```
var context = new SoftUniEntities()
var project = context.Projects
      .Single(e => e.Id == 2);
Console.WriteLine(project.Name);
```

CRUD Operations

With MiniORM

Creating New Entities

- To create a new database row use the method **Add(…)** of the corresponding DbSet:

```
var project = new Project()
{
  Name = "Judge System"
};

context.Projects.Add(project);
context.SaveChanges();
```

Create a new Project object

Add the object to the DbSet

Execute SQL statements

Updating Existing Entities

- **DbContext** allows modifying entity properties and persisting them in the database
  - Just load an entity, modify it and call **SaveChanges()**
- The **DbContext** automatically tracks all **changes** made on its entity **objects**

```
Employees employee =
  context.Employees.First();
employees.FirstName = "Alex";
context.SaveChanges();
```

SELECT the first order

Execute an SQL UPDATE

Deleting Existing Data

- Delete is done by **Remove()** on the specified entity collection
- **SaveChanges()** method performs the delete action in the database

```
Employees employee =
  softUniEntities.Employees.First();
softUniEntities.Employees.Remove(employee);
softUniEntities.SaveChanges();
```

Mark the entity for deleting at the next save

Execute the SQL DELETE command

Summary

- **ORM frameworks** map database schema to objects in a programming language
- **LINQ** can be used to query the DB through the **DB context**

```
var employees = context.Employees
   .Where(c => c.JobTitle == "Design
Engineering")
   .Select(c => c.FirstName)
   .ToList();
```

Introduction to Entity Framework Core

The ORM Concept, Config, CRUD Operations

SoftUni Team

Technical Trainers

Software University

SoftUni Foundation

Software University

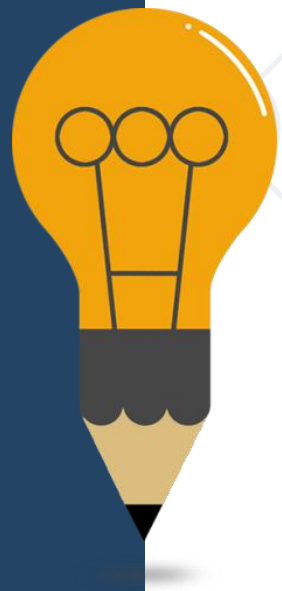
http://softuni.bg

Table of Contents

Entity Framework Core

Overview and Features

Entity Framework Core: Overview

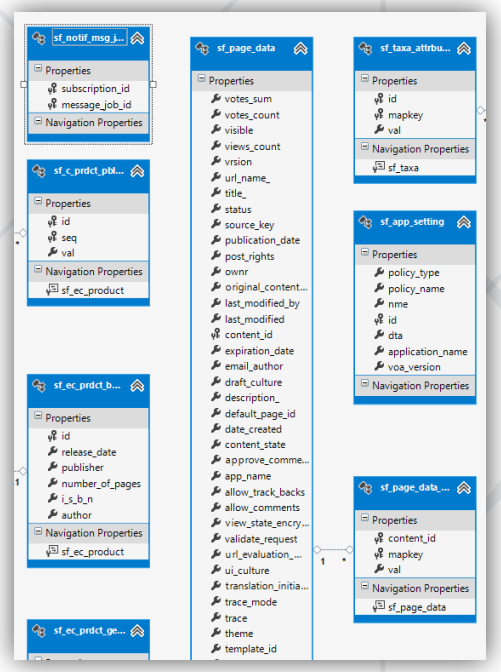


- The standard **ORM framework** for **.NET** and **.NET Core**
- Provides LINQ-based data queries and **CRUD** operations
- Automatic **change tracking** of in-memory objects
- Works with many relational databases (with different providers)
- Open source with independent release cycle

EF Core: Basic Workflow

SoftUni Foundation

1. Define the data model (**Code First** or **Scaffold from DB**)



2. Write & execute query over **IQueryable**

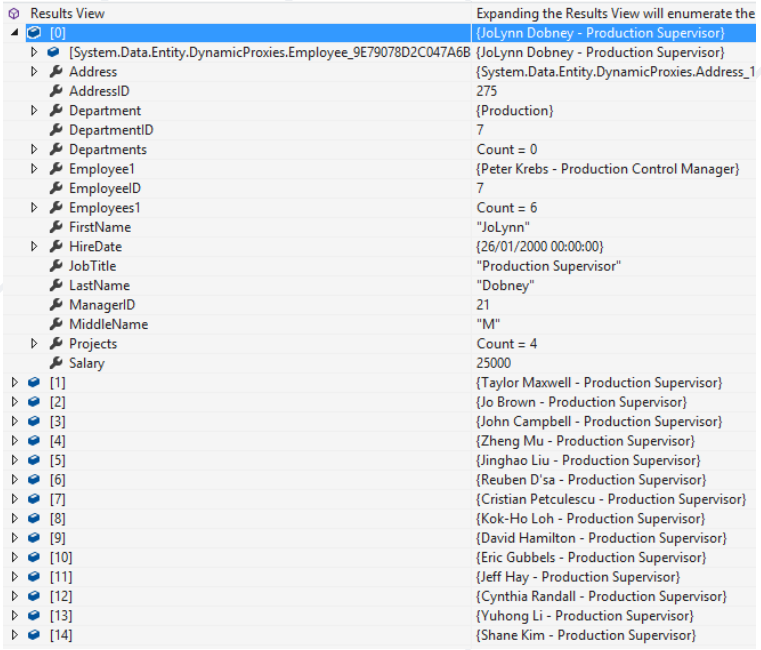
```
var toolName = "";

var snippetOptions = DefaultToolGroup
    .Tools
    .OfType<EditorListTool>()
    .Where(t =>
        t.Name == toolName &&
        t.Items != null &&
        t.Items.Any())
    .SelectMany(
        (t, index) =>
            t.Items
            .Select(item =>
                new {
                    text = item.Text,
                    value = item.Value
                }));

if (snippetOptions.Any())
{
    options[toolName] = snippetOptions;
}
```

3. EF generates & executes an **SQL query** in the **DB**

```
exec sp_executesql N'SELECT
[Filter2].[UserInCourseId] AS [UserInCourse
[Filter2].[UserId] AS [UserId],
[Filter2].[CourseInstanceId1] AS [CourseIns
[Filter2].[FirstCourseGroupId] AS [FirstCou
[Filter2].[SecondCourseGroupId] AS [SecondC
[Filter2].[ThirdCourseGroupId] AS [ThirdCou
[Filter2].[FourthCourseGroupId] AS [FourthC
[Filter2].[FifthCourseGroupId] AS [FifthCou
[Filter2].[IsLiveParticipant] AS [IsLivePar
[Filter2].[Accommodation] AS [Accommodatior
[Filter2].[ExcellentResults] AS [ExcellentR
[Filter2].[Result] AS [Result],
[Filter2].[CanDoTestExam] AS [CanDoTestExam
[Filter2].[CourseTestExamId] AS [CourseTest
[Filter2].[TestExamPoints] AS [TestExamPoir
[Filter2].[CanDoPracticalExam] AS [CanDoPra
[Filter2].[CoursePracticalExamId1] AS [Cour
[Filter2].[PracticalExamPoints] AS [Practic
[Filter2].[AttendancesCount] AS [Attendance
[Filter2].[HomeworkEvaluationPoints] AS [Ho
FROM   (SELECT [Extent1].[UserInCourseId] A
AS [SecondCourseGroupId], [Extent1].[ThirdC
[IsLiveParticipant], [Extent1].[Accommodati
[CourseTestExamId], [Extent1].[TestExamPoir
[PracticalExamPoints], [Extent1].[Attendanc
        FROM  [courses].[UsersInCourses] AS
        INNER JOIN [courses].[CoursePractic
        WHERE ( EXISTS (SELECT
                1 AS [C1]
                FROM [courses].[CoursePract
                WHERE [Extent1].[UserInCour
        )) AND ([Extent2].[AllowExamFilesEv
INNER JOIN [courses].[CoursePracticalExams]
WHERE ([Filter2].[UserId] = @p__linq__0) AN
```

EF Core: Basic Workflow (2)

4. EF transforms the query results into .NET objects



Results View	Expanding the Results View will enumerate the
[0]	{JoLynn Dobney - Production Supervisor}
[System.Data.Entity.DynamicProxies.Employee_9E79078D2C047A6B	{JoLynn Dobney - Production Supervisor}
Address	{System.Data.Entity.DynamicProxies.Address_1
AddressID	275
Department	{Production}
DepartmentID	7
Departments	Count = 0
Employee1	{Peter Krebs - Production Control Manager}
EmployeeID	7
Employees1	Count = 6
FirstName	"JoLynn"
HireDate	{26/01/2000 00:00:00}
JobTitle	"Production Supervisor"
LastName	"Dobney"
ManagerID	21
MiddleName	"M"
Projects	Count = 4
Salary	25000
[1]	{Taylor Maxwell - Production Supervisor}
[2]	{Jo Brown - Production Supervisor}
[3]	{John Campbell - Production Supervisor}
[4]	{Zheng Mu - Production Supervisor}
[5]	{Jinghao Liu - Production Supervisor}
[6]	{Reuben D'sa - Production Supervisor}
[7]	{Cristian Petculescu - Production Supervisor}
[8]	{Kok-Ho Loh - Production Supervisor}
[9]	{David Hamilton - Production Supervisor}
[10]	{Eric Gubbels - Production Supervisor}
[11]	{Jeff Hay - Production Supervisor}
[12]	{Cynthia Randall - Production Supervisor}
[13]	{Yuhong Li - Production Supervisor}
[14]	{Shane Kim - Production Supervisor}

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

```
private void ChangeBlogPostName(int id,
    string newName)
{
    var db = new Context();

    var post = db.Posts
        .FirstOrDefault(x => x.Id == id);

    if (post == null)
    {
        throw new ArgumentException(
            "Item with that id was not fo
            "id");
    }

    post.Name = newName;

    db.SaveChanges();
}
```

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

```
SELECT
[Extent1].[EmployeeID] AS [EmployeeID],
[Extent1].[FirstName] AS [FirstName],
[Extent1].[LastName] AS [LastName],
[Extent1].[MiddleName] AS [MiddleName],
[Extent1].[JobTitle] AS [JobTitle],
[Extent1].[DepartmentID] AS [DepartmentID],
[Extent1].[ManagerID] AS [ManagerID],
[Extent1].[HireDate] AS [HireDate],
[Extent1].[Salary] AS [Salary],
[Extent1].[AddressID] AS [AddressID]
FROM [dbo].[Employees] AS [Extent1]
WHERE N'Production Supervisor' = [Extent1].[JobTitle]
```

Entity Framework Core: Setup

SoftUni Foundation

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

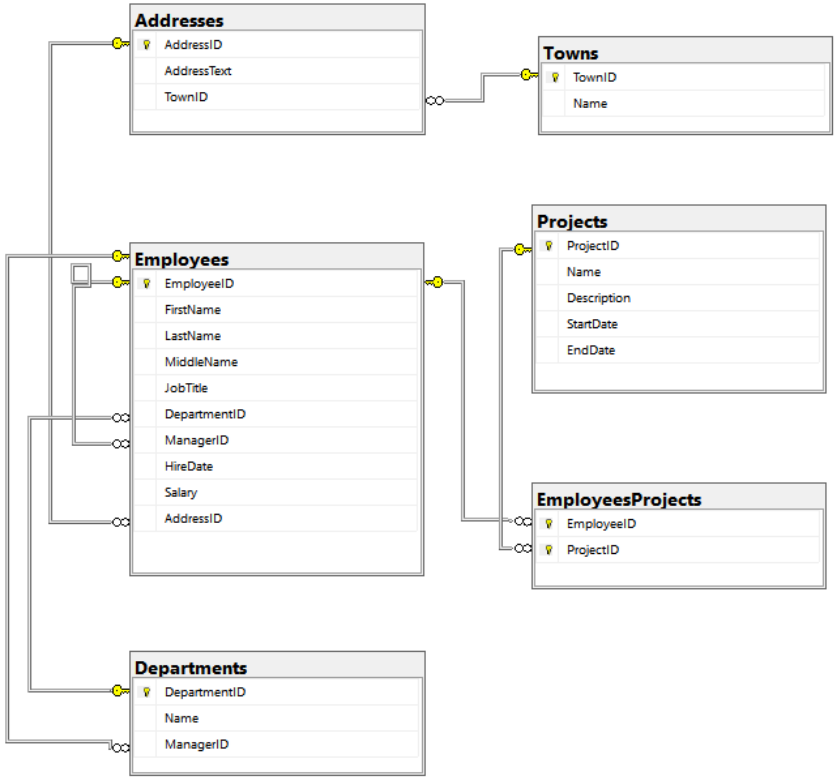
```
Install-Package Microsoft.EntityFrameworkCore
```

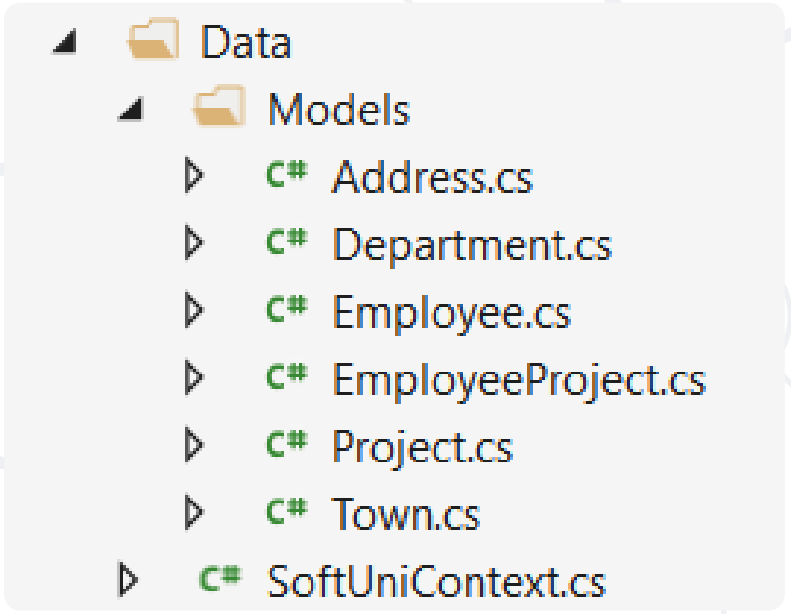
  - EF Core is modular – any **data providers** must be installed too:

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

Database First Model

- **Database First** model models the **entity classes after** the **database**





Database First Model: Setup

- Scaffolding DbContext from DB with **Scaffold-DbContext** command in **Package Manager Console**:

```
Scaffold-DbContext
  -Connection "Server=.;Database=…;Integrated Security=True"
  -Provider Microsoft.EntityFrameworkCore.SqlServer
  -OutputDir Data
```

- Scaffolding requires the following packages beforehand:

```
Install-Package Microsoft.EntityFrameworkCore.Tools
Install-Package Microsoft.EntityFrameworkCore.SqlServer.Design
```

EF Components

SoftUni Foundation

- The **DbContext** class
  - Holds the **database connection** and the **entity classes**
  - Provides **LINQ-based** data access
  - Provides **identity tracking**, **change tracking**, and an API for **CRUD** operations
- Entity classes
  - Hold **entities** (objects with their attributes and relations)
  - Each database **table** is typically mapped to a single **C# class**

EF Components (2)

- **Associations** (relationship mappings)
  - An association is a primary key / foreign key-based relationship between two entity classes
  - Allows navigation from one entity to another

```
var courses = student.Courses.Where(…);
```

- **Concurrency control**
  - **Entity Framework** uses **optimistic concurrency control**
    - No locking by default
  - Automatic concurrency conflict detection

Reading Data

Querying the DB using Entity Framework

The DbContext Class

- **DbContext** provides:
  - CRUD Operations
    - A way to **access entities**
    - Methods for **creating** new entities (**Add()** method)
    - Ability to **manipulate database data by** modifying **objects**
- Easily navigate through **table relations**
- Executing **LINQ queries** as native **SQL queries**
- Managing database **creation**/**deletion**/**migration**

Using DbContext Class

SoftUni Foundation

- First create instance of the **DbContext**:

```
var context = new SoftUniDbContext();
```

- In the constructor you can pass a database connection string
- **DbContext** properties:
  - **Database** – **EnsureCreated**/**Deleted** methods, DB Connection
  - **ChangeTracker** – Holds info about the **automatic change tracker**
  - All entity classes (tables) are listed as properties
    - e.g. **DbSet<Employee> Employees { get; set; }**

Reading Data with LINQ Query

SoftUni Foundation

- Executing **LINQ-to-Entities** query over EF entity:

```
using (var context = new SoftUniEntities())
{
  var employees = context.Employees
    .Where(e => e.JobTitle == "Design Engineer")
    .ToArray();
}
```

EF translates this to an SQL query

- **Employees** property in the **DbContext**:

```
public partial class SoftUniEntities : DbContext
{
  public DbSet<Employee> Employees { get; set; }
  public DbSet<Project> Projects { get; set; }
  public DbSet<Department> Departments { get; set; }
}
```

Reading Data with LINQ Query

SoftUni Foundation

- We can also use **extension methods** for constructing the query

```
using (var context = new SoftUniEntities())
{
  var employees = context.Employees
      .Where(c => c.JobTitle == "Design Engineering")
      .Select(c => c.FirstName)
      .ToList();
}
```

ToList() materializes the query

- Find element by **ID**

```
using (var context = new SoftUniEntities())
{
  var project = context.Projects.Find(2);
  Console.WriteLine(project.Name);
}
```

LINQ: Simple Operations

- **Where()**
  - Searches by given condition
- **First/Last()** / **FirstOrDefault/LastOrDefault()**
  - Gets the **first**/**last** element which matches the condition
  - Throws **InvalidOperationException** without **OrDefault**
- **Select()**
  - Projects (conversion) collection to another type
- **OrderBy()** / **ThenBy()** / **OrderByDescending()**
  - Orders a collection

LINQ: Simple Operations (2)

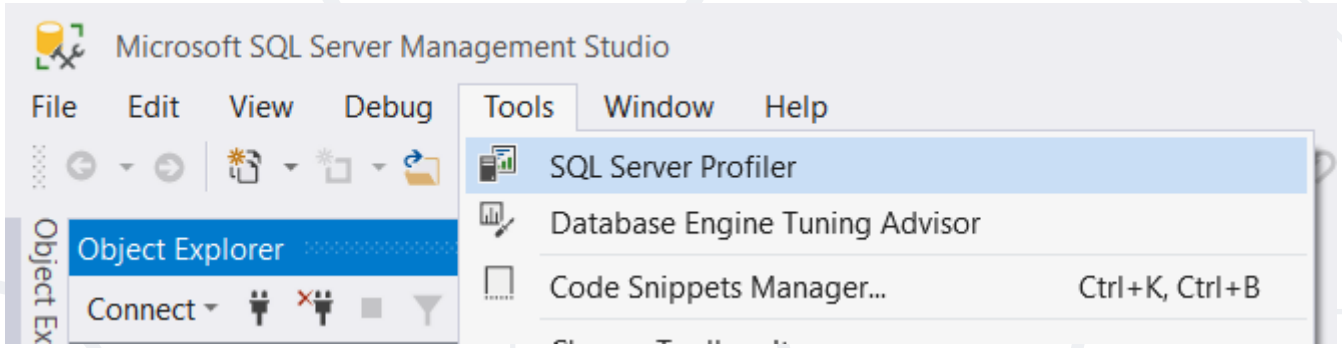
SoftUni Foundation

- **Any()**
  - Checks if any element matches a condition
- **All()**
  - Checks if all elements match a condition
- **Distinct()**
  - Returns only unique elements
- **Skip()** / **Take()**
  - Skips or takes X number of elements

Logging the Native SQL Queries

SoftUni Foundation

- Queries sent to SQL Server can be monitored with SQL Server Profiler
  - Included in **SQL Server Management Studio**:



- Queries can also be monitored with Express Profiler

https://expressprofiler.codeplex.com/

CRUD Operations

With Entity Framework

Creating New Data

- To create a new database row use the method **Add(…)** of the corresponding DbSet:

```
var project = new Project()
{
  Name = "Judge System",
  StartDate = new DateTime(2015, 4, 15),
};

context.Projects.Add(project);
context.SaveChanges();
```

Create a new **Project** object

Add the object to the **DbSet**

Execute SQL statements

Cascading Inserts

- We can also add cascading entities to the database:

```
Employee employee = new Employee();
employee.FirstName = "Petya";
employee.LastName = "Grozdarska";
employee.Projects.Add(new Project { Name = "SoftUni Conf"} );
softUniEntities.Employees.Add(employee);
softUniEntities.SaveChanges();
```

- The **Project** will be added when the **Employee** entity (employee) is inserted to the database

Updating Existing Data

- **DbContext** allows modifying entity properties and persisting them in the database
  - Just load an entity, modify it and call **SaveChanges()**
- The **DbContext** automatically tracks all changes made on its entity objects

```
Employees employee =
  softUniEntities.Employees.First();
employees.FirstName = "Alex";
context.SaveChanges();
```

SELECT the first order

Execute an SQL UPDATE

Deleting Existing Data

- Delete is done by **Remove()** on the specified entity collection
- **SaveChanges()** method performs the delete action in the database

```
Employees employee =
  softUniEntities.Employees.First();
softUniEntities.Employees.Remove(employee);
softUniEntities.SaveChanges();
```

Mark the entity for deleting at the next save

Execute the SQL DELETE command

Summary

SoftUni Foundation

- ORM frameworks maps database schema to objects in a programming language
- Entity Framework Core is the standard .NET ORM
- LINQ can be used to query the DB through the DB context

EF Core Code First

Entity Framework DB From Code

SoftUni Team

Technical Trainers

Software University

SoftUni Foundation

Software University

http://softuni.bg

Table of Contents

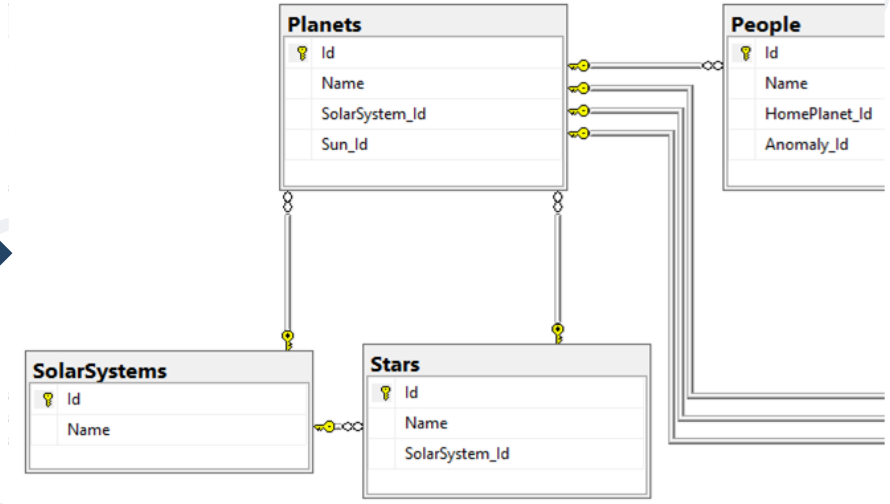
Code First Model

Motivation for Code First approach

What is the Code First Model?

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

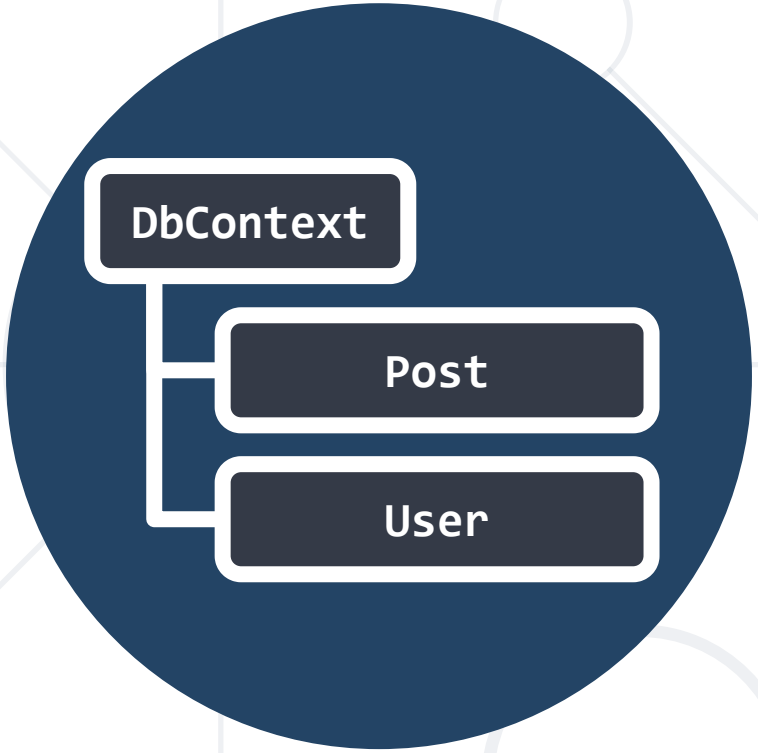
```
Planet.cs
  Planet
    Planet()
    Id : int
    Name : string
    Sun : Star
    SolarSystem : SolarSystem
    OriginAnomalies : ICollection<Anomaly>
SolarSystem.cs
  SolarSystem
    Id : int
    Name : string
Star.cs
  Star
    Id : int
    Name : string
    SolarSystem : SolarSystem
```



Why Use Code First?

SoftUni Foundation

- 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.



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 PostAnswer
{
    public int Id { get; set; }
    public string Content { get; set; }
    public int PostId { get; set; }
    public Post Post { get; set; }
}
```

Primary key

Foreign key

Navigation property

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

Domain Classes (Models) (2)

SoftUni Foundation

- Another example of a domain class (model)

```
public class Post
{
    public int Id { get; set; }
    public string Content { get; set; }
    public int AuthorId { get; set; }
    public User Author { get; set; }

    public IList<Reply> Replies { get; set; }
}
```

Navigation property

One-to-Many relation

DbSet Type

- Maps a **collection** of **entities** from a **table**
- Set operations: **Add**, **Attach**, **Remove**, **Find**
- **DbContext** contains multiple **DbSet<T>** properties

```
public class DbSet<TEntity> :
System.Data.Entity.Infrastructure.DbQuery<TEntity>
        where TEntity : class
    Member of System.Data.Entity
```

```
public DbSet<Post> Posts { get; set; }
```

The DbContext Class

SoftUni Foundation

- Usually named after the database e.g. **BlogDbContext**, **ForumDbContext**
- Inherits from **DbContext**
- Manages model classes using **DbSet<T>** type
- Implements **identity tracking**, **change tracking**
- Provides **API** for **CRUD** operations and **LINQ-based** data access
- Recommended to be in a separate class library
  - Don't forget to reference the EF Core library + any providers
- Use several **DbContext** if you have too much models

Defining DbContext Class – Example

EF Reference

Models Namespace

```
using Microsoft.EntityFrameworkCore;
using CodeFirst.Data.Models;

public class ForumDbContext : DbContext
{
    public DbSet<Category> Categories { get; set; }
    public DbSet<Post> Posts { get; set; }
    public DbSet<PostAnswer> PostAnswers { get; set; }
    public DbSet<User> Users { get; set; }
}
```

CRUD Operations with EF Code First

SoftUni Foundation

```
var db = new ForumDbContext();
var category = new Category { Name = "Database course" };
db.Categories.Add(category);

var post = new Post();
post.Title = "Homework Deadline";
post.Content = "Please extend the homework deadline";
post.Type = PostType.Normal;
post.Category = category;
post.Tags.Add(new Tag { Text = "homework" });
post.Tags.Add(new Tag { Text = "deadline" });

db.Posts.Add(post);

db.SaveChanges();
```

EF Core Configuration

NuGet Packages, Configuration

Code First with EF Core: Setup

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

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

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

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

How to Connect to SQL Server?

SoftUni Foundation

- One way to connect is to create a **Configuration** class with your connection string:

```
public static class Configuration
{
  public const string ConnectionString = "Server=.;Database=…;";
}
```

- Then add the connection string in the **OnConfiguring** method in the **DbContext** class

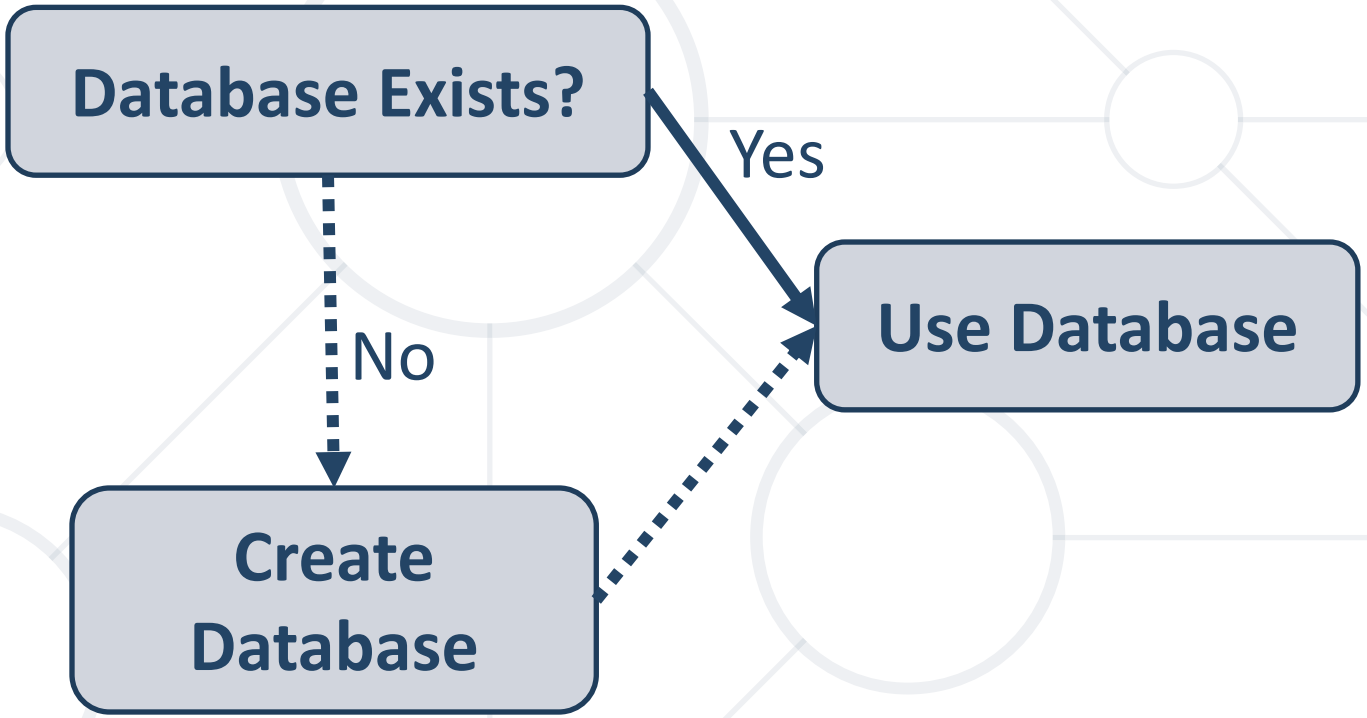
```
protected override void OnConfiguring(DbContextOptionsBuilder builder)
{
  if (!builder.IsConfigured)
    builder.UseSqlServer(Configuration.ConnectionString);
}
```

Fluent API

- The **OnModelCreating** Method let us use the Fluent API to describe our **table relations** to **EF Core**

```
protected override void OnModelCreating(ModelBuilder builder)
{
  builder.Entity<Category>()
    .HasMany(c => c.Posts)
    .WithOne(p => p.Category);

  builder.Entity<Post>()
    .HasMany(p => p.Replies)
    .WithOne(r => r.Post);

   builder.Entity<User>()
    .HasMany(u => u.Posts)
    .WithOne(p => p.Author);
}
```

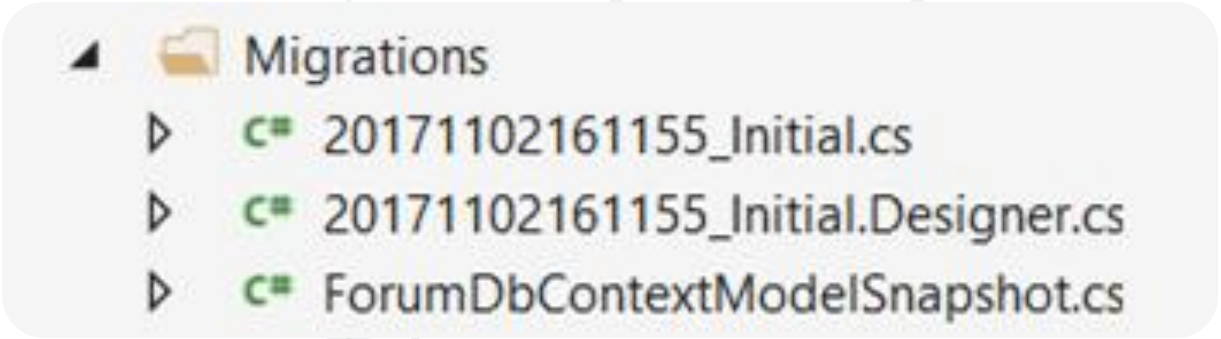
Database Connection Workflow



Database Migrations

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



Migrations in EF Core

- To use migrations in EF Core, we use the Add-Migration command from the **Package Manager Console**

```
Add-Migration {MigrationName}
```

- To undo a migration, we use **Remove-Migration**

```
Remove-Migration
```

- Commit changes to the database, using **Update-Database**

```
Update-Database
```

Summary

- Code First **increases productivity** by centralizing maintenance
- **Classes** represent real world objects with their **properties** and **behaviour**
- Entity Framework Core uses **data classes** (POCOs) to represent DB objects
- We can use **Database Migrations** to update our database without losing our data

Entity Relations

Customizing Entity Models

SoftUni Team

Technical Trainers

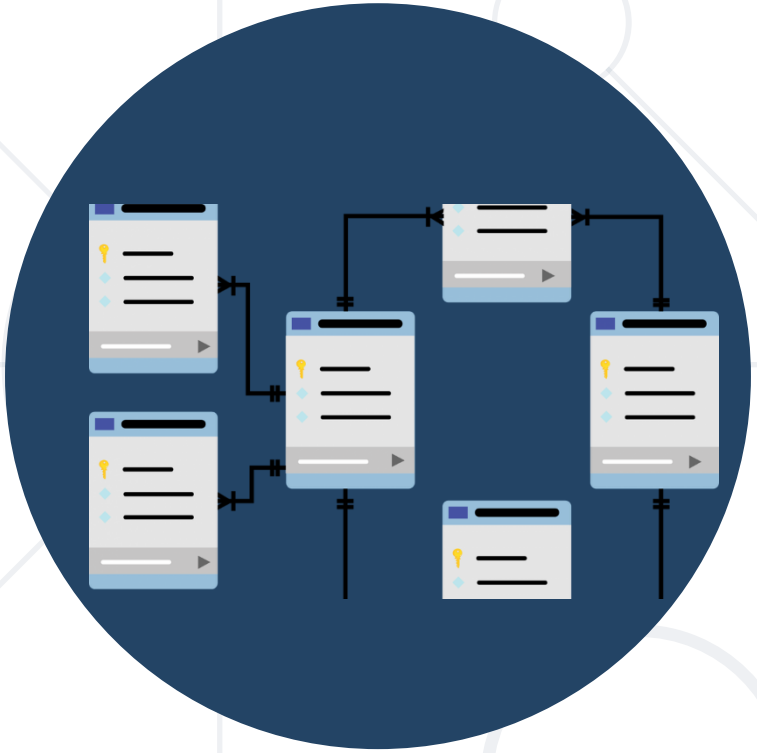
Software University

SoftUni Foundation

Software University

http://softuni.bg

Table of Contents

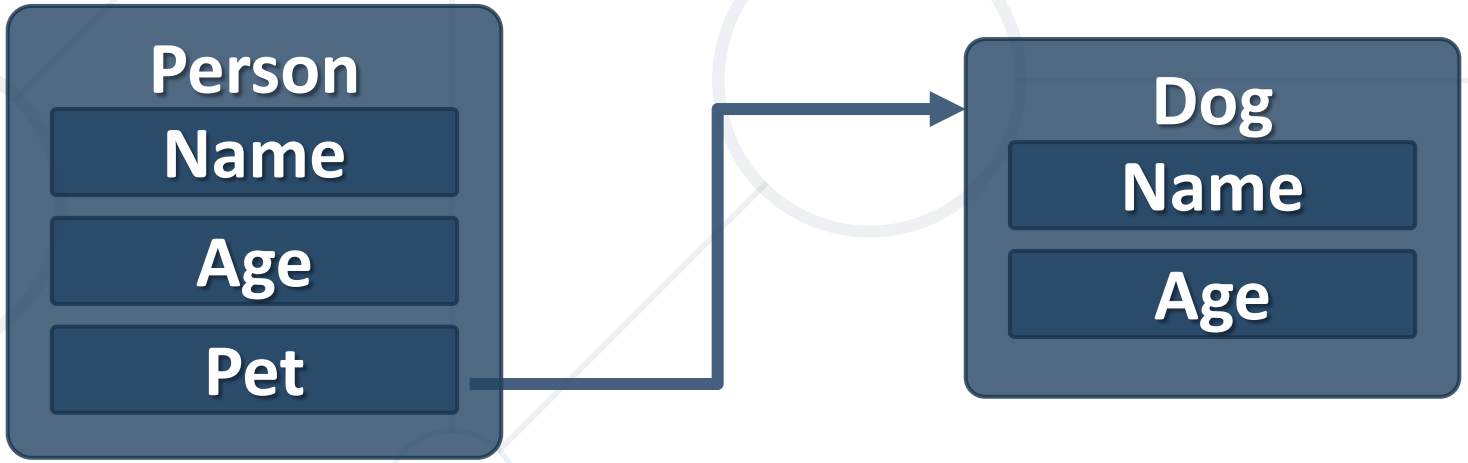


Object Composition

Describing Database Relationships

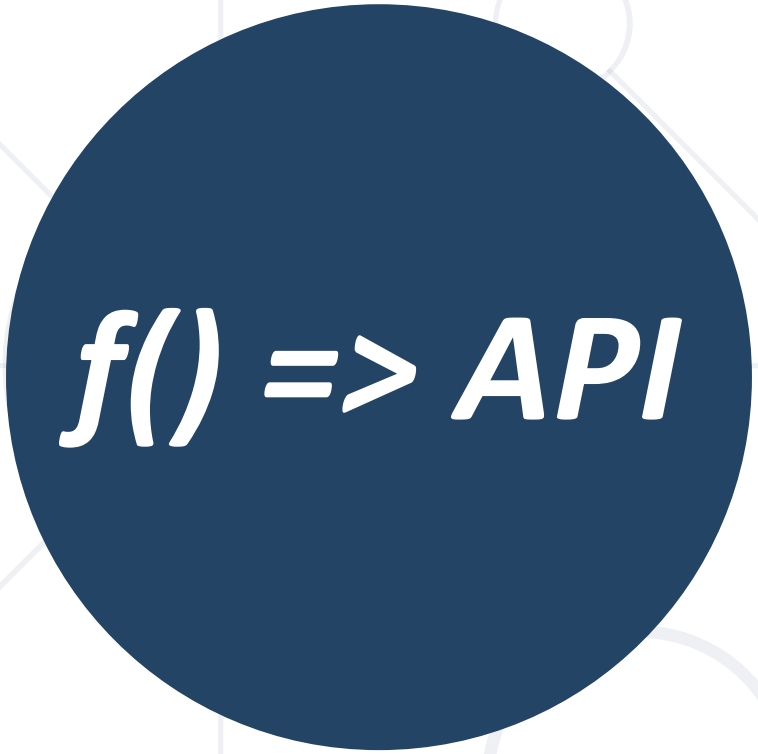
Object Composition

- Object composition denotes a "**has-a**" relationship
  - E.g. the **car** has an **engine**
- Defined in C# by one object having a property that is a reference to another



Navigation Properties

- Navigation properties create a **relationship** between entities
- Is either an **Entity Reference** (one to one or zero) or an **ICollection** (one to many or many to many)
- They provide **fast querying** of related records
- Can be **modified** by **directly** setting the reference



Fluent API

Working with Model Builder

Fluent API

- **Code First** maps your POCO classes to tables using a **set of conventions**
  - E.g. property named "**Id**" maps to the **Primary Key**
- Can be customized using **annotations** and the **Fluent API**
- Fluent API (Model Builder) allows **full control** over DB mappings
  - Custom names of objects (columns, tables, etc.) in the DB
  - Validation and data types
  - Define complicated entity relationships

Working with Fluent API

SoftUni Foundation

- Custom mappings are placed inside the **OnModelCreating** method of the DB context class

```
protected override void OnModelCreating(DbModelBuilder builder)
{
  builder.Entity<Student>().HasKey(s => s.StudentKey);
}
```

Fluent API: Renaming DB Objects

- Specifying Custom Table name

```
modelBuilder.Entity<Order>()
        .ToTable("OrderRef", "Admin");
```

- Custom Column name/DB Type

```
modelBuilder.Entity<Student>()
  .Property(s => s.Name)
  .HasColumnName("StudentName")
  .HasColumnType("varchar");
```

Optional schema name

Fluent API: Column Attributes

SoftUni Foundation

- Explicitly set Primary Key

```
modelBuilder
      .Entity<Student>().HasKey("StudentKey");
```

- Other column attributes

```
modelBuilder.Entity<Person>()
  .Property(p => p.FirstName)
  .IsRequired()
  .HasMaxLength(50)
```

```
modelBuilder.Entity<Post>()
  .Property(p => p.LastUpdated)
  .ValueGeneratedOnAddOrUpdate()
```

Fluent API: Miscellaneous Config

SoftUni Foundation

- Do not include property in DB (e.g. business logic properties)

```
modelBuilder
      .Entity<Department>().Ignore(d => d.Budget);
```

- Disabling cascade delete
  - If a FK property is non-nullable, cascade delete is **on by default**

```
modelBuilder.Entity<Course>()
   .HasRequired(t => t.Department)
   .WithMany(t => t.Courses)
   .HasForeignKey(d => d.DepartmentID)
   .OnDelete(DeleteBehavior.Restrict);
```

Throws exception on delete

Specialized Configuration Classes

- Mappings can be placed in entity-specific classes

```
public class StudentConfiguration
   : IEntityTypeConfiguration<Student>
{
   public void Configure(EntityTypeBuilder<Student> builder)
   {
      builder.HasKey(c => c.StudentKey);
   }
}
```

Specify target model

- Include in **OnModelCreating**:

```
builder.ApplyConfiguration(new StudentConfiguration());
```

Table Relationships

Expressed as Properties and Attributes

One-to-Zero-or-One

- Expressed in SQL Server as a shared primary key
- Relationship direction must be explicitly specified with a **ForeignKey** attribute
- ForeignKey is placed above the key property and contains the name of the navigation property and vice versa

One-to-Zero-or-One: Implementation

- Using the **ForeignKey** Attribute

```
public class Student
{
    [Key]
    public int Id { get; set; }
    public string Name { get; set; }

    public int AddressId { get; set; }
    [ForeignKey("Address")]
    public Address Address { get; set; }
}
```

Attributes

One-to-Zero-or-One: Implementation (2)

- Using the **ForeignKey** Attribute

```
public class Address
{
    public int Id { get; set; }
    public string Text { get; set; }

    public int StudentId { get; set; }
    [ForeignKey(nameof(Student))]
    public Student Student { get; set; }
}
```

One-to-Zero-or-One: Fluent API

- HasOne → WithOne

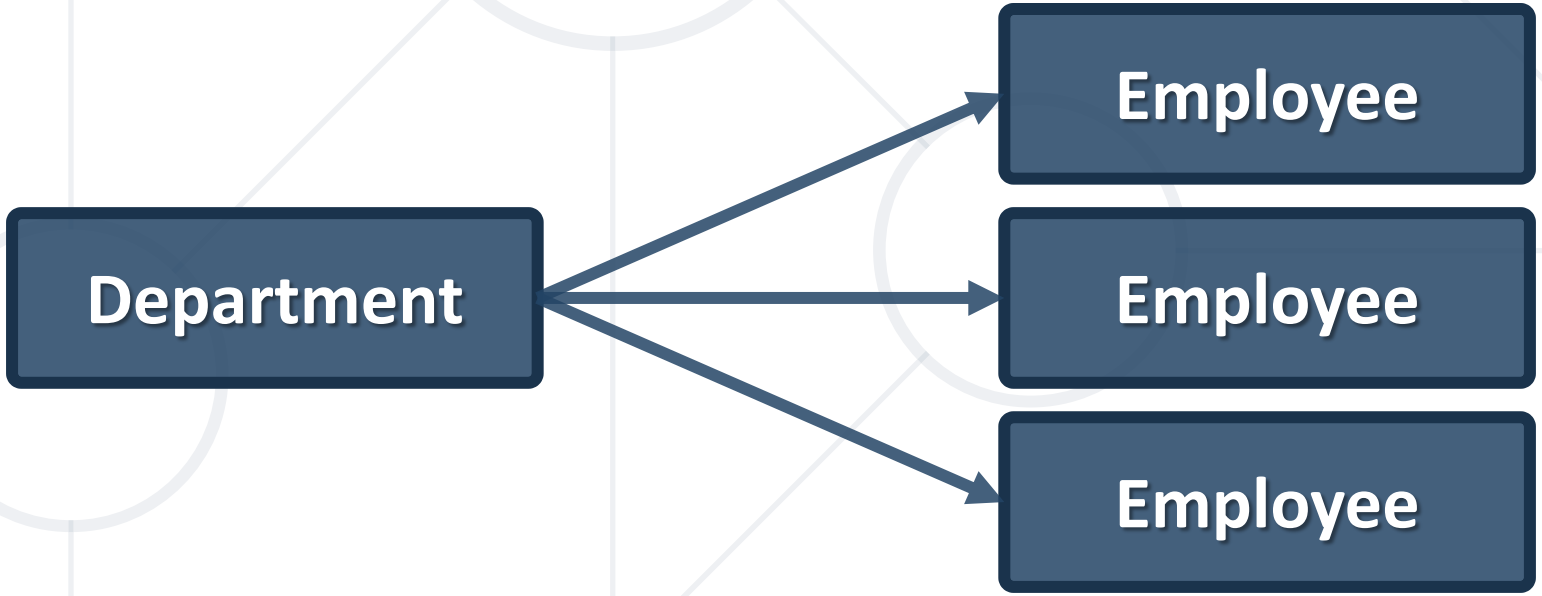
```
modelBuilder.Entity<Address>()
   .HasOne(a => a.Student)
   .WithOne(s => s.Address)
   .HasForeignKey(a => a.StudentId);
```

Address contains FK to Student

- If StudentId property is nullable (int?), relation becomes One-To-Zero-Or-One

One-to-Many

- Most common type of relationship
- Implemented with a **collection** inside the **parent entity**
  - The collection should be **initialized** in the **constructor**!



One-to-Many: Implementation

- Department has many employees

```
public class Department
{
    public int Id { get; set; }
    public string Name { get; set; }

    public ICollection<Employee> Employees { get; set; }
}
```

One-to-Many: Implementation (2)

- **Employees** have one **department**

```
public class Employee
{
    public int Id { get; set; }
    public string FirstName { get; set; }
    public string LastName { get; set; }

    public int DepartmentId { get; set; }
    public Department Department { get; set; }
}
```

One-to-Many: Fluent API

SoftUni Foundation

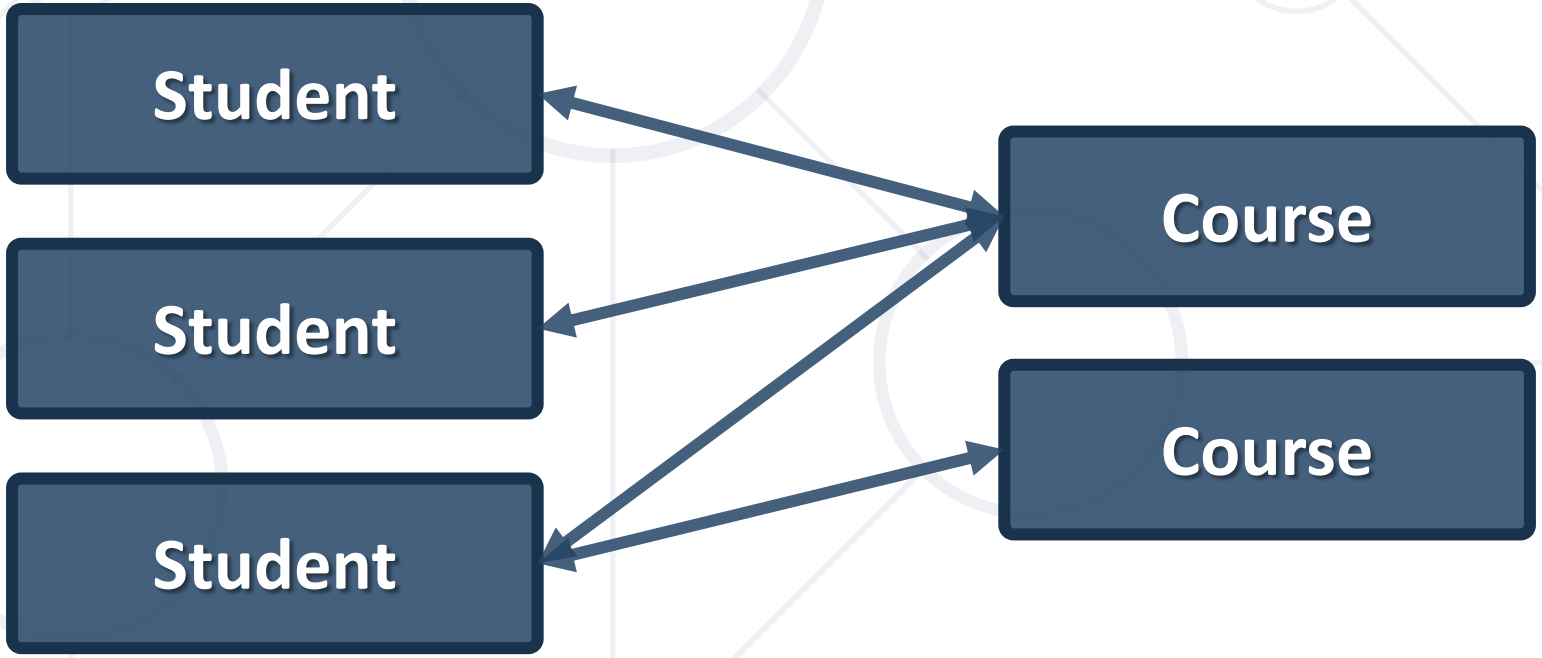
- HasMany → WithOne

```
modelBuilder.Entity<Post>()
   .HasMany(p => p.Comments)
   .WithOne(c => c.Post)
   .HasForeignKey(c => c.PostId);
```

```
modelBuilder.Entity<Employee>()
   .HasMany(e => e.Addresses)
   .WithOne(a => a.Employee)
   .HasForeignKey(a => a.EmployeeId);
```

Many-to-Many

- Requires a **join entity (separate class)** in EF Core
- Implemented with collections in each entity, referring the other



Many-to-Many Implementation (1)

SoftUni Foundation

```
public class Course
{
  public string Name { get; set; }

  public ICollection<StudentCourse> StudentsCourses { get; set; }
}
```

```
public class Student
{
  public string FirstName { get; set; }
  public string LastName { get; set; }

  public ICollection<StudentCourse> StudentsCourses { get; set; }
}
```

Many-to-Many Implementation (2)

SoftUni Foundation

- EF Core requires a **Join Entity**

```
public class StudentCourse
{
    public int StudentId { get; set; }
    public Student Student { get; set; }

    public int CourseId { get; set; }
    public Course Course { get; set; }
}
```

Many-to-Many: Fluent API

SoftUni Foundation

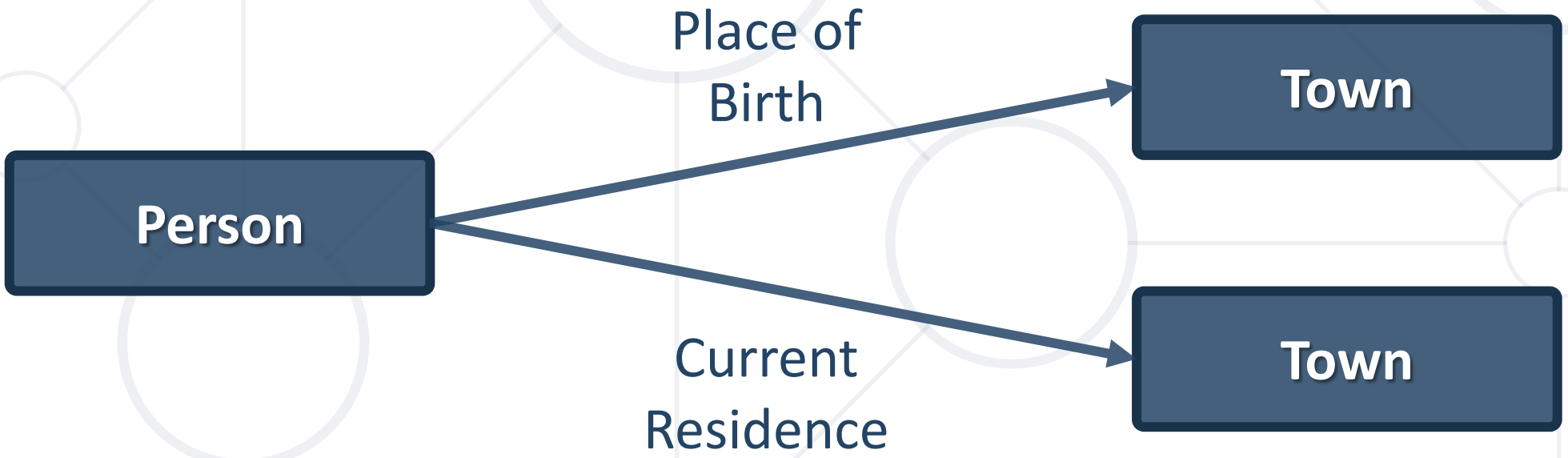
- Mapping **both sides** of relationship

```
modelBuilder.Entity<StudentCourse>()
   .HasKey(sc => new { sc.StudentId, sc.CourseId });

builder.Entity<StudentCourse>()
   .HasOne(sc => sc.Student)
   .WithMany(s => s.StudentCourses)
   .HasForeignKey(sc => sc.StudentId);

builder.Entity<StudentCourse>()
   .HasOne(sc => sc.Course)
   .WithMany(s => s.StudentCourses)
   .HasForeignKey(sc => sc.CourseId);
```

Composite Primary Key

Multiple Relations

- When two entities are related by more than one key
- Entity Framework needs help from **Inverse Properties**



Multiple Relations Implementation

SoftUni Foundation

- **Person** Domain Model – defined as usual

```
public class Person
{
  public int Id { get; set; }
  public string Name { get; set; }

  public Town PlaceOfBirth { get; set; }
  public Town CurrentResidence { get; set; }
}
```

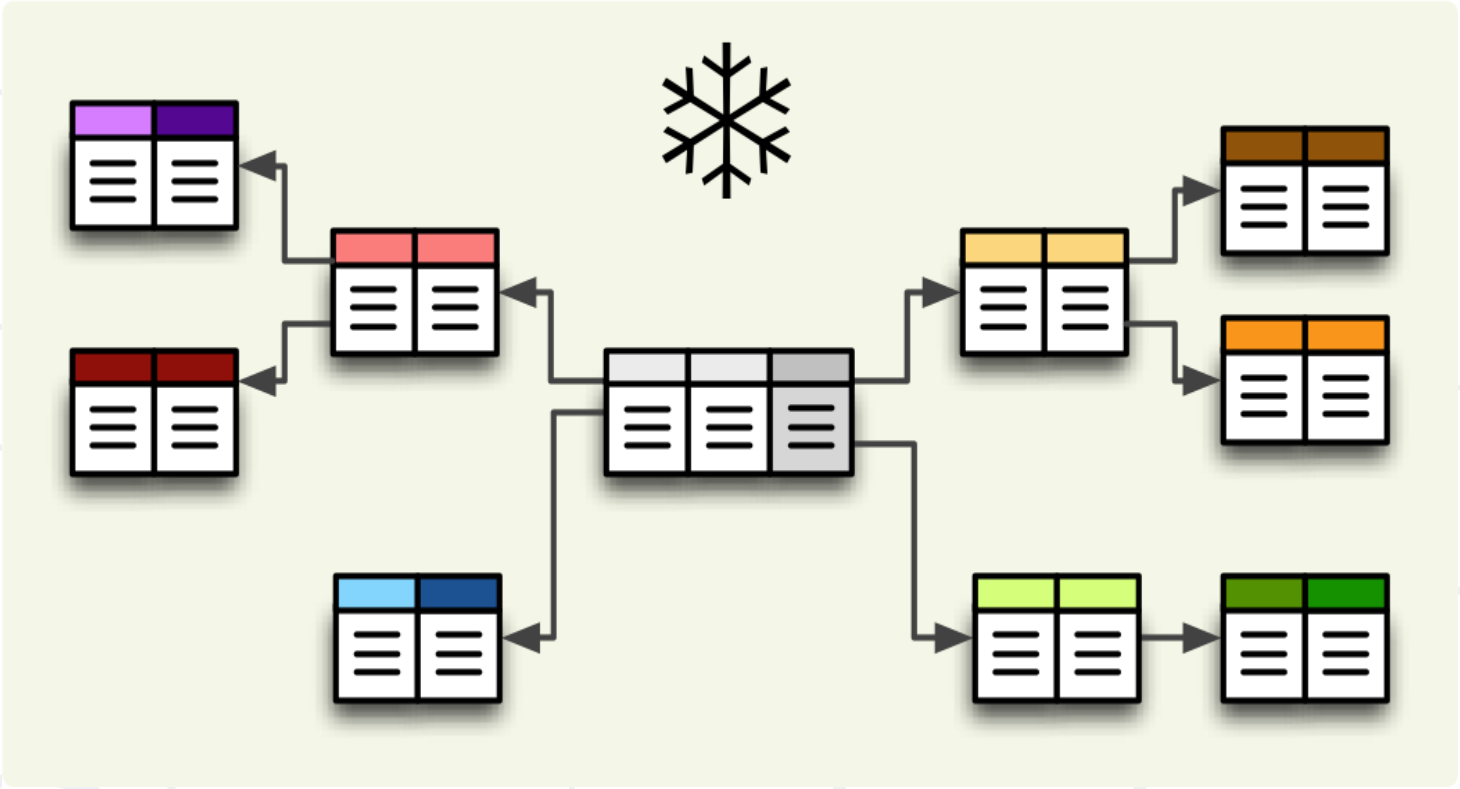
Multiple Relations Implementation (2)

SoftUni Foundation

- **Town** Domain Model

```
public class Town
{
    public int Id { get; set; }
    public string Name { get; set; }
    [InverseProperty("PlaceOfBirth")]
    public ICollection<Person> Natives { get; set; }
    [InverseProperty("CurrentResidence")]
    public ICollection<Person> Residents { get; set; }
}
```

Point towards related property



Filtering and Aggregating Tables

Select, Join and Group Data Using LINQ

Good Reasons to Use Select

SoftUni Foundation

- Limit network traffic by reducing the queried columns
- Syntax:

```
var employeesWithTown = context
   .Employees
   .Select(employee => new
   {
      EmployeeName = employee.FirstName,
      TownName = employee.Address.Town.Name
   });
```

- SQL Server Profiler

```
   SELECT [employee].[FirstName] AS [EmployeeName], [employee.Address.Town].[Name] AS [TownName]
     FROM [Employees] AS [employee]
LEFT JOIN [Addresses] AS [employee.Address] ON [employee].[AddressID] = [employee.Address].[AddressID]
LEFT JOIN [Towns] AS [employee.Address.Town] ON [employee.Address].[TownID] =
          [employee.Address.Town].[TownID]
```

Good Reasons not to Use Select

SoftUni Foundation

- Data that is selected is **not** of the **initial entity type**
  - **Anonymous type**, generated at runtime

```
(local variable) System.Collections.Generic.List<'a> employeesWithTown

Anonymous Types:
    'a is new { string EmployeeName, string TownName }

Local variable 'employeesWithTown' is never used
```

- **Data cannot be modified** (updated, deleted)
  - Entity is of a **different type**
  - Not associated with the **context** anymore

Joining Tables in EF: Using Join()

- Join tables in EF with **LINQ** / **extension methods** on **IEnumerable<T>** (like when joining collections)

```
var employees =
  softUniEntities.Employees.Join(
    softUniEntities.Departments,
    (e => e.DepartmentID),
    (d => d.DepartmentID),
    (e, d) => new {
      Employee = e.FirstName,
      JobTitle = e.JobTitle,
      Department = d.Name
    }
  );
```

Grouping Tables in EF

SoftUni Foundation

- Grouping also can be done by LINQ
  - The same way as with collections in LINQ
- Grouping with LINQ:

```
var groupedEmployees =
  from employee in softUniEntities.Employees
  group employee by employee.JobTitle;
```

- Grouping with extension methods:

```
var groupedCustomers = softUniEntities.Employees
  .GroupBy(employee => employee.JobTitle);
```

Result Models

Simplifying Models

Result Models

- **Select()**, **GroupBy()** can work with **custom classes**
  - Allows you to **pass them** to methods and use them as a return type
  - Requires some **extra code** (class definition)
- Sample Result Model:

```
public class UserResultModel
{
  public string FullName { get; set; }
  public string Age { get; set; }
}
```

Result Models (2)

- Assign the fields as you would with an anonymous object:

```
var currentUser = context.Users
  .Where(u => u.Id == 8)
  .Select(u => new UserResultModel
  {
    FullName = u.FirstName + " " + u.LastName,
    Age = u.Age
  })
  .SingleOrDefault();
```

- The new type can be used in a method signature:

```
public UserResultModel GetUserInfo(int Id) { … }
```

Attributes

Custom Entity Framework Behavior

Attributes

SoftUni Foundation

- EF Code First provides a set of **DataAnnotation attributes**
  - You can override default Entity Framework behavior
- To access nullability and size of fields:

```
using System.ComponentModel.DataAnnotations;
```

- To access schema customizations:

```
using System.ComponentModel.DataAnnotations.Schema;
```

- For a full set of configuration options you need the **Fluent API**

Key Attributes

- [Key] – explicitly specify **primary key**
  - When your PK column doesn't have an "Id" suffix

```
[Key]
public int StudentKey { get; set; }
```

  - **Composite key** is only defined using **Fluent API** for now

```
builder.Entity<EmployeesProjects>()
       .HasKey(k => new { k.EmployeeId, k.ProjectId });
```

Key Attributes (2)

- **ForeignKey** – explicitly **link** navigation property and foreign key property within the same class
- Works in **either direction** (FK to navigation property or navigation property to FK)

```
public class Client
{
  …
  [ForeignKey("Order")]
  public int OrderRefId { get; set; }
  public Order Order { get; set; }
}
```

Renaming Objects

- **Table** – manually specify the name of the table in the DB

```
[Table("StudentMaster")]
public class Student
{
  …
}
```

```
[Table("StudentMaster", Schema = "Admin")]
public class Student
{
  …
}
```

Renaming Objects (2)

- **Column** – manually specify the name of the column in the DB
  - You can also specify order and explicit data type

```
public class Student
{
  …
  [Column("StudentName", Order = 2, TypeName="varchar(50)")]
  public string Name { get; set; }
}
```

Optional parameters

Entity Validation

SoftUni Foundation

- **Required** – mark a nullable property as **NOT NULL** in the DB
  - Will throw an exception if not set to a value
  - Non-nullable types (e.g. **int**) will **not throw** an exception (will be set to language-specific default value)
- **MinLength** – specifies min length of a string (client validation)
- **MaxLength** / **StringLength** – specifies max length of a string (both client and DB validation)
- **Range** – set lower and/or upper limits of numeric property (client validation)

Other Attributes

- **Index** – create index for column
  - Primary key will always have an index

```
builder.Entity<Car>()
        .HasIndex(u => u.RegistrationNumber)
        .IsUnique();
```

- **NotMapped** – property will not be mapped to a column
  - For business logic properties

Validation Method

- Add using:

```
using System.ComponentModel.DataAnnotations;
```

- Create following method to validate entities:

```
private bool IsValid(object obj)
{
        var validationContext = new ValidationContext(obj);
        var validationResults = new List<ValidationResult>();

        return Validator.TryValidateObject(obj, validationContext,
                                validationResults, true);
}
```

Shadow Properties

Shadow Properties

- Shadow properties are **not defined** in your **.NET entity class**
  - They are **useful** when there is data in the database that **should not be exposed** on the mapped entity types.
- **Configure** shadow property:

```
builder.Entity<Project>()
       .Property<DateTime>("LastUpdated");
```

- **Change** value of shadow property:

```
context.Entry(Project).Property("LastUpdated")
       .CurrentValue = DateTime.Now;
```

Summary

- Objects can be composed from other objects to represent complex relationships
- Navigation properties speed up the traversal of related entities

Summary

- The **Fluent API** gives us full control over Entity Framework object mappings
- Information overhead can be limited by **selecting** only the needed properties
- **ResultModels** can be used to move aggregated data between methods
- **Attributes** can be used to express special table relationships and to customize entity behaviour

EF Advanced Querying

Performance Optimizations

SoftUni Team

Technical Trainers

Software University

SoftUni Foundation

Software University

http://softuni.bg

Table of Contents

Executing Native SQL Queries

Parameterless and Parameterized

Executing Native SQL Queries

SoftUni Foundation

- Executing a **native SQL query** in EF Core directly:

```
var query = "SELECT * FROM Employees";
var employees = db.Employees
  .FromSqlRaw(query)
  .ToArray();
```

- Limitations:
  - **JOIN** statements **don't** get mapped to the entity class
  - **Required columns** must **always** be selected
  - **Target table** must be the same as the **DbSet**
  - **SQL statements** other than **SELECT** are recognized automatically as non-composable. As a consequence, the full results of stored procedures are always returned to the client and any **LINQ** operators applied after **`FromSqlRaw`** are evaluated in-memory.

Native SQL Queries with Parameters

SoftUni Foundation

- Native SQL queries can also be parameterized:

```
var context = new SoftUniDbContext();
string nativeSQLQuery =
  "SELECT FirstName, LastName, JobTitle" +
  "FROM dbo.Employees WHERE JobTitle = {0}";

var employees = context.Employees.FromSqlRaw(
  nativeSQLQuery, "Marketing Specialist");

foreach (var employee in employees)
{
  Console.WriteLine(employee);
}
```

Parameter placeholder

Parameter value

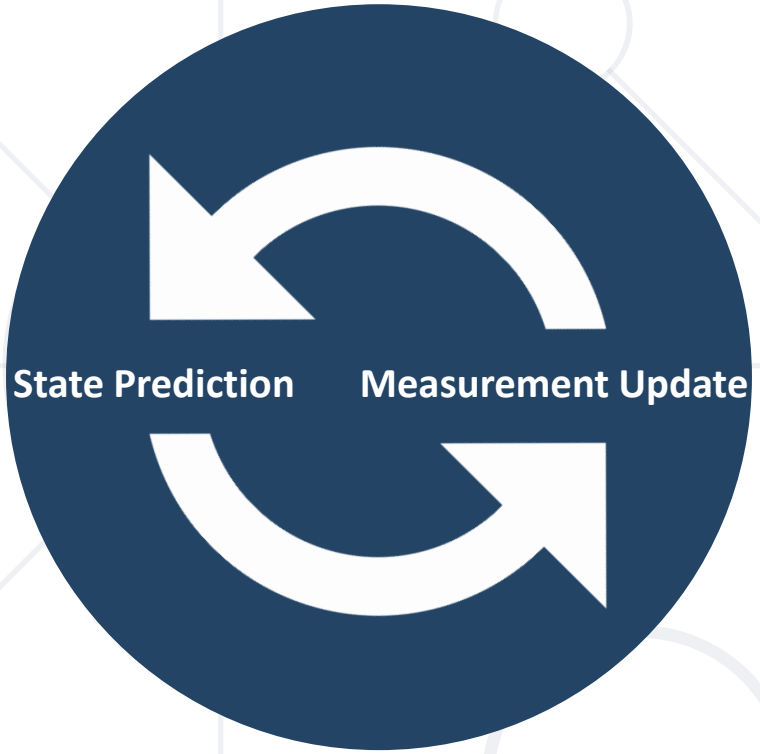
Interpolation in SQL Queries

SoftUni Foundation

- `FromSqlInterpolated` allows string interpolation syntax

```
var context = new SoftUniDbContext();
string jobTitle = "Marketing Specialist";
string nativeSQLQuery =
  "SELECT FirstName, LastName, JobTitle" +
  "FROM dbo.Employees WHERE JobTitle = {jobTitle}";

var employees = context.Employees.FromSqlInterpolated(
  nativeSQLQuery)

foreach (var employee in employees)
{
  Console.WriteLine(employee);
}
```

Interpolated parameter



Object State Tracking

Attaching and Detaching Objects

SoftUni Foundation

- In Entity Framework, objects can be:
  - **Attached** to the object context (tracked object)
  - **Detached** from an object context (untracked object)
- Attached objects are tracked and managed by the **DbContext**
  - **SaveChanges()** persists all changes in DB
- Detached objects are not referenced by the **DbContext**
  - Behave like a normal objects, which are not related to EF

Attaching Detached Objects

SoftUni Foundation

- When a query is executed inside a **DbContext**, the returned objects are **automatically attached** to it
- When a context is destroyed, all objects in it are automatically detached
  - E.g. in **Web applications** between requests
- You might later on **attach** objects that have been previously **detached** to a **new context**

Detaching Objects

- When is an object detached?
  - When we get the object from a **DbContext** and then **Dispose** it
  - Manually: by setting the **EntryState** to **Detached**

```
Employee GetEmployeeById(int id)
{
    using (var SoftUniDbContext = new SoftUniDbContext())
    {
      return SoftUniDbContext.Employees
        .First(p => p.EmployeeID == id);
    }
}
```

Returned employee is detached

Attaching Objects

- When we want to update a detached object we need to **reattach it** and then update it: change to **Attached** state

```
void UpdateName(Employee employee, string newName)
{
    using (var SoftUniDbContext = new SoftUniDbContext())
    {
        var entry = SoftUniDbContext.Entry(employee);
        entry.State = EntityState.Added;
        employee.FirstName = newName;
        SoftUniDbContext.SaveChanges();
    }
}
```

Stored Procedures

Executing a Stored Procedure

SoftUni Foundation

- Stored Procedures can be executed via SQL

```
CREATE PROCEDURE UpdateAge @param int
AS
UPDATE Employees SET Age = Age + @param;
```

```
var ageParameter = new SqlParameter("@age", 5);
var query = "EXEC UpdateAge @age";
context.Database.ExecuteSqlCommand(query, ageParameter);
```

Bulk Operations

Multiple Update and Delete in Single Query

EntityFramework-Plus

SoftUni Foundation

- Entity Framework **does not** support bulk operations
- **Z.EntityFramework.Plus** gives you the ability to perform **bulk update/delete** of entities
- Install **Z.EntityFramework.Plus.EFCore** as a NuGet package

```
Install-Package Z.EntityFramework.Plus.EFCore
```

- Read more: https://entityframework-plus.net

Bulk Delete

- Delete all users where **FirstName** matches given string

```
context.Employees
   .Where(u => u.FirstName == "Pesho")
   .Delete();
```

```
DELETE [dbo].[Employees]
FROM [dbo].[Employees] AS j0 INNER JOIN (
SELECT
    [Extent1].[Id] AS [Id]
    FROM [dbo].[Employees] AS [Extent1].[Name]
    WHERE N'Pesho' = [Extent1].[Name]
) AS j1 ON (j0.[Id] = j1.[Id])
```

Bulk Update: Syntax

- Update all Employees with name “Nasko” to “Plamen”

```
context.Employees
  .Where(t => t.Name == "Nasko")
  .Update(u => new Employee() {Name = "Plamen"});
```

- Update all Employees’ age to 99 who have the name “Plamen”

```
IQueryable<Employee> employees = context.Employees
  .Where(employee => employee.Name == "Plamen");

employees.Update(employee => new Employee() { Age = 99 });
```

Types of Loading

Lazy, Eager and Explicit Loading

Explicit Loading

- **Explicit loading** loads all records when they're needed
- Performed with the **Collection().Load()** method

```
var employee = context.Employees.First();

context.Entry(employee)
  .Reference(e => e.Department)
  .Load();

context.Entry(employee)
  .Collection(e => e.EmployeeProjects)
  .Load();
```

Eager Loading

SoftUni Foundation

- **Eager loading** loads **all related records** of an entity **at once**
- Performed with the **Include** method

```
context.Towns.Include("Employees");
```

```
context.Towns.Include(town => town.Employees);
```

```
context.Employees
  .Include(employee => employee.Address)
  .ThenInclude(address => address.Town)
```

Lazy Loading

SoftUni Foundation

- Lazy Loading **delays** loading of data until it is used
- EF Core enables lazy-loading for any navigation property that can be **overridden**
- Offers better performance in certain cases
  - Less RAM usage
  - Smaller result sets returned

Lazy Loading Proxies

- Install Lazy Loading Proxies

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

- Enable the package

```
void OnConfiguring (DbContextOptionsBuilder options)
{
  options
    .UseLazyLoadingProxies()
    .UseSqlServer(myConnectionString);
}
```

Concurrency Checks

Optimistic Concurrency Control in EF

SoftUni Foundation

- EF Core runs in **optimistic concurrency** mode (no locking)
  - By default the conflict resolution strategy in EF is "**last one wins**"
  - The last change overwrites all previous concurrent changes
- Enabling "**first wins**" strategy for certain property in EF:
  - **[ConcurrencyCheck]**

Last One Wins – Example

SoftUni Foundation

```
var contextFirst = new SoftUniDbContext();
var lastProjectFirstUser = contextFirst.Projects.First();
lastProjectFirstUser.Name = "Changed by the First User";

// The second user changes the same record
var contextSecondUser = new SoftUniDbContext();
var lastProjectSecond = contextSecondUser.Projects.First();
lastProjectSecond.Name = "Changed by the Second User";

// Conflicting changes: last wins
contextFirst.SaveChanges();
contextSecondUser.SaveChanges();
```

Second user wins

First One Wins – Example

SoftUni Foundation

```
var context = new SoftUniDbContext();
var lastTownFirstUser = contextFirst.Towns.First();
lastTownFirstUser.Name = "First User";

var contextSecondUser = new SoftUniDbContext();
var lastTownSecondUser = contextSecondUser.Towns.First();
lastTownSecondUser.Name = "Second User";

context.SaveChanges();
contextSecondUser.SaveChanges();
```

Changes get saved

DbUpdateConcurrencyException

Cascade Operations

Deleting Related Entities

Cascade Delete Scenarios

- **Required FK** with **cascade delete** set to **true**, **deletes everything** related to the deleted property
- **Required FK** with **cascade delete** set to **false**, **throws exception** (it cannot leave the navigational property with no value)
- **Optional FK** with **cascade delete** set to **true**, **deletes everything** related to the deleted property.
- **Optional FK** with **cascade delete** set to **false**, **sets** the value of the **FK to NULL**

Cascade Delete with Fluent API

SoftUni Foundation

- Using **OnDelete** with **DeleteBehavior** Enumeration:
  - **DeleteBehavior.Cascade**
    - Deletes related entities (default for required FK)
  - **DeleteBehavior.Restrict**
    - Throws exception on delete
  - **DeleteBehavior.ClientSetNull**
    - Default behavior for optional FK (does not affect database)
  - **DeleteBehavior.SetNull**
    - Sets the property to null (affects database)

Cascade Delete with Fluent API (2)

SoftUni Foundation

- Cascade delete syntax:

```
modelBuilder.Entity<User>()
    .HasMany(u => u.Replies)
    .WithOne(a => a.Author)
    .OnDelete(DeleteBehavior.Restrict);
```

```
modelBuilder.Entity<User>()
    .HasMany(u => u.Replies)
    .WithOne(a => a.Author)
    .OnDelete(DeleteBehavior.Cascade);
```

Summary

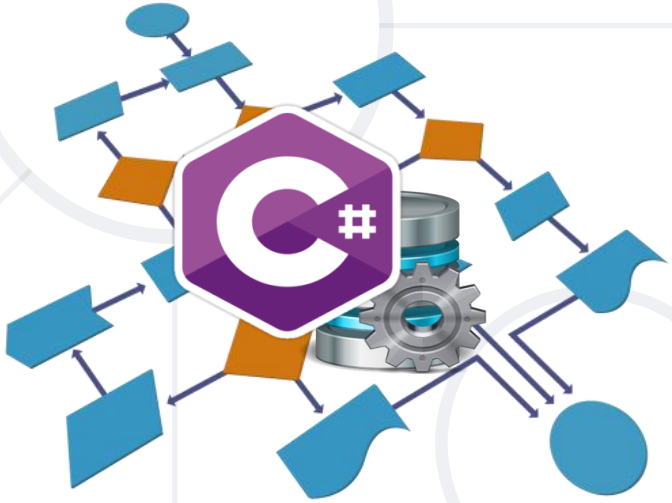
SoftUni Foundation

- Databases can be accessed directly with **SQL queries** from C# code
- EF keeps track of the **model state**
- **Entity Framework-Plus** lets you bundle **update** and **delete** operations
- With multiple users, **concurrency** of operations must be observed
- **Cascade delete** is on by default

C# Auto Mapping Objects

Manual Mapping

and AutoMapper Library



SoftUni Team

Technical Trainers

Software University

SoftUni Foundation

Software University

http://softuni.bg

Table of Contents

Data Transfer Objects

Definition and Usage

What is a Data Transfer Object?

- A **DTO** is an object that **carries data** between processes
  - Used to **aggregate** only the **needed information** in a single call
  - Example: In web applications, between the **server** and **client**
- Doesn't contain any logic – only **stores values**

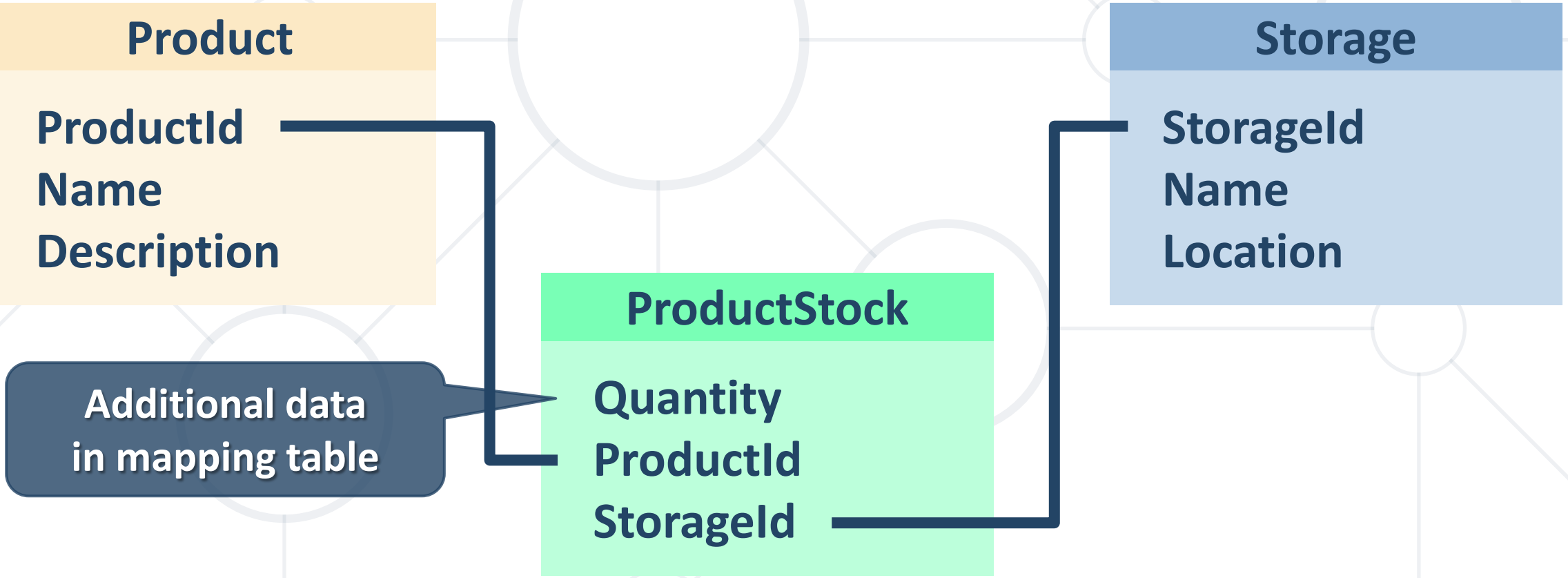
```
public class ProductDTO
{
   public string Name { get; set; }
   public int StockQty { get; set; }
}
```

DTO Usage Scenarios

- **Remove** circular references
- **Hide** particular properties that **clients** are not supposed to view
- **Omit** some properties in order to **reduce** payload **size**
- **Flatten** object graphs that contain nested objects to make them more convenient for clients
- **Decouple** your service layer from your database layer

Manual Mapping

- Relationship Diagram



Manual Mapping (2)

- Get product name and stock quantity in a new DTO object

```
var product =
context.Products.FirstOrDefault();
var productDto = new ProductDTO
{
   Name = product.Name,
   StockQty = product.ProductStocks
      .Sum(ps => ps.Quantity)
};
```

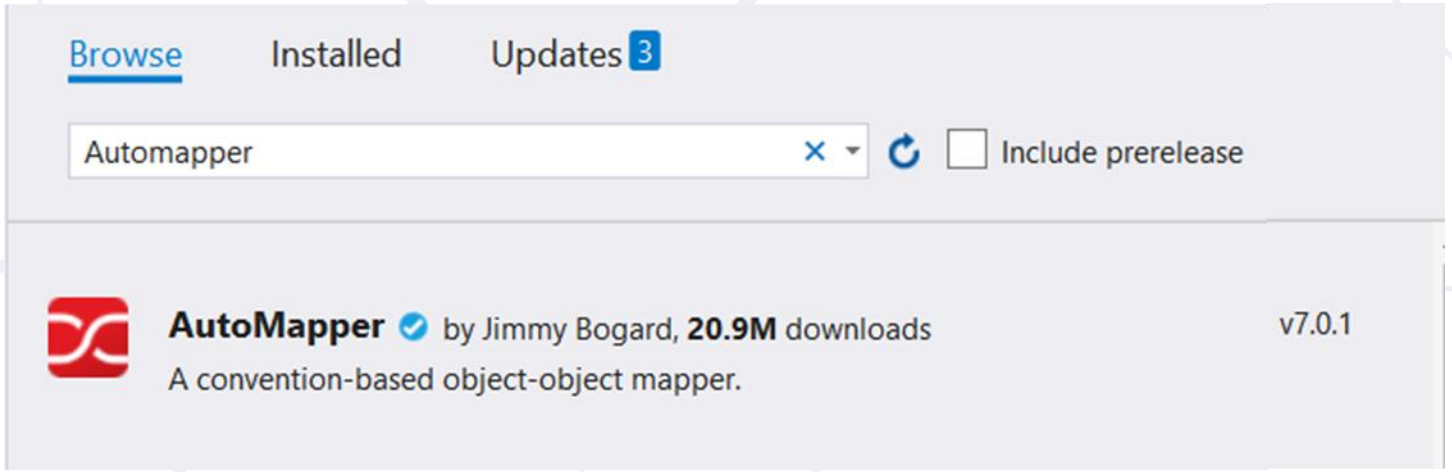
Aggregate information from mapping table

AutoMapper Library

Automatic Translation of Domain Objects

What is AutoMapper?

- Library to eliminate **manual mapping** code
- Available as a **NuGet** Package
- Official **GitHub Page**




```
Install-Package AutoMapper
```

Initialization and Configuration

- AutoMapper offers a **static service** for use and configuration
  - Add mappings between objects and DTOs

```
Mapper.Initialize(cfg => cfg.CreateMap<Product,
ProductDTO>());
```

Source

Target

- Properties will be mapped **by name**

```
var product = context.Products.FirstOrDefault();
ProductDTO dto = Mapper.Map<ProductDTO>(product);
```

Multiple Mappings

SoftUni Foundation

- You can configure all mapping configurations at once

```
Mapper.Initialize(cfg =>
{
  cfg.CreateMap<Product, ProductDTO>();
  cfg.CreateMap<Order, OrderDTO>();
  cfg.CreateMap<Client, ClientDTO>();
  cfg.CreateMap<SupportTicket, TicketDTO>();
});
```

Custom Member Mapping

SoftUni Foundation

- Map properties that don't match naming convention

```
Mapper.Initialize(cfg =>
   cfg.CreateMap<Product, ProductDTO>()
      .ForMember(dto => dto.StockQty,
                 opt => opt.MapFrom(src =>
                   src.ProductStocks.Sum(p =>
p.Quantity))));
```

Destination property

Source

Flattening Complex Properties

SoftUni Foundation

- **AutoMapper** can also be used to flatten complex properties

```
Mapper.Initialize(cfg =>
  cfg.CreateMap<Event, CalendarEventViewModel>()
     .ForMember(dest => dest.Date,
                opt => opt.MapFrom(src => src.Date.Date))
     .ForMember(dest => dest.Hour,
                opt => opt.MapFrom(src => src.Date.Hour))
     .ForMember(dest => dest.Minute,
                opt => opt.MapFrom(src => src.Date.Minute)));
```

Flattening Complex Objects

SoftUni Foundation

- **Flattening** of related objects is automatically supported

```
public class OrderDTO
{
  public string ClientName { get; set; }
  public decimal Total { get; set; }
}
```

- **AutoMapper** understands ClientName is the **Name** of a **Client**

```
Mapper.Initialize(cfg => cfg.CreateMap<Order, OrderDTO>());
OrderDTO dto = Mapper.Map<Order, OrderDTO>(order);
```

Unflattening Complex Objects

SoftUni Foundation

- **Unflattening** of related objects is automatically supported

```
public class OrderDTO
{
  public string ClientName { get; set; }
  public decimal Total { get; set; }
}
```

- **AutoMapper** understands ClientName is the **Name** of a **Client,** but to unflatten it, it needs **ReverseMap**

```
Mapper
    .Initialize(cfg => cfg.CreateMap<Order, OrderDTO>()
    .ReverseMap());
```

Mapping Collections

- EF Core uses **IQueryable<T>** for all DB operations
  - AutoMapper can work with IQueryable<T> to map classes
- Using AutoMapper to map an entire DB collection:

```
var posts = context.Posts
  .Where(p => p.Author.Username == "gosho")
  .ProjectTo<PostDto>()
  .ToArray();
```

IQueryable<Post>

IQueryable<PostDto>

- Works like an automatic **.Select()**
  - EF Core generates **optimized SQL** (like with an **anonymous object**)

AutoMapper.Collection

SoftUni Foundation

- Adds ability to map collections to existing collections **without re-creating** the collection object
- Will **Add/Update/Delete** items from a preexisting collection object based on user defined equivalency between the collection's generic item type from the source collection and the destination collection

```
Mapper
    .Initialize(cfg => cfg.AddCollectionMappers());
```

AutoMapper.Collection.EntityFrameworkCore

SoftUni Foundation

- **Automapper.Collection.EntityFrameworkCore** will help you mapping of EntityFrameowrk Core DbContext-object

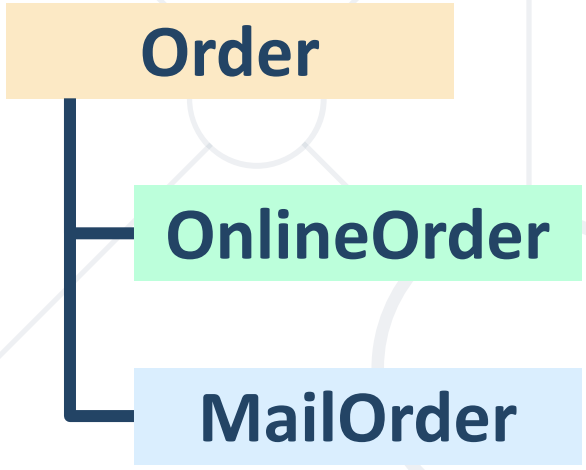
```
Mapper.Initialize(cfg =>
{
    cfg.AddCollectionMappers();
    cfg.SetGeneratePropertyMaps
      <GenerateEntityFrameworkCorePrimaryKeyPropertyMaps<Context>>();
    // Configuration code
});
```

- Comparing to a single existing Entity for updating

```
dbContext.Orders.Persist().InsertOrUpdate<OrderDTO>(newOrderDto);
dbContext.Orders.Persist().InsertOrUpdate<OrderDTO>(existingOrderDto);
dbContext.Orders.Persist().Remove<OrderDTO>(deletedOrderDto);
dbContext.SubmitChanges();
```

Inheritance Mapping

- Inheritance chains are defined via Include()
- AutoMapper chooses the most appropriate child class



Register with parent

```
Mapper.Initialize(cfg => {
  cfg.CreateMap<Order, OrderDto>()
    .Include<OnlineOrder, OnlineOrderDto>()
    .Include<MailOrder, MailOrderDto>();
  cfg.CreateMap<OnlineOrder, OnlineOrderDto>();
  cfg.CreateMap<MailOrder, MailOrderDto>();
});
```

Child mapping

Mapping Profiles

SoftUni Foundation

- We can extract our configuration to a class (called a **profile**)

```
public class ForumProfile : Profile
{
  public ForumProfile()
  {
    CreateMap<Post, PostDto>();
    CreateMap<Category, CategoryDto>();
  }
}
```

using AutoMapper;

- Using our configuration class:

```
Mapper.Initialize(cfg => cfg.AddProfile<ForumProfile>());
```

Summary

- To reduce round-trip latency and payload size, data is transformed into a **DTO**
- **AutoMapper** is a library that automates this process and reduces boilerplate code
- Complex objects can be **flattened** to fractions of their sizes

External Format Processing

Parsing JSON, JSON.NET

{JSON}

JavaScript Object Notation

SoftUni Team

Technical Trainers

Software University

SoftUni Foundation

Software University

http://softuni.bg

Table of Contents

The JSON Data Format

Definition and Syntax

JSON Data Format

SoftUni Foundation

- **JSON** (**J**ava**S**cript **O**bject **N**otation) is a lightweight data format
  - Human and machine-readable plain text
  - Based on **JavaScript** objects
  - Independent of development platforms and languages
  - JSON data consists of:
    - Values (strings, numbers, etc.)
    - Key-value pairs: **{ key : value }**
    - Arrays: **[value1, value2, …]**

JSON Data Format (2)

SoftUni Foundation

- The JSON data format follows the rules of object creation in JS
  - **Strings**, **numbers** and **Booleans** are valid JSON:

```
"this is a string and is valid JSON"
```

```
3.14
```

```
true
```

  - **Arrays** are valid JSON:

```
[5, "text", true]
```

  - **Objects** are valid JSON (key-value pairs):

```
{
  "firstName": "Vladimir", "lastName": "Georgiev",
  "jobTitle": "Technical Trainer", "age": 25
}
```

Processing JSON

Parsing JSON in C# and .NET

Built-in JSON Support

- .NET has a built-in **DataContractJsonSerializer** class
- Contained in **System.Runtime.Serialization** assembly
- Supports **deserializing** (parsing) strings and **serializing** objects
- Including **DataContractJsonSerializer** into a project:

```
using System.Runtime.Serialization.Json;
```

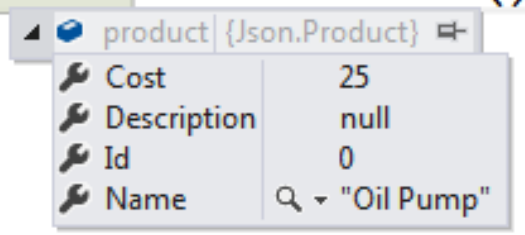
Serializing JSON

SoftUni Foundation

- DataContractJsonSerializer can serialize an object:

```
static string SerializeJson<T>(T obj)
{
  var serializer = new DataContractJsonSerializer(obj.GetType());
  using (var stream = new MemoryStream())
  {
    serializer.WriteObject(stream, obj);
    var result = Encoding.UTF8.GetString(stream.ToArray());
    return result;
  }
}
```

```
var product = new Product();
```



```
{
  "Id":0,
  "Name":"Oil Pump",
  "Description":null,
  "Cost":25
}
```

Deserializing JSON

SoftUni Foundation

- DataContractJsonSerializer can deserialize a JSON string:

```
static T DeserializeJson<T>(string jsonString)
{
  var serializer = new DataContractJsonSerializer(typeof(T));
  var jsonStringBytes = Encoding.UTF8.GetBytes(jsonString);
  using (var stream = new MemoryStream(jsonStringBytes))
  {
    var result = (T)serializer.ReadObject(stream);
    return result;
  }
}
```

```
{
  "Id":0,
  "Name":"Oil Pump",
  "Description":null,
  "Cost":25
}
```

```
var product = new Product();
```

product {Json.Product}

Cost	25
Description	null
Id	0
Name	"Oil Pump"

JSON.NET

Better JSON Parsing for .NET Developers

What is JSON.NET?

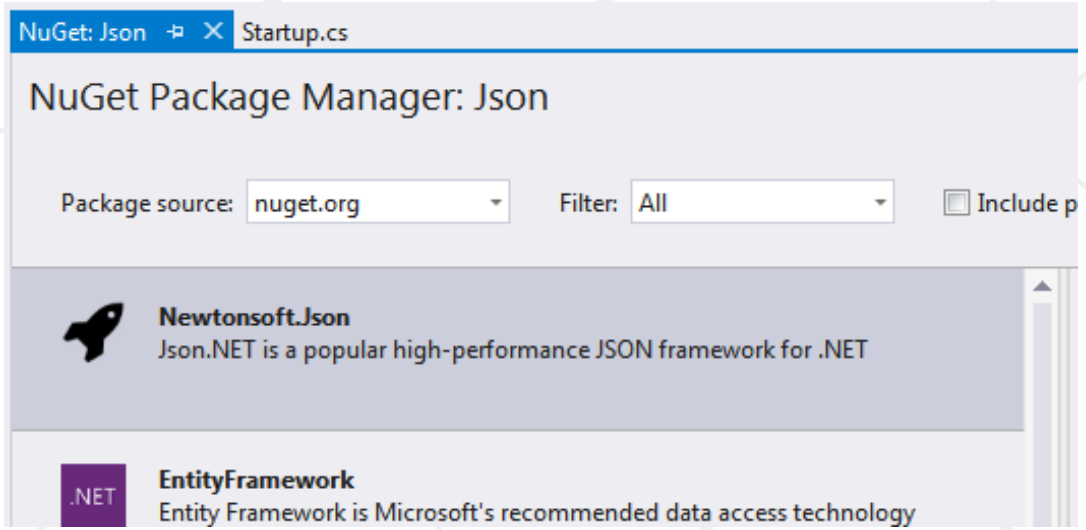
SoftUni Foundation

- **JSON.NET** is a JSON **framework** for .NET
  - **More functionality** than built-in functionality
  - Supports **LINQ-to-JSON**
  - Out-of-the-box support for parsing between **JSON** and **XML**
  - Open-source project: **http://www.newtonsoft.com**
  - Json.NET vs .NET Serializers: **https://www.newtonsoft.com/json/help/html/JsonNetVsDotNetSerializers.htm**

Installing JSON.NET

SoftUni Foundation

- To install JSON.NET use the **NuGet Package Manager**:



- Or with a command in the Package Manager Console:

```
Install-Package Newtonsoft.Json
```

General Usage

- JSON.NET exposes a static service **JsonConvert**
- Used for parsing and configuration
  - To **Serialize** an object:

```
var jsonProduct = JsonConvert.SerializeObject(product);
```

  - To **Deserialize** an object:

```
var objProduct =
  JsonConvert.DeserializeObject<Product>(jsonProduct);
```

JSON.NET Features

- JSON.NET can be configured to:
  - **Indent** the output JSON string
  - To convert JSON to **anonymous types**
  - To control the **casing** and **properties** to parse
  - To skip errors
- JSON.NET also supports:
  - LINQ-to-JSON
  - Direct parsing between XML and JSON

Configuring JSON.NET

SoftUni Foundation

- By default, the result is a **single line of text**
- To indent the output string use **Formatting.Indented**

```
JsonConvert.SerializeObject(products, Formatting.Indented);
```

```
{
  "pump": {
    "Id": 0,
    "Name": "Oil Pump",
    "Description": null,
    "Cost": 25.0
  },
  "filter": {
    "Id": 0,
    "Name": "Oil Filter",
    "Description": null,
    "Cost": 15.0
  }
}
```

Configuring JSON.NET

SoftUni Foundation

- Deserializing to **anonymous** types:

Incoming JSON

```
var json = @"{ 'firstName': 'Vladimir',
               'lastName': 'Georgiev',
               'jobTitle': 'Technical Trainer' }";
var template = new
{
    FirstName = string.Empty,
    LastName = string.Empty,
    Occupation = string.Empty
};
var person = JsonConvert.DeserializeAnonymousType(json, template);
```

Template objects

JSON.NET Parsing of Objects

- By default JSON.NET takes each property / field from the class and parses it
  - This can be controlled using attributes:

```
public class User
{
  [JsonProperty("user")]
  public string Username { get; set; }

  [JsonIgnore]
  public string Password { get; set; }
}
```

Parse Username to user

Skip the property

JSON.NET Parsing of Objects

- By default JSON.NET takes each property / field from the class and parses it
  - This can be controlled using **ContractResolver**:

```
DefaultContractResolver contractResolver = new DefaultContractResolver()
{
    NamingStrategy = new SnakeCaseNamingStrategy()
};

var serialized = JsonConvert.SerializeObject(person, new JsonSerializerSettings()
{
    ContractResolver = contractResolver,
    Formatting = Formatting.Indented
});
```

LINQ-to-JSON

SoftUni Foundation

- LINQ-to-JSON works with JObjects
  - Create from JSON string:

```
JObject obj = JObject.Parse(jsonProduct);
```

  - Reading from file:

```
var people = JObject.Parse(File.ReadAllText(@"c:\people.json"))
```

  - Using **JObject**:

```
foreach (JToken person in people)
{
  Console.WriteLine(person["FirstName"]); // Ivan
  Console.WriteLine(person["LastName"]); // Petrov
}
```

LINQ-to-JSON (2)

SoftUni Foundation

- JObjects can be queried with LINQ

```
var json = JObject.Parse(@"{'products': [
  {'name': 'Fruits', 'products': ['apple', 'banana']},
  {'name': 'Vegetables', 'products': ['cucumber']}]}");

var products = json["products"].Select(t =>
  string.Format("{0} ({1})",
    t["name"],
    string.Join(", ", c["products"])
))

// Fruits (apple, banana)
// Vegetables (cucumber)
```

XML-to-JSON

SoftUni Foundation

```
string xml = @"<?xml version='1.0' standalone='no'?>
 <root>
    <person id='1'>
        <name>Alan</name>
        <url>www.google.com</url>
    </person>
    <person id='2'>
        <name>Louis</name>
        <url>www.yahoo.com</url>
    </person>
</root>";

XmlDocument doc = new XmlDocument();
doc.LoadXml(xml);
string jsonText = JsonConvert.SerializeXmlNode(doc);
```

```
{
    "?xml": {
    "@version": "1.0",
    "@standalone": "no"
    },
    "root": {
        "person": [
        {
            "@id": "1",
            "name": "Alan",
            "url": "www.google.com"
        },
        {
            "@id": "2",
            "name": "Louis",
            "url": "www.yahoo.com"
        }
        ]
    }
}
```

Summary

- JSON is cross platform data format
- **DataContractJsonSerializer** is the default JSON Parser in C#
- **JSON.NET** is a fast framework for working with JSON data

XML Processing

Parsing XML

XDocument and LINQ

SoftUni Team

Technical Trainers

Software University

SoftUni Foundation

Technical Trainers

Software University

Table of Contents

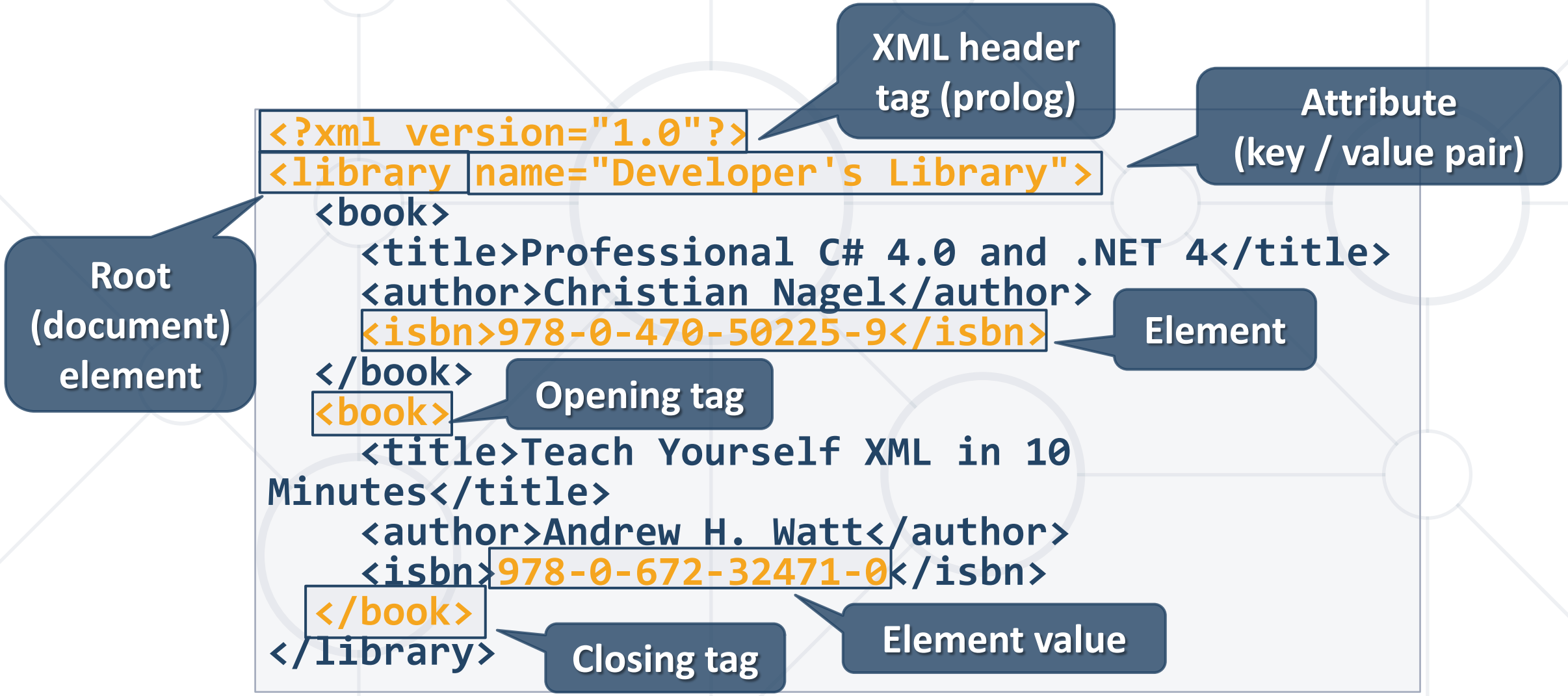
What is XML?

Format Description and Application

What is XML?

- EXtensible Markup Language
  - **Universal notation** (data format / language) for describing structured data using text with tags
  - Designed to **store** and **transport** data
  - The data is stored together with the **meta-data** about it

XML – Example


XML header tag (prolog)
Attribute (key / value pair)
Root (document) element
Element
Opening tag
Element value
Closing tag
<?xml version="1.0"?>
<library name="Developer's Library">
<book>
<title>Professional C# 4.0 and .NET 4</title>
<author>Christian Nagel</author>
<isbn>978-0-470-50225-9</isbn>
</book>
<book>
<title>Teach Yourself XML in 10 Minutes</title>
<author>Andrew H. Watt</author>
<isbn>978-0-672-32471-0</isbn>
</book>
</library>

XML Syntax

- Header – defines a **version** and character **encoding**

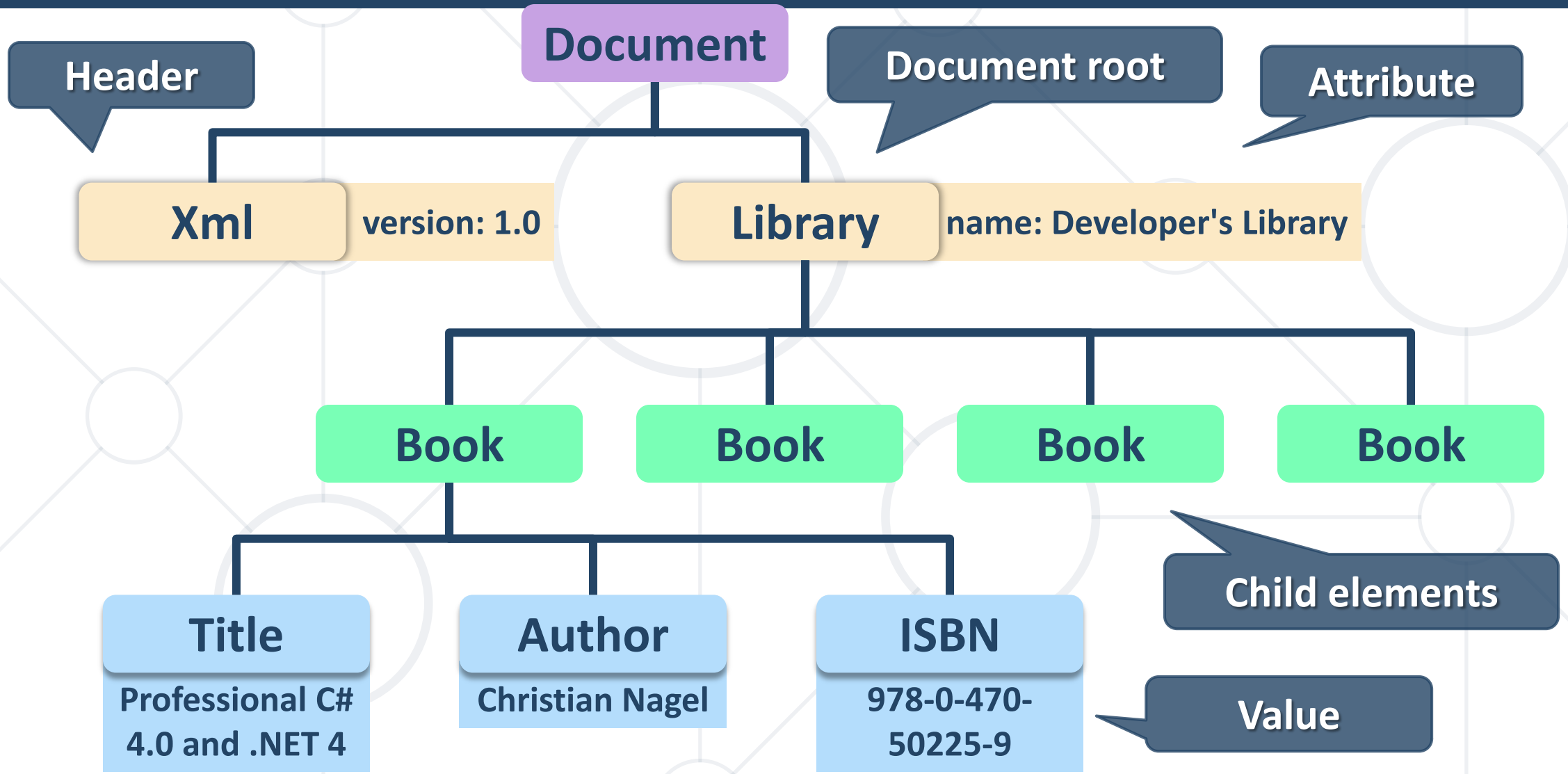
```
<?xml version="1.0" encoding="UTF-8"?>
```

- **Elements** – define the structure
- **Attributes** – element metadata
- **Values** – actual data, that can also be nested elements


```
<title lang="en">Professional C# 4.0 and .NET 4</title>
```

- Root element – required to **only** have **one**

XML - Structure



XML and HTML

- Similarities between XML and HTML
  - Both are **text based** notations
  - Both use **tags** and **attributes**
- Differences between XML and HTML
  - HTML describes documents, XML is a syntax for describing other languages (**meta-language**)
  - HTML describes the **layout** and the structure of information
  - XML requires the documents to be **well-formatted**

XML: Advantages

SoftUni Foundation

- Advantages of XML:
  - XML is **human-readable** (unlike binary formats)
  - Stores any kind of **structured data**
  - Data comes with self-describing **meta-data**
  - Full Unicode support
  - Custom XML-based languages can be designed for certain apps
  - **Parsers** available for virtually all languages and platforms

XML: Disadvantages

SoftUni Foundation

- Disadvantages of XML:
  - XML data is **bigger** (takes more space) than binary or JSON
    - More memory consumption, more network traffic, more hard-disk space, more resources, etc.
  - **Decreased performance**
    - CPU consumption: need of parsing / constructing the XML tags
- XML is **not** suitable for **all** kinds of **data**
  - E.g. binary data: graphics, images, videos, etc.

Parsing XML

Using XDocument and LINQ

LINQ to XML

- LINQ to XML
  - Use the power of **LINQ** to process XML data
  - Easily read, search, write, modify XML documents
- LINQ to XML classes:
  - **XDocument** – represents a LINQ-enabled XML document (containing prolog, root element, …)
  - **XElement** – main component holding information

Reading XML

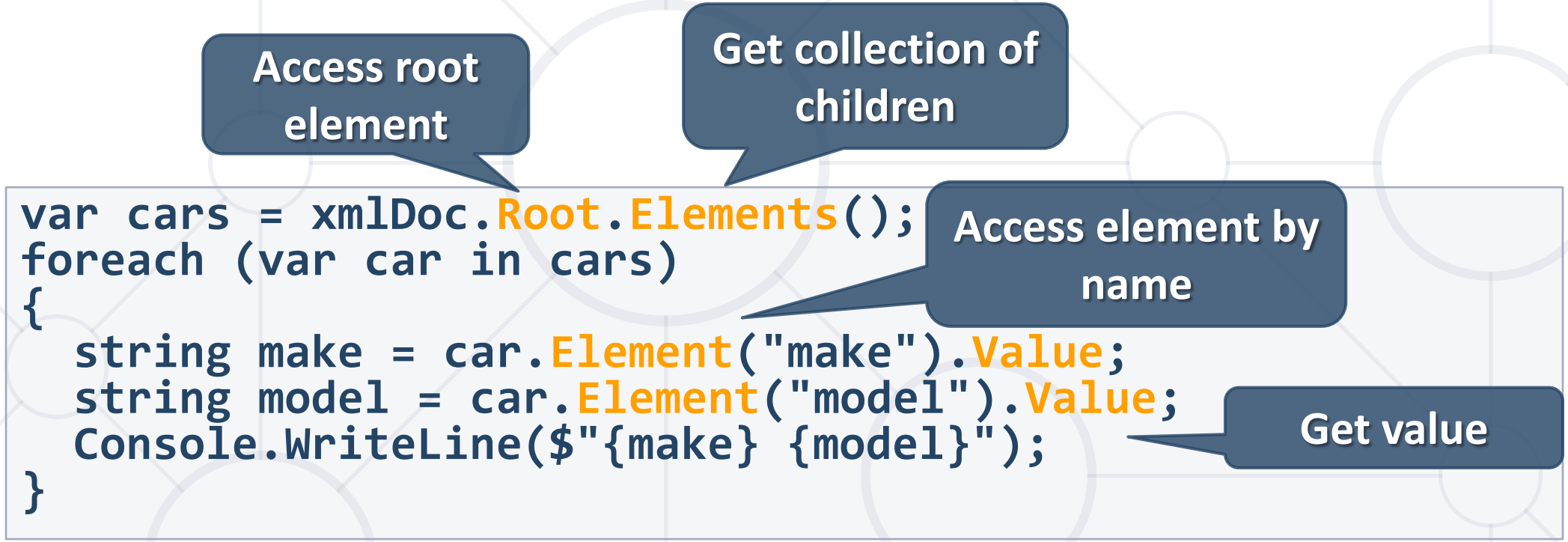
- To process an XML string:

```
string str =
@"<?xml version=""1.0""?>
<!-- comment at the root level -->
<Root>
    <Child>Content</Child>
</Root>";
XDocument doc = XDocument.Parse(str);
```

- Loading XML directly from file:

```
XDocument xmlDoc = XDocument.Load("../../books.xml");
```

Working with XDocument



Working with XDocument (2)

- Set an element value by name
  - If it doesn't exist, it will be **added**
  - If it is set to **null**, it will be **removed**

```
customer.SetElementValue("birth-date", "1990-10-04T00:00:00");
```

- Remove an element from its parent

```
var youngDriver = customer.Element("is-young-driver");
youngDriver.Remove();
```

Working with XDocument (3)

SoftUni Foundation

- Get or set an element attribute by name

```
customer.Attribute("name").Value
```

- Get a list of all attributes for an element

```
var attrs = customer.Attributes;
```

- Set an attribute value by name
  - If it doesn't exist, it will be **added**
  - If it is set to **null**, it will be **removed**

```
customer.SetAttributeValue("age", "21");
```

LINQ to XML – Searching with LINQ

SoftUni Foundation

- Searching in XML with LINQ is like searching with LINQ in array

```
XDocument xmlDoc = XDocument.Load("cars.xml");
var cars = xmlDoc.Root.Elements()
  .Where(e => e.Element("make").Value == "Opel" &&
              (long)e.Element("travelled-distance") >= 300000)
  .Select(c => new
    {
      Model = c.Element("model").Value,
      Traveled = c.Element("travelled-distance").Value
    })
  .ToList();
foreach (var car in cars)
  Console.WriteLine(car.Model + " " + car.Traveled);
```

Creating XML with XElement

SoftUni Foundation

- XDocuments can be composed from XElements and XAttributes

```
<books>
  <book>
    <author>Don Box</author>
    <title lang="en">Essential .NET</title>
  </book>
</book>
```

```
XDocument xmlDoc = new XDocument();
xmlDoc.Add(
  new XElement("books",
    new XElement("book",
      new XElement("author", "Don Box"),
      new XElement("title", "ASP.NET", new XAttribute("lang",
"en"))
)));
```

Add as root

Added with value

Optional attribute

Serializing XML to File

SoftUni Foundation

- To flush a XDocument to file with default settings:

```
xmlDoc.Save("myBooks.xml");
```

- To disable automatic indentation:

```
xmlDoc.Save("myBooks.xml", SaveOptions.DisableFormatting);
```

- To serialize **any object** to file:

```
var serializer = new XmlSerializer(typeof(ProductDTO));
using (var writer = new StreamWriter("myProduct.xml");)
{
  serializer.Serialize(writer, product);
}
```

Deserialize XML from String XML

SoftUni Foundation

- To **deserialize** an object from a XML string

```
var serializer = new XmlSerializer(typeof(OrderDto[]), new
XmlRootAttribute("Orders"));

var deserializedOrders =
  (OrderDto[])serializer.Deserialize(new StringReader(xmlString));
```

- Specifying **root attribute** name

```
var attr = new XmlRootAttribute("Orders");
var serializer = new XmlSerializer(typeof(OrderDto[]), attr);

var deserializedOrders =
  (OrderDto[])serializer.Deserialize(new
StringReader(xmlString));
```

XML Attributes

Using xml attributes

XML Attributes

SoftUni Foundation

- We can use several attributes to control serialization to XML
  - **[XmlType("Name")]** – Specifies the type's **name** in XML
  - **[XmlAttribute("name")]** – Serializes as **XML Attribute**
  - **[XmlElement]** – Serialize as **XML Element**
  - **[XmlIgnore]** – **Do not** serialize
  - **[XmlArray]** – Serialize as an **array** of XML elements
  - **[XmlRoot]** – Specifies the **root** element name
  - **[XmlText]** – Serialize **multiple xml elements** on **one line**

XML Attributes: Example

- We can use several XML attributes to control serialization

```
[XmlType("Book")]
public class BookDto
{
 [XmlAttribute("name")]
 public string Name { get; }

 [XmlElement("Author")]
 public string Author { get; }

 [XmlIgnore]
 public decimal Price { get; }
}
```

XML Type name

Not serialized

```
<Book name="It">
  <Author>Stephen King</Author>
</Book>
<Book name="Frankenstein">
  <Author>Mary Shelley</Author>
</Book>
<Book name="Queen Lucia">
  <Author>E.F. Benson</Author>
</Book>
<Book name="Paper Towns">
  <Author>John Green</Author>
</Book>
```

Summary

- **XDocument** is a system object for working with XML in .NET, which supports LINQ
- XML can be read and saved **directly to file**
- **XML Attributes** are easy way to describe the **XML file**

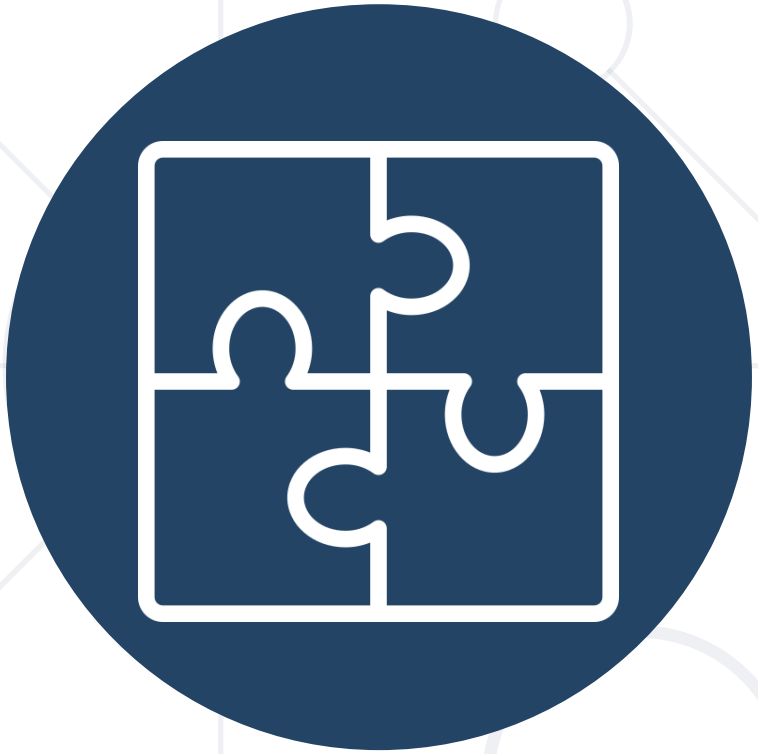
Design Patterns

SoftUni Team

Technical Trainers

Software University

http://softuni.bg



Design Patterns

Definition, Solutions and Elements

What are Design Patterns?

- **General** and **reusable solutions** to common problems in software design
- A **template** for solving given problems
- Add additional layers of **abstraction** in order to reach flexibility

What do Design Patterns Solve?

- Patterns solve **software structural problems** like:
  - Abstraction
  - Encapsulation
  - Separation of concerns
  - Coupling and cohesion
  - Separation of interface and implementation
  - Divide and conquer

Elements of a Design Pattern

- Pattern name - Increases **vocabulary** of designers
- Problem - **Intent**, context and when to apply
- Solution - **Abstract** code
- Consequences - **Results** and trade-offs

Why Design Patterns?

Benefits and Drawbacks

Benefits

- Names form a common vocabulary
- Enable large-scale **reuse** of software architectures
- Help improve developer **communication**
- Help ease the **transition** to Object Oriented technology
- Can **speed-up** the development

Drawbacks

- Do not lead to a direct code reuse
- Deceptively simple
- Developers may suffer from **pattern overload** and **overdesign**
- Validated by **experience** and discussion, not by automated testing
- Should be used only of **understood well**

Types of Design Patterns

Main Types

SoftUni Foundation

- Creational patterns
  - Deal with **initialization and configuration** of classes and objects
- Structural patterns
  - Describe ways to **assemble** objects to implement **new functionality**
  - **Composition** of classes and objects
- Behavioral patterns
  - Deal with dynamic **interactions** among societies of classes
  - Distribute **responsibility**

Creational Patterns

Purposes

- Deal with **object creation** mechanisms
- Trying to create objects in a **manner suitable** to the **situation**
- Two main ideas
  - **Encapsulating** knowledge about which classes the system uses
  - **Hiding** how instances of these classes are created

Singleton Pattern

SoftUni Foundation

- The most often used creational design pattern
- A Singleton class is supposed to have **only one instance**
- It is **not a global variable**
- Possible problems
  - Lazy loading
  - Thread-safe

Double-Check Singleton Example

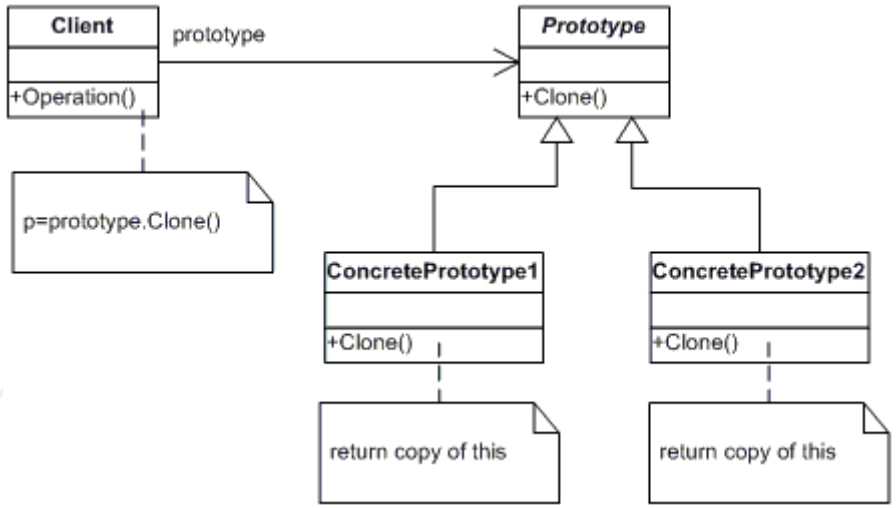
SoftUni Foundation

```
public sealed class Singleton {
  private static Singleton instance;
  private Singleton() { }
  public static Singleton Instance {
    get {
      if (instance == null) {
        lock (instance) {
          if (instance == null)
            instance = new Singleton(); } }
      return instance; } } }
```

Prototype Pattern

SoftUni Foundation

- Factory for **cloning** new instances from a prototype
  - Create new objects by copying this prototype
  - Instead if using the "new" keyword
- **ICloneable** interface acts as Prototype



The Prototype Abstract Class

SoftUni Foundation

```
abstract class Prototype {
  private string _id;

  public Prototype(string id) {
    this._id = id; }

  public string Id => this._id;

  public abstract Prototype Clone();
}
```

A Concrete Prototype Class

SoftUni Foundation

```
class ConcretePrototype : Prototype
{
  public ConcretePrototype(string id) : base(id) { }

  public override Prototype Clone()
    => return (Prototype)this.MemberwiseClone();
}
```

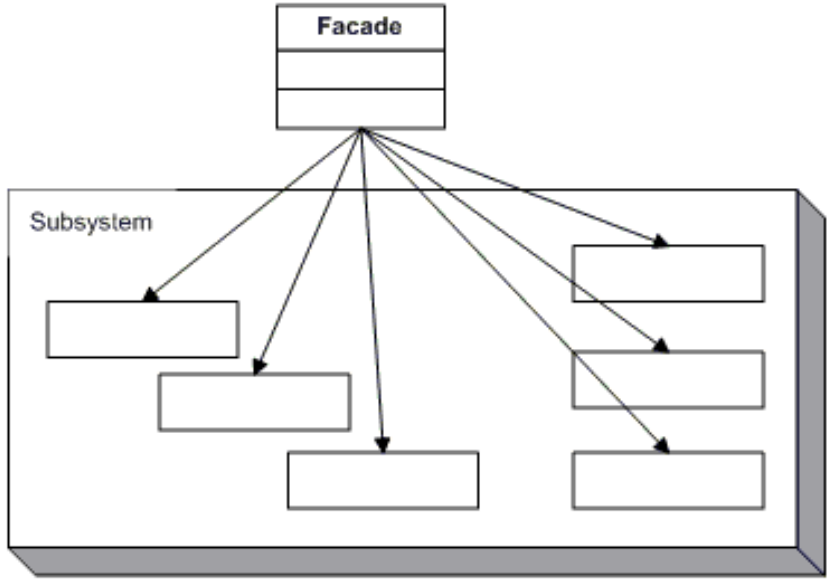
Structural Patterns

Purposes

- Describe ways to assemble **objects** to implement a **new functionality**
- Ease the design by identifying a simple way to realize **relationship** between entities
- All about Class and Object composition
  - **Inheritance** to compose interfaces
  - Ways to compose objects to obtain **new functionality**

Façade Pattern

- Provides a **unified interface** to a set of interfaces in a subsystem
- Defines a **higher-level interface** that makes the subsystem easier to use



The Façade Class (1)

SoftUni Foundation

```
class Facade
{
  private SubSystemOne _one;
  private SubSystemTwo _two;

  public Facade()
  {
    _one = new SubSystemOne();
    _two = new SubSystemTwo();
  }
```

The Façade Class (2)

SoftUni Foundation

```
  public void MethodA() {
    Console.WriteLine("\nMethodA() ---- ");
    _one.MethodOne();
    _two.MethodTwo(); }

  public void MethodB() {
    Console.WriteLine("\nMethodB() ---- ");
    _two.MethodTwo(); }
}
```

Subsystem Classes

SoftUni Foundation

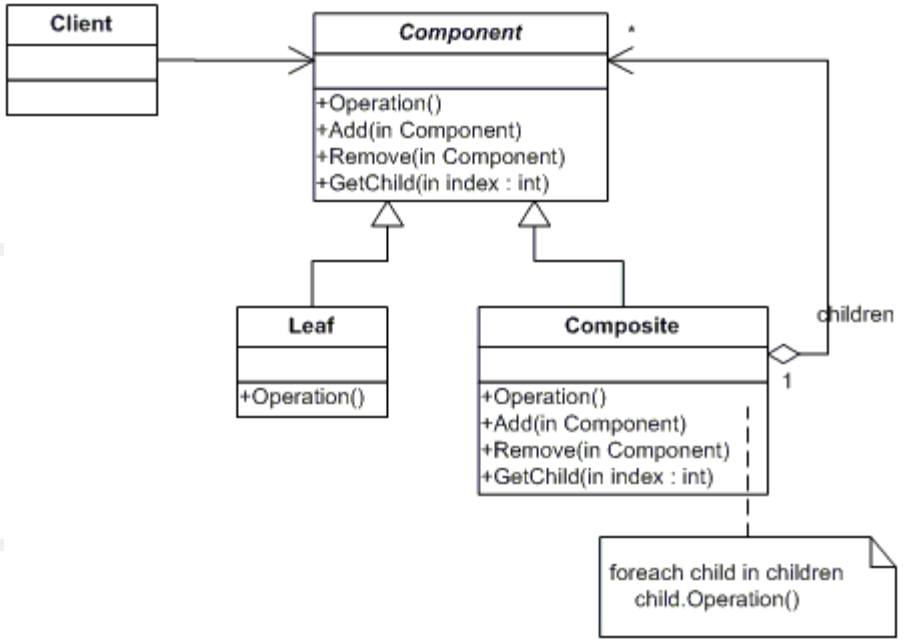
```
class SubSystemOne
{
  public void MethodOne()
    => Console.WriteLine(" SubSystemOne Method");
}
```

```
class SubSystemTwo
{
  public void MethodTwo()
    => Console.WriteLine(" SubSystemTwo Method");
}
```

Composite Pattern

SoftUni Foundation

- Allows to **combine** different types of objects in tree structures
- Gives the possibility to treat the **same object(s)**
- Used when
  - You have different objects that you want to **treat the same way**
  - You want to present **hierarchy** of objects



The Component Abstract Class

SoftUni Foundation

```
abstract class Component {
  protected string name;

  public Component(string name) {
      this.name = name; }

  public abstract void Add(Component c);
  public abstract void Remove(Component c);
  public abstract void Display(int depth);
}
```

The Composite Class (1)

SoftUni Foundation

```
class Composite : Component {
  private List<Component> _children = new List<Component>();

  public Composite(string name) : base(name) { }

  public override void Add(Component component)
      => _children.Add(component);

  public override void Remove(Component component)
      => _children.Remove(component);
```

The Composite Class (2)

SoftUni Foundation

```
public override void Display(int depth)
  {
    Console.WriteLine(new String('-', depth) + name);

    foreach (Component component in _children)
    {
      component.Display(depth + 2);
    }
  }
}
```

The Leaf Class

SoftUni Foundation

```
class Leaf : Component {
  public Leaf(string name) : base(name) { }

  public override void Add(Component c)
    => Console.WriteLine("Cannot add to a leaf");
  public override void Remove(Component c)
    => Console.WriteLine("Cannot remove from a leaf");
  public override void Display(int depth)
    => Console.WriteLine(new String('-', depth) + name);
}
```

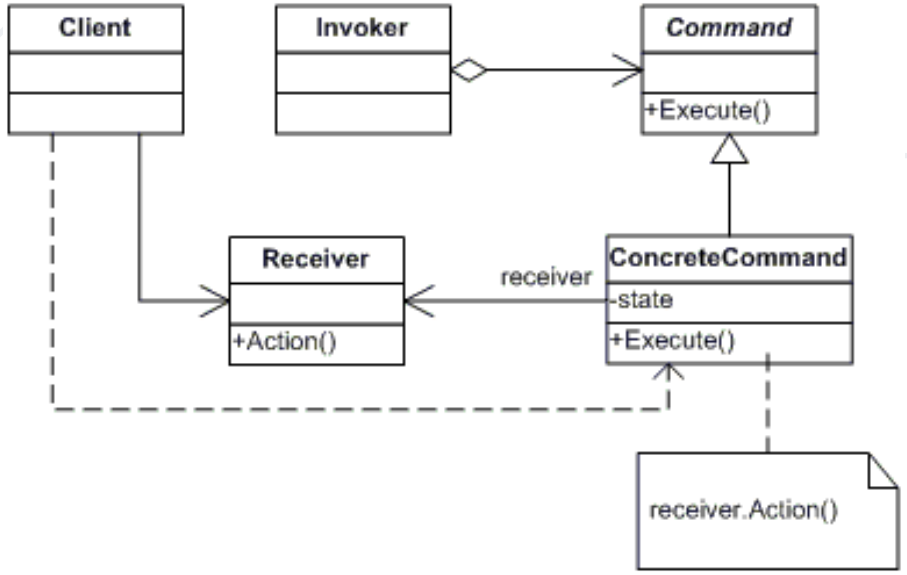
Behavioral Patterns

Purposes

- Concerned with **interaction** between objects
  - Either with the **assignment of responsibilities** between objects
  - Or **encapsulating behavior** in an object and delegating requests to it
- Increases **flexibility** in carrying out cross-classes communication

Command Pattern

- An object **encapsulates** all the information needed to call a method at a later time
  - Lets you **parameterize** clients with different requests, queue or log requests, and support undoable operations



The Command Abstract Class

SoftUni Foundation

```
abstract class Command
{
  protected Receiver receiver;

  public Command(Receiver receiver) {
    this.receiver = receiver; }

  public abstract void Execute();
}
```

Concrete Command Class

SoftUni Foundation

```
class ConcreteCommand : Command
{
  public ConcreteCommand(Receiver receiver)
    : base(receiver) { }

  public override void Execute()
    => receiver.Action();
}
```

The Receiver Class

SoftUni Foundation

```
class Receiver
{
  public void Action()
  {
    Console.WriteLine("Called Receiver.Action()");
  }
}
```

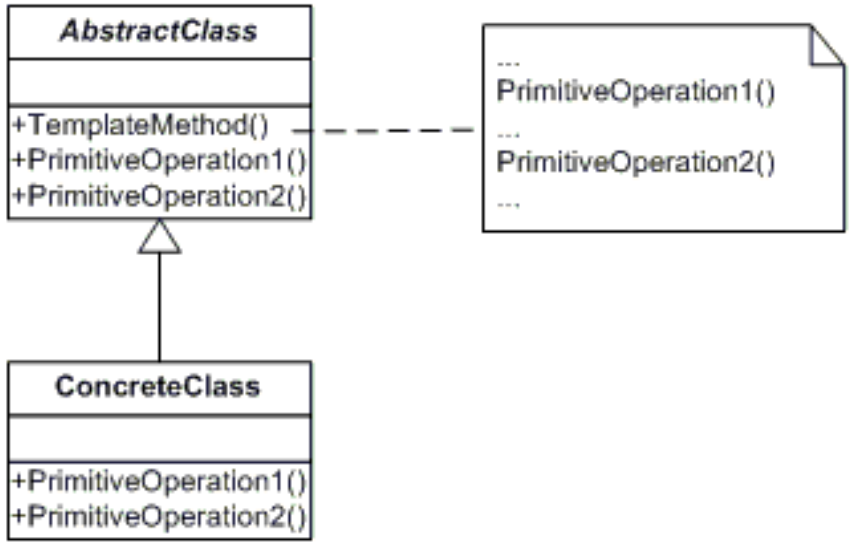
The Invoker Class

SoftUni Foundation

```
class Invoker
{
  private Command _command;

  public void SetCommand(Command command)
    => this._command = command;

  public void ExecuteCommand()
    => _command.Execute();
}
```

Template Pattern

- Define the **skeleton** of an algorithm in a method, leaving some implementation to its subclasses
- Allows the subclasses to **redefine** the implementation of some of the **parts** of the algorithm, but not its structure



The Abstract Class

SoftUni Foundation

```
abstract class AbstractClass
{
  public abstract void PrimitiveOperation1();
  public abstract void PrimitiveOperation2();

  public void TemplateMethod() {
    PrimitiveOperation1();
    PrimitiveOperation2();
    Console.WriteLine(""); }
}
```

A Concrete Class

SoftUni Foundation

```
class ConcreteClassA : AbstractClass
{
  public override void PrimitiveOperation1()
    => Console.WriteLine("ConcreteClassA.
       PrimitiveOperation1()");

  public override void PrimitiveOperation2()
    => Console.WriteLine("ConcreteClassA
       .PrimitiveOperation2()");
}
```

Summary

- Design Patterns
  - Provide solution to common problems
  - Add additional layers of abstraction
- Three main types of Design Patterns
  - Creational
  - Structural
  - Behavioral