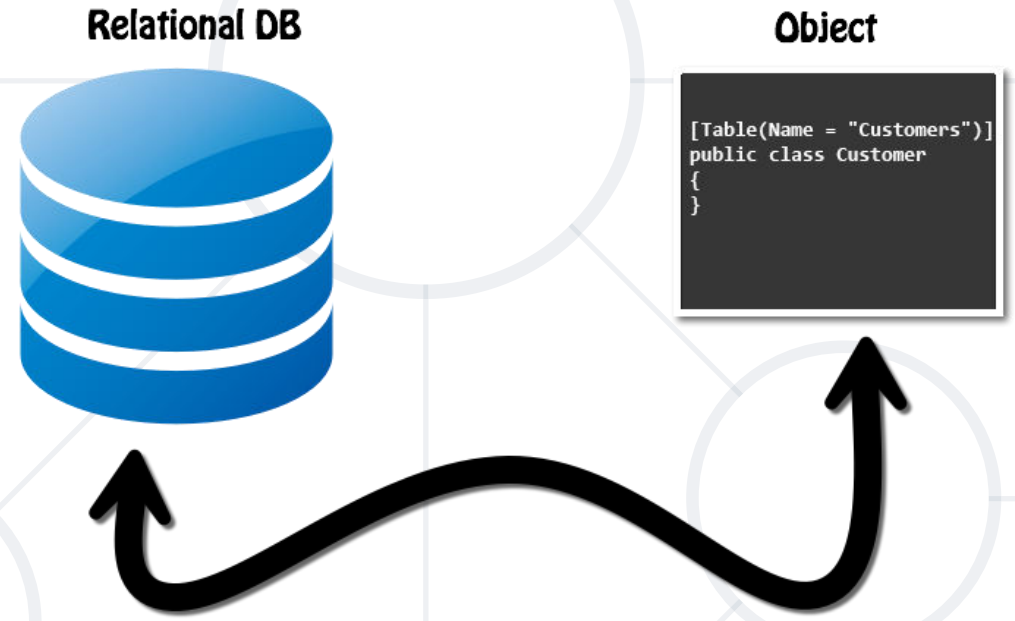
ORM Fundamentals

The ORM Concept, Config, CRUD Operations



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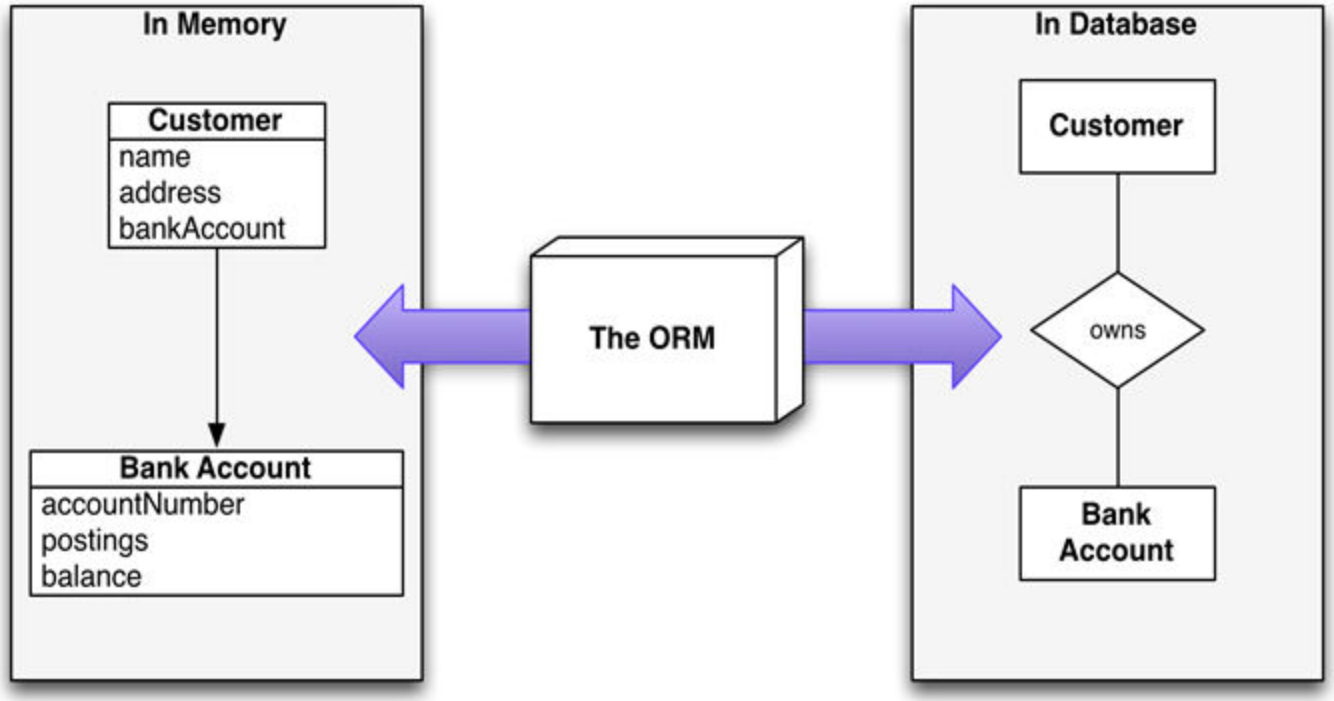
#csharp-db

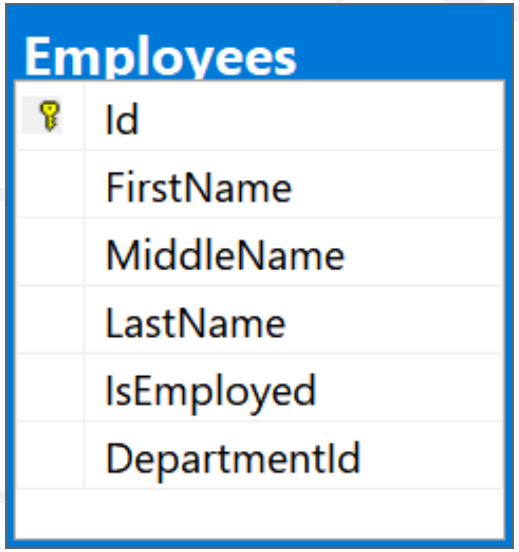


Introduction to ORM

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

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- 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

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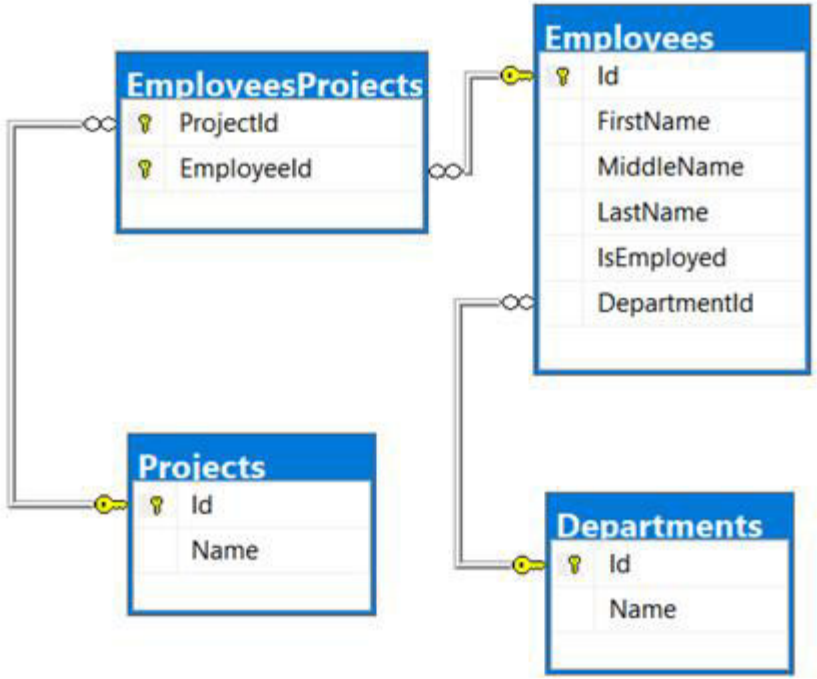
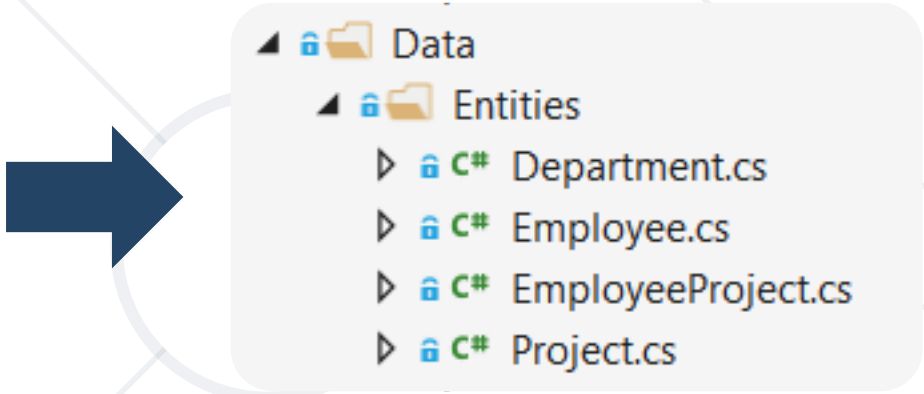
- **Define data model** (database-first)
  - Entity Classes
  - **DbContext** (with **DbSets**)
- Initialize **DbContext**
  - Using connection string
- Query data using context
- Manipulate data (add/remove/update entities)
- Context gets persisted into database

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

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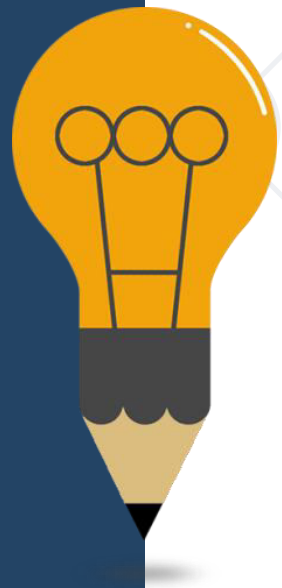
- **Entity classes** are regular **C# classes**
- Used for **storing** the **data** from the DB **in-memory**



Employees
Id
FirstName
MiddleName
LastName
IsEmployed
DepartmentId

```
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

- 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)

- 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>

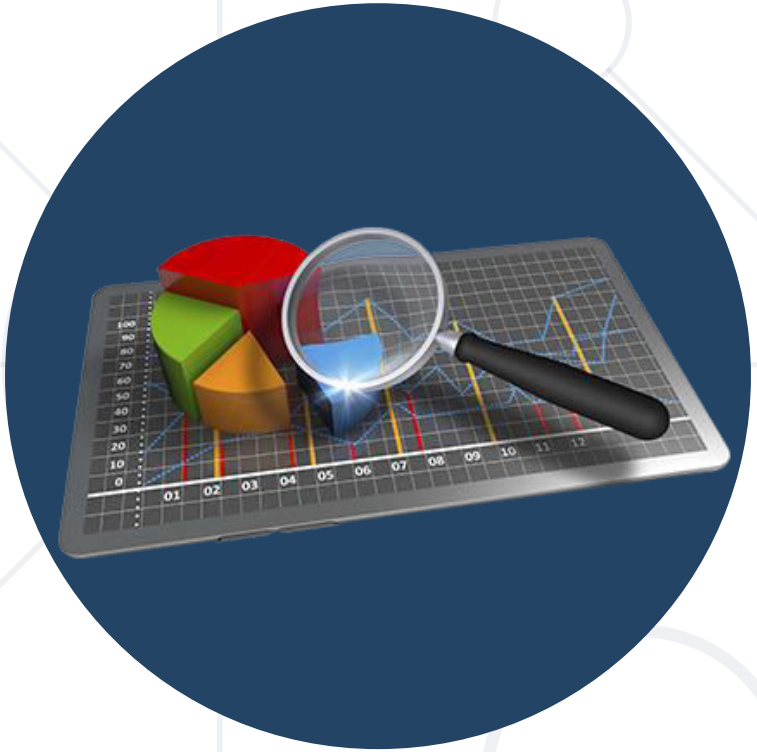
Specialized Collections

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

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- 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

- 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)

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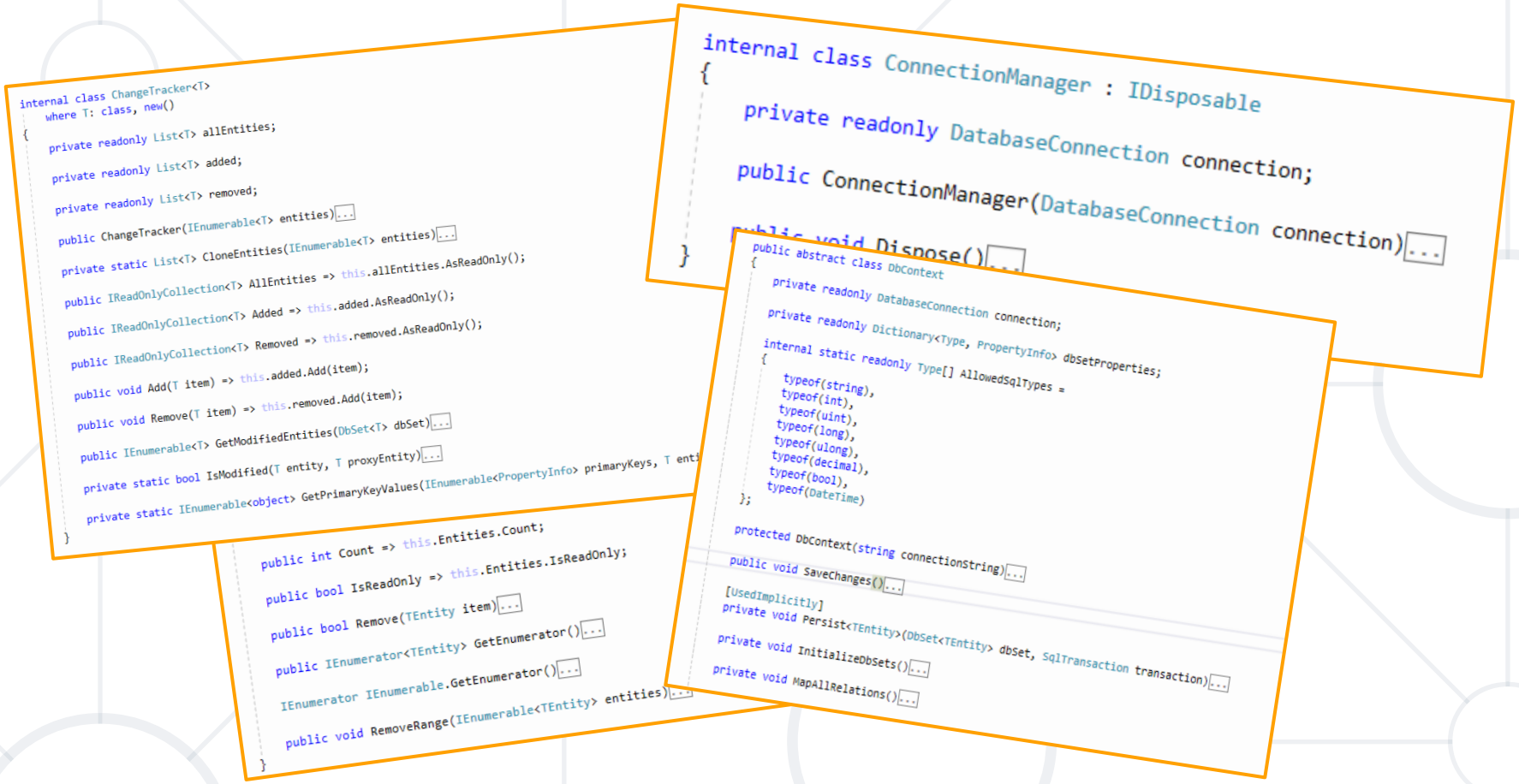
- Cloning Process:

```
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

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- 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

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- 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

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- 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();
```

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