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MASTERING

Entity Framework Core: From Start to Finish

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INTRODUCTION TO

Entity Framework Core

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Overview

Entity Framework Core (EF Core) is a popular **Object-Relational Mapper** (ORM) framework for .NET developers. It simplifies data access by bridging the gap between your application **objects** and **relational databases**. With EF Core, you can focus on your application logic while it handles the complexities of database interactions.

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History

- Entity Framework (EF) is an open-source Object-Relational Mapper (ORM) for .NET.

- Developed by **Microsoft**, it allows developers to work with a database using .NET objects.

- **Launched in 2008 with .NET Framework 3.5**, EF has evolved significantly over the years.

- EF Core, a **cross-platform** version, was introduced with .NET Core.

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Key Features and Benefits

- **Code-First development:** Design your domain model using C# classes and let EF Core generate the database schema.

- **Database-First approach:** Reverse engineer your database schema into C# classes for existing databases.

- **Change tracking:** Automatically tracks changes made to your entities and manages updates efficiently.

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Key Features and Benefits

- **LINQ to Entities:** Query your data using familiar LINQ syntax.
- **Migrations:** Manage database schema changes over time.
- **Cross-platform support:** Works with various databases like SQL Server, SQLite, PostgreSQL, and more.

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EF Core vs. Other ORMs

While EF Core is a powerful choice, it's essential to consider other ORMs based on your project requirements. Some popular alternatives include:

- **Dapper:** Lightweight micro-ORM focused on performance.
- **NHibernate:** Mature ORM with advanced features.

Choose the ORM that best aligns with your project's needs, considering factors like performance, features, and developer familiarity.

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Conclusion

- Entity Framework is a robust and versatile ORM that simplifies data access in .NET applications.

- With its rich feature set and continuous improvements, EF remains a top choice for developers.

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GETTING

Started with Entity Framework Core

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Introduction

Entity Framework Core (EF Core) is a **lightweight**, **extensible**, open-source, and cross-platform version of the popular Entity Framework data access technology. It simplifies data access and manipulation in your .NET applications.

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Installing EF Core 💾

To get started, you need to install the EF Core package. Use the following NuGet command in the Package Manager Console:

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

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Setting Up Your First EF Core Project

1. Create a new project:

```
dotnet new console -n EFCoreDemo
cd EFCoreDemo
```

2. Add EF Core packages:

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

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3. Create a model:

```
public class Product
{
    public int Id { get; set; }
    public string Name { get; set; }
    public decimal Price { get; set; }
}
```

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Configuring the DbContext⚙️

Create a DbContext class to manage your database operations:

```
1  public class AppDbContext : DbContext
2  {
3      public DbSet<Product> Products { get; set; }
4
5      protected override void OnConfiguring(DbContextOptionsBuilder optionsBuilder)
6      {
7          optionsBuilder.
8          UseSqlServer(
9            @"Server=(localdb)\mssqllocaldb;Database=EFCoreDemoDb;Trusted_Connection=True;"
10         );
11     }
12 }
```

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Basic CRUD Operations

Create:

```
1  using (var context = new AppDbContext())
2  {
3      var product = new Product
4      { Name = "Laptop", Price = 999.99M };
5      context.Products.Add(product);
6      context.SaveChanges();
7  }
```

Read:

```
1  using (var context = new AppDbContext())
2  {
3      var product = context.Products.FirstOrDefault(p => p.Name == "Laptop");
4      Console.WriteLine($"Product: {product.Name}, Price: {product.Price}");
5  }
```

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Updating Records ✏️

```
1   using (var context = new AppDbContext())
2   {
3       var product = context.Products
4       .FirstOrDefault(p => p.Name == "Laptop");
5       if (product != null)
6       {
7           product.Price = 899.99M;
8           context.SaveChanges();
9       }
10  }
```

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Deleting Records

```
using (var context = new AppDbContext())
{
    var product = context.Products
    .FirstOrDefault(p => p.Name == "Laptop");
    if (product != null)
    {
        context.Products.Remove(product);
        context.SaveChanges();
    }
}
```

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Conclusion 🎉

This is a basic introduction. EF Core offers much more, including advanced querying, relationships, migrations, and performance optimizations. Stay tuned for more in-depth content!

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Entity Framework Code First Approach

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01

Introduction

What is Code First?

- An approach where you define your model classes first and then generate the database schema from these classes.
- Provides greater control over the database schema through C# code.

Advantages:

- Aligns with Domain-Driven Design (DDD).
- Simplifies database version control.
- Eases the migration and update process.

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02

Creating and Configuring Models

Basic Model Class:

```
1   public class Product
2   {
3       public int ProductId { get; set; }
4       public string Name { get; set; }
5       public decimal Price { get; set; }
6   }
```

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Data Annotations:

```
1  public class Product
2  {
3      [Key]
4      public int ProductId { get; set; }
5
6      [Required]
7      [MaxLength(100)]
8      public string Name { get; set; }
9
10     [Range(0, 1000)]
11     public decimal Price { get; set; }
12 }
```

Fluent API:

```
1  protected override void OnModelCreating(ModelBuilder modelBuilder)
2  {
3      modelBuilder.Entity<Product>()
4          .Property(p => p.Name)
5          .IsRequired()
6          .HasMaxLength(100);
7  }
```

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Migrations and Database Updates

Adding a Migration:

```
// Adding a Migration:
// Use the Package Manager Console
Add-Migration InitialCreate

// Or use the .NET CLI
dotnet ef migrations add InitialCreate

```

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Applying Migrations:

```
// Use the Package Manager Console
Update-Database

// Or use the .NET CLI
dotnet ef database update

```

Updating the Model:

- **Modify your model classes.**

```
// Add a new migration:
Add-Migration AddNewColumn

// update the database
Update-Database
```

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Code First in Action

DbContext Class

```
1  public class ApplicationContext : DbContext
2  {
3      public DbSet<Product> Products { get; set; }
4
5      protected override void OnConfiguring
6                (DbContextOptionsBuilder optionsBuilder)
7      {
8          optionsBuilder
9          .UseSqlServer(@"Server=.;Database=CodeFirstDB;Trusted_Connection=True;");
10     }
11
12     protected override void OnModelCreating(ModelBuilder modelBuilder)
13     {
14         modelBuilder.Entity<Product>()
15             .Property(p => p.Name)
16             .IsRequired()
17             .HasMaxLength(100);
18     }
19 }
```

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Usage:

```
using (var context = new ApplicationContext())
{
    var product = new Product
                  {
                    Name = "Laptop",
                    Price = 999.99M
                  };
    context.Products.Add(product);
    context.SaveChanges();
}
```

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EF Core Database First Approach

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01

Introduction

Database First Approach allows you to create a data model based on an existing database. This approach is ideal for projects where the database is already designed and running.

Key Features:

- Works with existing databases
- Auto-generates context and entity classes
- Supports complex database structures

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Reverse Engineering an Existing Database

To use the Database First Approach, you need to reverse engineer your existing database. Use the Scaffold-DbContext command to generate your context and entity classes.

```
// This command will create a Models directory with
// context and entity classes representing your database.
Scaffold-DbContext "YourConnectionString"
    Microsoft.EntityFrameworkCore.SqlServer -OutputDir Models
```

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Customizing the Generated Models

The generated models can be **customized** to fit your application's needs. You can modify data annotations, relationships, and other properties.

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Example

```
1   public partial class Product
2   {
3       [Key]
4       public int ProductId { get; set; }
5
6       [Required]
7       [MaxLength(50)]
8       public string ProductName { get; set; }
9
10      public decimal Price { get; set; }
11  }
```

Here, we've added data annotations to the **Product** model for validation and constraints.

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Managing Changes with Migrations

Even with Database First, you can manage schema changes using migrations. This allows you to keep your database schema in sync with your model changes.

Example: Adding a Migration

```
1   Add-Migration AddNewColumn
2   Update-Database
```

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Conclusion and Best Practices

- Regularly update your models by re-scaffolding as the database evolves.
- Keep your models clean and organized by splitting them into partial classes.
- Use migrations to handle schema changes efficiently.

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Entity Framework Model First Approach

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01

Introduction

Model First is an approach where you create the conceptual model first and then generate the database schema from this model. It is ideal for projects where you prefer to design your database visually.

Benefits:

- Visual modeling of the database schema.
- Automatically generates database from the model.
- It is easy to make changes and update the database.

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02

Design Your Model

Use the **Entity Framework Designer** to create your model.

Add a New Model:

- Right-click on your project.
- Select Add > New Item.
- Choose ADO.NET Entity Data Model.
- Select Model First option.

Design the Model:

- Use the designer to add entities and relationships.
- Set properties and configure relationships (one-to-one, one-to-many, many-to-many).

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Designing a Simple Model

```
// Define an entity for a "Student"
public class Student
{
    public int StudentId { get; set; }
    public string Name { get; set; }
    public DateTime EnrollmentDate { get; set; }
}

// Define an entity for a "Course"
public class Course
{
    public int CourseId { get; set; }
    public string Title { get; set; }
    public int Credits { get; set; }
}
```

In the designer, you would visually add these entities and configure the relationships.

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Generate Your Database

Once your model is designed, you can generate the database schema.

Generate Database:

- Right-click on the designer surface.
- Select Generate Database from Model.

Configure Connection:

- Set up the connection string to your database.
- Review and execute the generated SQL script.

Update the Database:

- Apply the changes to create or update the database schema.

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Example: Generated SQL Script

```
1   CREATE TABLE Students (
2     StudentId INT PRIMARY KEY,
3     Name NVARCHAR(MAX),
4     EnrollmentDate DATETIME
5   );
6
7   CREATE TABLE Courses (
8     CourseId INT PRIMARY KEY,
9     Title NVARCHAR(MAX),
10    Credits INT
11  );
12
13  ALTER TABLE Students
14  ADD CONSTRAINT FK_Student_Course
15  FOREIGN KEY (CourseId) REFERENCES Courses(CourseId);
```

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Code First vs. Model First

Code First:

- Start by writing C# classes.
- The database is generated from the code.
- Ideal for developers who prefer to write code.

Model First:

- Start by designing the model visually.
- The database is generated from the model.
- Ideal for visualizing and managing the database schema.

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Entity Framework Core Performance Optimization

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01

Introduction

Entity Framework Core (EF Core) is powerful, but performance can be a concern. Let's explore best practices, query optimization techniques, and caching strategies to enhance performance.

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Best Practices for Performance

01. Tracking Changes: Track only the entities you need to modify using AsTracking or AsNoTracking. Unnecessary tracking overhead can impact performance.

```
1   var customerToUpdate = _context.Customers.AsTracking()
2                                 .FirstOrDefault(c => c.Id == 1);
```

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02. Lazy Loading vs. Eager Loading:

Utilize lazy loading for relationships accessed infrequently. Eager loading is efficient for frequently accessed data, reducing round trips to the database.

```
// Lazy Loading
var customer = _context.Customers.Find(1);
// Orders loaded only when accessed
customer.Orders.ToList();

// Eager Loading
var customer = _context.Customers.Include(c => c.Orders)
                .FirstOrDefault(c => c.Id == 1);
```

03. Batch Save Changes:

```
context.BulkInsert(customers);
context.BulkSaveChanges();
```

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Query Optimization Techniques

```
// 1) Select Specific Fields:
var userNames = context.Customers
                .Select(c => new { c.Name }).ToList();


// 2) Use Compiled Queries:
var compiledQuery = EF.CompileQuery((MyDbContext ctx) =>
  ctx.Customers.Where(u => u.Age > 18));
var customers = compiledQuery(context).ToList();


// 3) Filter early
var activeCustomers = context.Customers
                      .Where(u => u.IsActive).ToList();
```

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Caching Strategies

01. In-Memory Caching: Cache frequently accessed data in-memory using libraries like MemoryCache for faster retrieval.

```
var activeCustomers = context.Customers
                      .Where(u => u.IsActive).ToList();


var cache = new MemoryCache();
var cacheKey = $"customer-{customerId}";
if (!cache.TryGetValue(cacheKey, out Customer customer))
{
  customer = _context.Customers.Find(customerId);
  cache.Set(cacheKey, customer, TimeSpan.FromMinutes(30));
}
```

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02. Response Caching

```
1  [ResponseCache(Duration = 60)]
2  public IActionResult GetUsers()
3  {
4      var users = context.Users.ToList();
5      return Ok(users);
6  }
```

03. Distributed Cache:

```
1  services.AddStackExchangeRedisCache(options =>
2  {
3      options.Configuration = "localhost:6379";
4  });
```

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EF Core Migrations

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Understanding Migrations

Entity Framework Core Migrations is a powerful feature that simplifies database **schema management** alongside your application's evolution. It automates the process of creating and applying changes to your database schema, ensuring your database remains in sync with your evolving data models.

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Creating and Applying Migrations

```
1  // Step 1: Add a new migration
2  dotnet ef migrations add InitialCreate
3
4  // Step 2: Apply the migration to the database
5  dotnet ef database update
```

- The **add command** creates a migration file with the necessary schema changes.
- The **update command** applies these changes to the database.

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Handling Schema Changes

Adding a Column:

```
1  public class MyEntity
2  {
3      public int Id { get; set; }
4      public string NewColumn { get; set; } // New Column
5  }
```

```
dotnet ef migrations add AddNewColumn
dotnet ef database update
```

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Removing a Column

```
1   public class MyEntity
2   {
3       public int Id { get; set; }
4       // Remove the column
5   }
```

```
dotnet ef migrations add RemoveColumn
dotnet ef database update
```

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Best Practices for Migrations

- Keep migrations small and manageable.
- Test migrations in a staging environment before applying to production.
- Use meaningful names for migration files.

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Tips for Smooth Migration Process

- Always backup your database before applying migrations.
- Review the generated SQL script to understand the changes being applied.
- Keep the migration history clean by removing obsolete migrations if possible.

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Entity Framework Relationships

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Introduction to EF Core Relationships

Entity Framework Core (EF Core) empowers you to model complex data relationships within your applications. Understanding these relationships is fundamental to building robust and efficient data models. The core concepts of EF Core relationships include:

- **One-to-One**
- **One-to-Many**
- **Many-to-Many**

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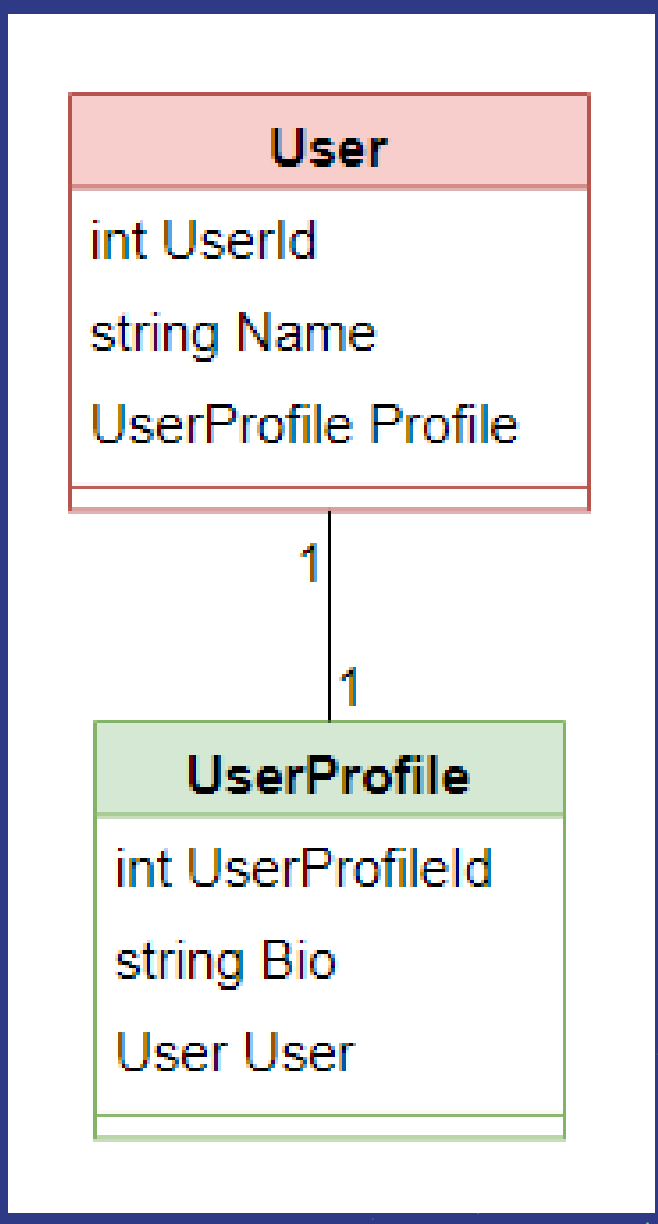
One-to-One Relationships

In a One-to-One relationship, each entity instance is associated with a single instance of another entity.



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```
1   public class User
2   {
3       public int UserId { get; set; }
4       public string Name { get; set; }
5       public UserProfile Profile { get; set; }
6   }
7
8   public class UserProfile
9   {
10      public int UserProfileId { get; set; }
11      public string Bio { get; set; }
12      public User User { get; set; }
13  }
14
15  modelBuilder.Entity<User>()
16      .HasOne(u => u.Profile)
17      .WithOne(p => p.User)
18      .HasForeignKey<UserProfile>(p => p.UserProfileId);
```

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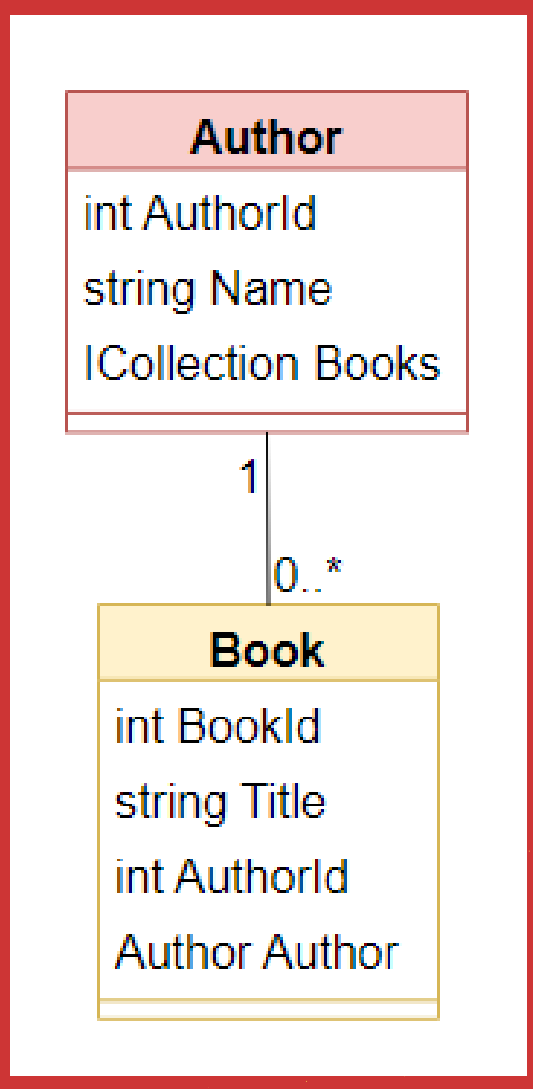
One-to-Many Relationships

In a One-to-Many relationship, a single entity instance is associated with multiple instances of another entity.



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```
public class Author
{
    public int AuthorId { get; set; }
    public string Name { get; set; }
    public ICollection<Book> Books { get; set; }
}

public class Book
{
    public int BookId { get; set; }
    public string Title { get; set; }
    public int AuthorId { get; set; }
    public Author Author { get; set; }
}

modelBuilder.Entity<Author>()
    .HasMany(a => a.Books)
    .WithOne(b => b.Author)
    .HasForeignKey(b => b.AuthorId);
```

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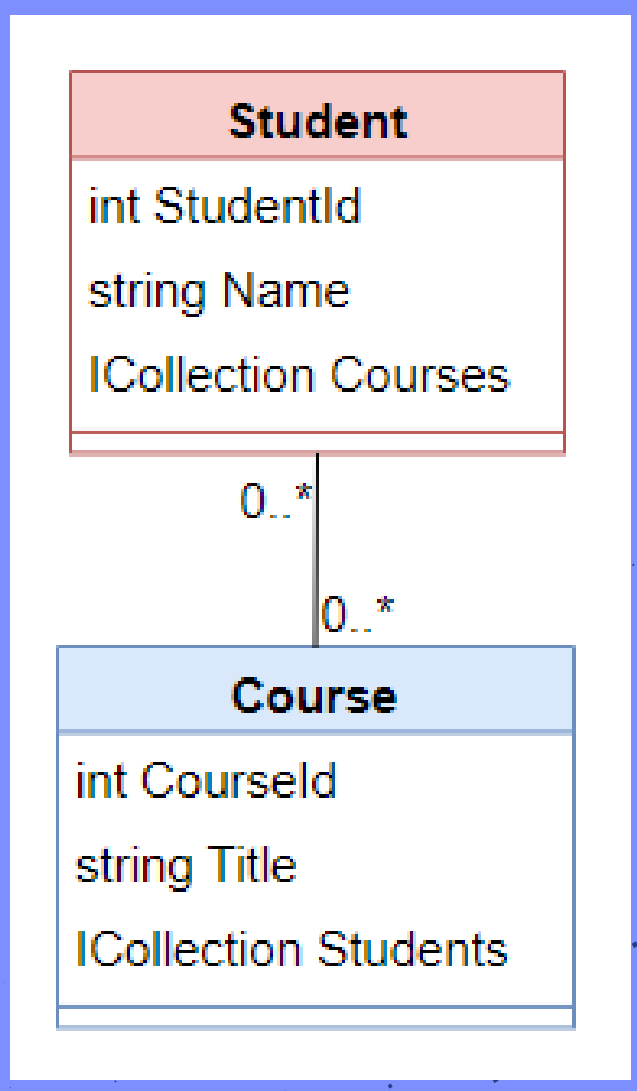
Many-to-Many Relationships

In a Many-to-Many relationship, multiple instances of one entity are associated with multiple instances of another entity.



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07

```
public class Student
{
    public int StudentId { get; set; }
    public string Name { get; set; }
    public ICollection<Course> Courses { get; set; }
}

public class Course
{
    public int CourseId { get; set; }
    public string Title { get; set; }
    public ICollection<Student> Students { get; set; }
}

modelBuilder.Entity<Student>()
    .HasMany(s => s.Courses)
    .WithMany(c => c.Students)
    .UsingEntity(j => j.ToTable("StudentCourses"));
```

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08

Navigational Properties

Navigational properties are properties on an entity that hold references to related entities, allowing you to navigate from one entity to its related entities.

Example: In the previous examples, the Profile property in the User class, the Books collection in the Author class, and the Courses collection in the Student class are navigational properties.

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Cascade Delete

Cascade delete automatically deletes dependent entities when the principal entity is deleted. This helps maintain data integrity by ensuring no orphaned records.

```
1   modelBuilder.Entity<Author>()
2   .HasMany(a => a.Books)
3   .WithOne(b => b.Author)
4   .OnDelete(DeleteBehavior.Cascade);
```

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Handling Orphaned Records

Orphaned records occur when a principal entity is deleted, but its related entities are not. Using cascade delete can prevent this. Alternatively, you can configure **DeleteBehavior.Restrict** or **DeleteBehavior.SetNull**.

```
1   modelBuilder.Entity<Author>()
2       .HasMany(a => a.Books)
3       .WithOne(b => b.Author)
4       .OnDelete(DeleteBehavior.Restrict);
5       // Or DeleteBehavior.SetNull
```

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Conclusion and Best Practices

- Always define relationships explicitly in your model.
- Use navigational properties for easy data access.
- Implement cascade delete carefully to avoid unintended data loss.
- Regularly review and update your data model as your application evolves.

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MASTERING

EF Core: Data Annotations vs. Fluent API

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01

Understanding Data Annotations

Data Annotations are attributes you can apply to your model classes and properties to configure the behavior of EF Core. These attributes provide a simple way to specify **metadata** about the models.

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02

Example

```
1   public class Student
2   {
3       [Key]
4       public int StudentId { get; set; }
5
6       [Required]
7       [MaxLength(50)]
8       public string Name { get; set; }
9
10      [Range(1, 100)]
11      public int Age { get; set; }
12  }
```

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03

Key Data Annotations to Know

Here are some commonly used Data Annotations:

- [**Key**] - Specifies the primary key.
- [**Required**] - Marks a property as required.
- [**MaxLength**] - Sets the maximum length of a string field.
- [**Range**] - Defines a numeric range.

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04

Example

```
1   public class Course
2   {
3       [Key]
4       public int CourseId { get; set; }
5
6       [Required]
7       [MaxLength(100)]
8       public string Title { get; set; }
9
10      [Range(1, 10)]
11      public int Credits { get; set; }
12  }
```

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Getting Started with Fluent API

Fluent API provides more advanced configuration options compared to Data Annotations. It is defined in the **OnModelCreating** method of your **DbContext** class.

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06

Example

```
public class SchoolContext : DbContext
{
    public DbSet<Student> Students { get; set; }

    protected override void OnModelCreating(ModelBuilder modelBuilder)
    {
        modelBuilder.Entity<Student>()
            .HasKey(s => s.StudentId);

        modelBuilder.Entity<Student>()
            .Property(s => s.Name)
            .IsRequired()
            .HasMaxLength(50);

        modelBuilder.Entity<Student>()
            .Property(s => s.Age)
            .HasRange(1, 100);
    }
}
```

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Advanced Fluent API Configurations

Fluent API offers extensive configuration options, such as:

- **HasKey** - Defines the primary key.
- **Property** - Configures properties.
- **HasMaxLength** - Sets the maximum length.
- **IsRequired** - Specifies required fields.

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Example

```
modelBuilder.Entity<Course>()
    .HasKey(c => c.CourseId);

modelBuilder.Entity<Course>()
    .Property(c => c.Title)
    .IsRequired()
    .HasMaxLength(100);

modelBuilder.Entity<Course>()
    .Property(c => c.Credits)
    .HasRange(1, 10);
```

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Data Annotations vs. Fluent API

Data Annotations:

- Simpler to use.
- Ideal for straightforward configurations.
- Limited in flexibility.

Fluent API:

- Offers advanced configurations.
- Provides more control over model behavior.
- Recommended for complex scenarios.

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When to Use Which?

- Use Data Annotations for simple, quick configurations.
- Opt for Fluent API for complex, extensive configurations.
- Both methods can be used together, but Fluent API **overrides** Data Annotations.

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Key Takeaways

- Data Annotations are great for simplicity.
- Fluent API provides advanced configuration options.
- Choose based on the complexity of your model requirements.

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Concurrency Control in EF Core

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Concurrency Control Basics

Concurrency control ensures data consistency when multiple users access and modify data concurrently. Entity Framework provides built-in mechanisms to handle **concurrency conflicts** effectively.

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Dealing with Conflicts

When multiple users attempt to update the same data, conflicts arise. Entity Framework uses concurrency tokens to detect and resolve these conflicts.

```
1   public class Product
2   {
3       public int ProductId { get; set; }
4       public string Name { get; set; }
5       public decimal Price { get; set; }
6       [Timestamp]
7       public byte[] RowVersion { get; set; }
8   }
```

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Optimistic Concurrency Control

Optimistic concurrency assumes conflicts are rare and checks for conflicts before committing changes. Use the [**Timestamp**] attribute or a custom property to track changes.

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```
try
{
    context.SaveChanges();
}
catch (DbUpdateConcurrencyException ex)
{
    // Handle concurrency conflict
    var entry = ex.Entries.Single();
    var clientValues = (Product)entry.Entity;
    var databaseEntry = entry.GetDatabaseValues();
    var databaseValues = (Product)databaseEntry.ToObject();

    // Update client values with database values or handle as needed
}
```

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Pessimistic Concurrency

Pessimistic concurrency locks the data to prevent other users from modifying it until the current transaction is complete. This approach is less common in Entity Framework but can be implemented with explicit locks.

```
using (var transaction = context.Database
    .BeginTransaction(System.Data.IsolationLevel.Serializable))
{
    // Perform data operations
    context.SaveChanges();
    transaction.Commit();
}
```

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Implementing Custom Control

Custom concurrency control can be achieved by manually handling conflict detection and resolution logic tailored to your application's needs.

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```
1   public async Task UpdateProductAsync(Product updatedProduct)
2   {
3       var product = await context.Products.FindAsync(updatedProduct.ProductId);
4       if (product.RowVersion.SequenceEqual(updatedProduct.RowVersion))
5       {
6           context.Entry(product).CurrentValues.SetValues(updatedProduct);
7           await context.SaveChangesAsync();
8       }
9       else
10      {
11          // Handle conflict
12          throw new DbUpdateConcurrencyException();
13      }
14  }
```

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Ensuring Data Integrity

Effective concurrency control in Entity Framework ensures data integrity and a smooth user experience. Choose the right strategy based on your application's requirements.

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Entity Framework Transactions

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Understanding Transactions

- Transactions ensure data integrity by treating **multiple operations** as a single unit.
- They are essential for maintaining **consistency**, especially in complex applications.

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Built-in Transaction Management

- Entity Framework (EF) provides built-in transaction management through the **DbContext**.
- EF automatically handles transactions for single **SaveChanges** calls.

```
using (var context = new AppDbContext())
{
    // Operations
    context.SaveChanges(); // EF handles transaction automatically
}
```

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Handling Multiple Operations as a Unit

Transactions are crucial for ensuring data **integrity** when performing multiple related operations. For instance, transferring money between accounts involves debiting one account and crediting another. Both operations should be part of a single transaction:

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Example

```
using (var transaction = context.Database.BeginTransaction())
{
    try
    {
        // Debit one account
        // Credit another account
        context.SaveChanges();
        transaction.Commit();
    }
    catch (Exception ex)
    {
        transaction.Rollback();
        // Handle the exception
    }
}
```

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Rollback Strategies

- Rollbacks revert all changes if any operation fails.
- Essential for maintaining **data integrity** in case of errors.

```
using (var context = new AppDbContext())
{
    using (var transaction = context.Database.BeginTransaction())
    {
        try
        {
            // Operations
            transaction.Commit();
        }
        catch (Exception)
        {
            transaction.Rollback();
        }
    }
}
```

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Commit Strategies

- Use **Commit** to finalize transactions after successful operations.
- Always wrap Commit within a **try-catch** block to handle exceptions.

```
1  using (var context = new AppDbContext())
2  {
3      using (var transaction = context.Database.BeginTransaction())
4      {
5          try
6          {
7              // Operations
8              transaction.Commit();
9          }
10         catch (Exception)
11         {
12             transaction.Rollback();
13             // Log or handle the exception
14         }
15     }
16 }
```

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Combining Explicit Transactions with Multiple Contexts

- Handle transactions across **multiple DbContext** instances.
- Ensure consistency across different data sources.

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```
using (var context1 = new AppDbContext1())
using (var context2 = new AppDbContext2())
{
    using (var transaction = context1.Database.BeginTransaction())
    {
        try
        {
            // Operations on context1
            context1.SaveChanges();

            // Operations on context2
            context2.Database
                    .UseTransaction(transaction.GetDbTransaction());
            context2.SaveChanges();

            transaction.Commit();
        }
        catch (Exception)
        {
            transaction.Rollback();
        }
    }
}
```

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Key Takeaways

- Transactions are critical for data integrity.
- EF provides built-in and explicit transaction management.
- Rollbacks and commits ensure consistency and handle errors effectively.

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Entity Framework Change Tracking

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Understanding Change Tracking

Change tracking is a mechanism that allows EF Core to keep track of changes to your entities. This helps EF Core determine what SQL commands need to be executed to persist changes to the database.

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Example

```
using (var context = new AppDbContext())
{
    var blog = context.Blogs
                .FirstOrDefault(b => b.BlogId == 1);
    blog.Title = "Updated Title";
    // EF Core tracks the change in the Title property
}

```

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Managing State of Entities

EF Core tracks the state of each entity (Added, Unchanged, Modified, Deleted) to determine the operations to be performed during **SaveChanges**.

```
using (var context = new AppDbContext())
{
    var blog = context.Blogs
                .FirstOrDefault(b => b.BlogId == 1);
    context.Entry(blog).State = EntityState.Modified;
    context.SaveChanges();
    // The state is set to Modified, prompting an UPDATE command
}
```

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Using No-Tracking Queries

No-tracking queries improve performance for **read-only operations** by not tracking the entities in the context. This reduces memory usage and speeds up query execution.

```
using (var context = new AppDbContext())
{
    var blogs = context.Blogs.AsNoTracking().ToList();
    // No change tracking is performed, ideal for read-only operations
}
```

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Benefits of No-Tracking Queries

- Performance: Faster queries and lower memory footprint.
- Scalability: Better for large-scale read operations.
- Simplicity: Reduces overhead when changes to entities are not needed.

```
using (var context = new AppDbContext())
{
    var post = context.Posts.AsNoTracking().FirstOrDefault(p => p.PostId == 1);
    // Efficiently retrieves the post without tracking its state
}
```

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Summary

- **Change Tracking:** Tracks changes to determine necessary database operations.
- **Entity State Management:** Manages entity states for accurate database updates.
- **No-Tracking Queries:** Optimizes performance for read-only operations.

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Entity Framework Core with Dependency Injection

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Understanding the Basics

Entity Framework Core (EF Core) is an **Object-Relational Mapper** (ORM) that simplifies data access in .NET applications. **Dependency Injection** (DI) is a design pattern that promotes loose coupling and testability. Combining these two powerful tools can significantly enhance your application's architecture.

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Integrating EF Core with DI

To integrate EF Core with DI, you typically register the DbContext in your DI container. This allows you to inject the **DbContext** into your services and repositories, promoting better testability and maintainability.

```
1  public void ConfigureServices(IServiceCollection services)
2  {
3      services.AddDbContext<MyDbContext>(options =>
4          options.UseSqlServer(connectionString));
5  }
```

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Configuring DbContext in DI Container with Lifetime

Properly configuring the DbContext lifetime is crucial for optimal performance and resource management. Consider the following options:

Scoped: Create a new DbContext instance for each request, suitable for most web applications.

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Singleton: Create a single DbContext instance for the entire application lifetime, suitable for specific scenarios.

Transient: Create a new DbContext instance for each dependency injection resolution, useful for testing.

```
services.AddDbContext<ApplicationDbContext>(options =>
    options.UseSqlServer(Configuration.GetConnectionString("DefaultConnection")),
    ServiceLifetime.Transient);
```

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Benefits of Integrating EF with DI

- Separation of Concerns: Keeps data access logic separate from business logic.
- Testability: Easier to mock DbContext for unit testing.
- Maintainability: Centralized configuration of DbContext.

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Testing with Entity Framework Core

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Why Testing is Crucial ?

Testing ensures your Entity Framework Core applications are reliable, maintainable, and free of bugs. Proper testing strategies can save time and resources in the long run.

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Unit Testing EF Core Applications

Unit testing focuses on testing **individual components** in isolation. For EF Core, it means testing your repository or service logic without hitting the actual database.

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03

Example

```
1  public class ProductServiceTests
2  {
3      private readonly ProductService _service;
4      private readonly Mock<IProductRepository> _mockRepo;
5
6      public ProductServiceTests()
7      {
8          _mockRepo = new Mock<IProductRepository>();
9          _service = new ProductService(_mockRepo.Object);
10     }
11
12     [Fact]
13     public void GetProduct_ShouldReturnProduct_WhenProductExists()
14     {
15         var productId = 1;
16         _mockRepo.Setup(repo => repo.GetProduct(productId))
17                  .Returns(new Product
18                      { Id = productId,
19                        Name = "Test Product"
20                      });
21
22         var result = _service.GetProduct(productId);
23
24         Assert.NotNull(result);
25         Assert.Equal("Test Product", result.Name);
26     }
27 }
```

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Mocking DbContext for Tests

Mocking **DbContext** helps you simulate database interactions in your tests, ensuring your business logic is tested without relying on a real database.

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Example

```

public class DbContextMock
{
    public static Mock<DbSet<T>> GetDbSet<T>(List<T> entities) where T : class
    {
        var queryable = entities.AsQueryable();
        var dbSet = new Mock<DbSet<T>>();

        dbSet.As<IQueryable<T>>()
        .Setup(m => m.Provider).Returns(queryable.Provider);

        dbSet.As<IQueryable<T>>()
        .Setup(m => m.Expression).Returns(queryable.Expression);

        dbSet.As<IQueryable<T>>()
        .Setup(m => m.ElementType).Returns(queryable.ElementType);

        dbSet.As<IQueryable<T>>()
        .Setup(m => m.GetEnumerator()).Returns(queryable.GetEnumerator());
        return dbSet;
    }
}
```

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Integration Testing with In-Memory Databases

Integration tests verify that different parts of the application work together. Using in-memory databases like InMemoryDatabase ensures your tests run fast and in isolation.

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```
public class ProductServiceIntegrationTests
{
    private readonly DbContextOptions<AppDbContext> _options;

    public ProductServiceIntegrationTests()
    {
        _options = new DbContextOptionsBuilder<AppDbContext>()
                    .UseInMemoryDatabase(databaseName: "TestDatabase")
                    .Options;
    }

    [Fact]
    public void GetProduct_ShouldReturnProduct_WhenProductExists()
    {
        using (var context = new AppDbContext(_options))
        {
            context.Products.Add(new Product
                                { Id = 1,
                                  Name = "Integration Test Product"
                                });
            context.SaveChanges();
        }

        using (var context = new AppDbContext(_options))
        {
            var service = new ProductService(context);
            var result = service.GetProduct(1);

            Assert.NotNull(result);
            Assert.Equal("Integration Test Product", result.Name);
        }
    }
}
```

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Best Practices for Testing with EF Core

- Use in-memory databases for integration tests.
- Mock DbContext for unit tests.
- Isolate tests to ensure reliability.
- Always clean up data after tests.

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Entity Framework in Microservices Architecture

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Introduction

Entity Framework Core (EF Core) is a powerful ORM for .NET applications. But how does it fit into the microservices world?

- **Decoupling:** Each microservice has its own database and DbContext, promoting independence.
- **Data Ownership**: Clear ownership of data within each service.
- **Scalability:** Independent scaling of microservices and databases.

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02

Using EF Core in Microservices

Let's dive into the practical aspects of using EF Core in microservices.

- **Dedicated DbContext:** Create a separate DbContext for each microservice.
- **Dependency Injection:** Use DI to manage DbContext instances.
- **Migrations:** Manage database schema changes independently for each service.

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03

Example

```
1  public class OrderServiceDbContext : DbContext
2  {
3      public DbSet<Order> Orders { get; set; }
4
5      public OrderServiceDbContext(
6          DbContextOptions<OrderServiceDbContext> options)
7          : base(options)
8      {
9      }
10 }
```

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Sharing Models and DbContext

While sharing models might seem tempting, it's generally not recommended.

- **Tight Coupling:** Shared models can lead to tight coupling between services.
- **Data Consistency Challenges:** Maintaining data consistency across services becomes difficult.
- **Alternative Approaches:** Consider using DTOs or CQRS for data transfer.

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Handling Distributed Transactions

In a microservices architecture, handling transactions that span multiple services can be challenging. EF Core provides mechanisms to handle distributed transactions using tools like the **Outbox pattern** or **Saga pattern**.

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Outbox Pattern

```
public async Task SaveOrderAsync(Order order)
{
    using (var transaction = await _dbContext.Database.BeginTransactionAsync())
    {
        _dbContext.Orders.Add(order);
        await _dbContext.SaveChangesAsync();

        var outboxMessage = new OutboxMessage
        {
            Id = Guid.NewGuid(),
            OccurredOn = DateTime.UtcNow,
            Type = nameof(OrderCreated),
            Data = JsonConvert.SerializeObject(new OrderCreated(order.Id))
        };

        _dbContext.OutboxMessages.Add(outboxMessage);
        await _dbContext.SaveChangesAsync();

        await transaction.CommitAsync();
    }
}
```

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Saga Pattern

```
1   public async Task HandleOrderCreationAsync(Order order)
2   {
3       // Step 1: Create order
4       _dbContext.Orders.Add(order);
5       await _dbContext.SaveChangesAsync();
6
7       // Step 2: Publish event for inventory service
8       await _eventPublisher.PublishAsync(new OrderCreatedEvent(order.Id));
9   }
10
11  public async Task HandleOrderCreatedEventAsync(OrderCreatedEvent @event)
12  {
13      // Step 3: Update inventory based on the order created
14      var order = await _dbContext.Orders.FindAsync(@event.OrderId);
15      // Update inventory logic
16  }
```

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EF Core Applications with Azure

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Deploying EF Core Applications to Azure

- Simplify your deployment process using Azure App Service or Azure Kubernetes Service (AKS).
- Automate deployment pipelines with Azure DevOps.

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Example: **Basic Azure App Service Deployment Script**

```
# Sample deployment script using Azure CLI
az webapp create --resource-group MyResourceGroup \
                 --plan MyAppServicePlan \
                 --name MyWebApp \
                 --runtime "DOTNETCORE|8.0"

dotnet publish -c Release -o ./publish

az webapp deploy --resource-group MyResourceGroup \
                 --name MyWebApp \
                 --src-path ./publish
```

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Using Azure SQL with EF Core

- Leverage Azure SQL Database for robust and scalable relational data storage.
- Secure your data with built-in high availability and backup solutions.

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Example: Configuring EF Core with Azure SQL

```
1  public class ApplicationDbContext : DbContext
2  {
3      protected override void OnConfiguring(
4          DbContextOptionsBuilder optionsBuilder)
5      {
6          optionsBuilder.UseSqlServer(
7              "Server=tcp:myserver.database.windows.net,1433;" +
8              "Initial Catalog=mydb;" +
9              "User ID=myuser;" +
10             "Password=mypassword;");
11     }
12 }
```

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Best Practices for EF Core in Azure

- Optimize your database access with connection pooling and retry policies.
- Implement caching strategies using Azure Cache for Redis to reduce database load.

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Example: Adding Retry Policy

```
public class ApplicationDbContext : DbContext
{
    protected override void OnConfiguring(
        DbContextOptionsBuilder optionsBuilder)
    {
        optionsBuilder.UseSqlServer(
            "Server=tcp:myserver.database.windows.net,1433;" +
            "Initial Catalog=mydb;" +
            "User ID=myuser;" +
            "Password=mypassword;",
            sqlOptions => sqlOptions.EnableRetryOnFailure(
                maxRetryCount: 5,
                maxRetryDelay: TimeSpan.FromSeconds(30),
                errorNumbersToAdd: null));
    }
}
```

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Real-World Examples with EF Core

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Case Study: Optimizing Performance for a High-Traffic E-Commerce Platform

In this case study, an e-commerce platform struggled with performance issues due to inefficient queries. By refactoring LINQ queries and utilizing async operations, the team achieved a 50% improvement in response times.

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02

Example

```
1  // Before optimization
2  var orders = context.Orders
3              .Where(o => o.CustomerId == customerId).ToList();
4
5  // After optimization
6  var orders = await context.Orders
7      .AsNoTracking()
8      .Where(o => o.CustomerId == customerId)
9      .ToListAsync();
10
```

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03

Success Story: Seamless Data Migration in a Financial Application

A financial application required a seamless data migration to a new schema. By leveraging EF Core's migrations and custom scripts, the team ensured a smooth transition without data loss or downtime.

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04

Example

```
// Applying a migration
dotnet ef migrations add UpdateSchema
dotnet ef database update

// Custom migration script
public override void Up()
{
    // Custom logic for data transformation
}
```

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05

Common Pitfall: Inefficient Loading of Related Data

A common mistake is loading related data inefficiently, leading to performance bottlenecks. Use eager loading, explicit loading, or lazy loading appropriately to optimize your queries.

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Example

```
1  // Inefficient loading (N+1 problem)
2  var customers = context.Customers.ToList();
3  foreach (var customer in customers)
4  {
5      var orders = customer.Orders.ToList(); // N+1 queries
6  }
7
8  // Efficient loading with eager loading
9  var customersWithOrders = context.Customers
10     .Include(c => c.Orders)
11     .ToList();
```

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Lesson Learned: Importance of Query Optimization

Real projects highlight the importance of query optimization. Analyzing execution plans and indexing strategies can significantly improve performance.

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Example

```
1  // Adding an index to improve query performance
2  modelBuilder.Entity<Order>()
3      .HasIndex(o => o.OrderDate);
4
5  // Optimized query using index
6  var recentOrders = context.Orders
7      .Where(o => o.OrderDate > DateTime.Now.AddDays(-30))
8      .ToList();
9
```

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Case Study: Handling Concurrency Conflicts in a Collaborative App

A collaborative application faced concurrency issues with multiple users editing the same data. Implementing optimistic concurrency control helped manage conflicts effectively.

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10

Example

```
// Configuring concurrency token
modelBuilder.Entity<Document>()
    .Property(d => d.RowVersion)
    .IsRowVersion();

// Handling concurrency conflict
try
{
    context.SaveChanges();
}
catch (DbUpdateConcurrencyException ex)
{
    // Resolve conflict
}
```

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Common Pitfall: Ignoring Logging and Monitoring

Neglecting logging and monitoring can lead to undetected issues in production. Use EF Core's built-in logging and third-party tools to track query performance and errors.

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Example

```
// Enabling logging in EF Core
var optionsBuilder = new DbContextOptionsBuilder<MyDbContext>();
optionsBuilder.UseLoggerFactory(MyLoggerFactory);

// Configuring logging in appsettings.json
{
  "Logging": {
    "LogLevel": {
      "Microsoft.EntityFrameworkCore": "Information"
    }
  }
}
```

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13

Lesson Learned: Effective Use of Transactions

Managing transactions is crucial in real-world applications. Use EF Core's transaction management to ensure data integrity and handle rollback scenarios.

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Example

```
1   using var transaction = context.Database.BeginTransaction();
2   try
3   {
4       // Perform multiple operations
5       context.SaveChanges();
6       transaction.Commit();
7   }
8   catch
9   {
10      transaction.Rollback();
11      throw;
12  }
```

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