ENTITY FRAMEWORK CORE FOR MERE MORTALS

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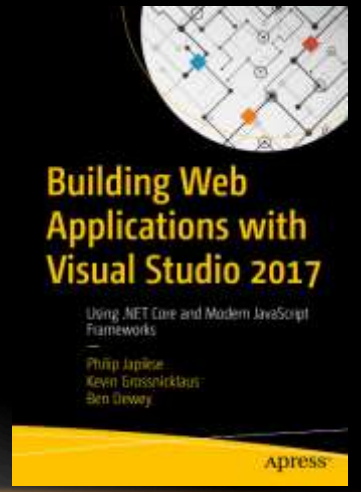

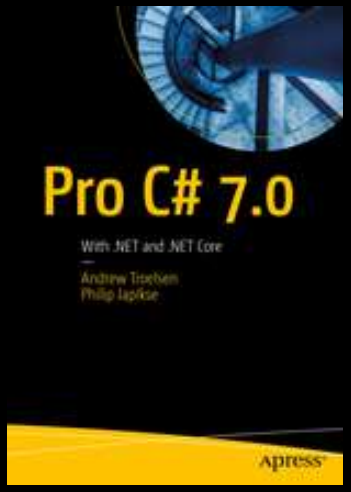

THE CASE FOR OBJECT RELATIONAL MAPPERS (ORMS)

THE PROBLEM

- SQL Databases:
  - Store data relationally using scalar values (with some exceptions)

- Applications:
  - Model data after the domain using complex, object oriented entities

- Translating back and forth takes a lot of code
- Data access code isn't an application differentiator

OBJECT RELATIONAL MAPPING DEFINED

"**Object-relational mapping** (**ORM**, **O/RM**, and **O/R mapping tool**) in computer science is a programming technique for converting data between incompatible type systems using object-oriented programming languages. "

--Wikipedia (https://en.wikipedia.org/wiki/Object-relational_mapping)

ORM BENEFITS

- ORMs convert relational data to domain models and back
- Developers work with classes that support the domain instead of defined by the confines of SQL based data stores.
- Modern ORMs typically implement:
  - Unit of Work Pattern, Repository Pattern, Implicit Transaction support

UNIT OF WORK DESIGN PATTERN

Maintains a list of objects affected by a business transaction and coordinates the writing out of changes and the resolution of concurrency problems.

--Martin Fowler

REPOSITORY DESIGN PATTERN

Mediates between the domain and data mapping layers using a collection-like interface for accessing domain objects.

--Martin Fowler

IMPLICIT TRANSACTION SUPPORT

- All operations executed in a Unit of Work are wrapped in a transaction
  - Requires ORM and DBMS support
- Explicit transactions can be used for multiple Units of Work

COMMON ARGUMENTS AGAINST ORMS

- Too much “magic”
- “They are slow”
- “Our data is too complex”
- “They are hard to learn”
- The “DBAs won’t let us”

ORM USE CASES

The Bad

- Reporting solutions
- ETL Operations
- Set based operations

The Good

- CRUD operations
- Forms over data
- Line of business applications

IT'S NOT THE RING OF POWER!

EF PROJECT STATUS

ENTITY FRAMEWORK CORE

- Newest version of Entity Framework - complete re-write from EF 6.x
  - Lightweight, Modularized
  - Cross Platform (built on .NET Core)
  - Based on an ‘Opt-in’ model – only load needed packages

- EF Core 2.2
  - Many more features added
  - Still some missing features from EF 6.x

EF CORE 3.0/.NET CORE 3

- EF Core 3 won't run on .NET Framework
  - Only .NET Core 3/NetStandard 2.1
- Breaking Changes from 2.x
  - dotnet ef must be manually installed as a global tool
    - dotnet tool install --global dotnet-ef --version <exact-version>
  - FromSql -> FromSqlRaw/FromSqlInterpolated
- DbQuery moved to DbSet
- Plus many more:

https://docs.microsoft.com/en-us/ef/core/what-is-new/ef-core-3.0/breaking-changes

(SOME) MISSING* FEATURES IN CURRENT VERSION OF EF CORE 2.2

- EDMX Designer
  - Not coming back!
- ~~Spatial Data Types (2.2)~~
- Command Interception*
- Alternate inheritance mapping patterns
  - Implemented: Table Per Hierarchy (TPH)
  - Missing: Table Per Type (TPT), Table Per Concrete Type (TPC)
- Stored Procedure Mapping
- Some Data Annotations
- ~~Raw SQL (Non-Entity Types)~~
- ~~Lazy loading~~
- ~~Data Initialization~~
- ~~Group By Translation~~

http://bit.ly/ef6_efcore

DATA ANNOTATIONS REMOVED/CHANGED IN EF CORE

Removed

- Only works in Fluent API
  - Composite Keys
  - Index, Composite Indices
- ComplexType
  - Fluent API (2.0)
  - Owned attribute (2.1)

Changed

- Table
  - Must specify schema properly

FEATURES ADDED TO EF CORE (NOT IN EF 6)

- Batching of Statements (1.0)
- Shadow State Properties (1.0)
- Alternate Keys (1.0)
- Client side key generation (1.0)
- Mixed Client/Server evaluation (1.0)
- Raw SQL with LINQ (1.0)
- Field Mapping (1.1)
- DbContext Pooling (2.0)
- Like query operator (2.0)
- Global Query Filters (2.0)
- String interpolation with raw SQL (2.0)
- Scalar function mapping (2.0)
- Explicitly compiled LINQ queries (2.0)
- Attach a graph of new and existing entities (2.0)

FEATURES ADDED TO EF CORE IN 2.1 (NOT IN EF 6)

- Query Types w/o keys
- ChangeTracker Events
- Property Value Conversions (2,1)
- Entity ctors with parameters (2.1)
- Eager loading for derived types (2.1)

EF COMPONENTS

MAJOR COMPONENTS OF EF

- DbContext
- ChangeTracker
- DbSet
- Entities
- Database Providers

DBCONTEXT

- Represents a session with the database and is used in query and save operations
  - Database property exposes a DatabaseFacade for db related info and operations
- Implements a combination of the Unit of Work and Repository patterns
- Provides additional model configuration via Fluent API
- Is configured using DbContextOptions/DbContextOptionsBuilder

DBCONTEXT CHANGES FROM EF 6

- Fully embraces dependency injection
- Requires DbContextOptions for configuration
  - OnConfiguring provides fall back mechanism
  - DbContext Design Time Factory (new)

DBCONTEXT DESIGN TIME FACTORY

- EF Core Tooling Commands requires parameterless ctor or
- IDesignTimeDbContextFactory<TContext>
  - Used by EF Migrations to create DbContext

CHANGE TRACKER

- Provides access to change tracking information and operations for entity instances tracked by the context.
- Also tracks the original values
- Works with the DbContext when SaveChanges is called

DBSET<T> WHERE T: {ENTITY CLASS}

- Represents a collection of all entities of a given type in a Context.
  - Implements IQueryable<T> in addition to collection interfaces
- Can be used to query and save instances of entities.
- LINQ statements used against a DbSet<T> are translated into queries against the data store.
  - Some parts might be evaluated in memory depending on the data store
- Items removed, added, or changed in a DbSet are not persisted until SaveChanges is called on the Context.

ENTITIES

- Simple .NET classes designed to model the domain
  - Often referred to as Plain Old CLR Objects (POCOs)
- Mapped to the relational data through conventions, data annotations and/or the fluent API
- Relate to other entities in the model through navigation properties

EF CORE PROVIDER MODEL

- EF Core uses a provider model to allow use with different data stores
- Concepts common to most providers are contained in the core components
- Provider specific concepts are in specific components

DATABASE PROVIDERS AVAILABLE

Third Party support:

- MySql (Official, Pomelo)
- SQLite
- PostgreSQL (Third party)
- Db2 (IBM)
- Oracle (paid only)
- MyCat
- Firebird
- SQL Compact

Supported by EF Core directly:

- SQL Server
  - Used in this course
- SQLite
- InMemory
  - Covered in Essential EF Core 2.0 Part 2 with testing
- Cosmos (2.2)

FEATURE DEMOS

CONFIGURATION

- Uses DbContextOptionsBuilder
  - instead of just name of connection string
- Constructor Injection

```
public SpyStoreContext(DbContextOptions<SpyStoreContext> options):base(options) {}
```

- OnConfiguring

```
protected override void OnConfiguring(DbContextOptionsBuilder optionsBuilder)
{
    if (!optionsBuilder.IsConfigured)
    {
        optionsBuilder.UseSqlServer($“{connectionString}");
    }
}
```

PERFORMANCE

PERFORMANCE

- EF Core has significant performance improvements over EF 6
  - Performance is a top priority for the EF Core team

- EF Core batches multiple statements into a single call
  - Uses table valued parameters to process changes in a single network call
  - Reduced network traffic and cost (for cloud based databases)

- Batch size can be configured through the DbContextOptions

BATCHING IN ACTION

```
exec sp_executesql N'SET NOCOUNT ON;
UPDATE [Blogs] SET [Url] = @p0 WHERE [BlogId] = @p1;
SELECT @@ROWCOUNT;
UPDATE [Blogs] SET [Url] = @p2 WHERE [BlogId] = @p3;
SELECT @@ROWCOUNT;

DECLARE @toInsert2 TABLE ([Name] nvarchar(max), [Url] nvarchar(max), [_Position] [int]);
INSERT INTO @toInsert2 VALUES (@p4, @p5, 0), (@p6, @p7, 1), (@p8, @p9, 2), (@p10, @p11, 3), (@p12, @p13, 4), (@p14, @p15, 5);

DECLARE @inserted2 TABLE ([BlogId] int, [_Position] [int]);
MERGE [Blogs] USING @toInsert2 AS i ON 1=0 WHEN NOT MATCHED THEN
INSERT ([Name], [Url]) VALUES (i.[Name], i.[Url]) OUTPUT INSERTED.[BlogId], i._Position INTO @inserted2;

SELECT [t].[BlogId] FROM [Blogs] t INNER JOIN @inserted2 i ON ([t].[BlogId] = [i].[BlogId]) ORDER BY [i].[_Position];

',N'@p1 int,@p0 nvarchar(4000),@p3 int,@p2 nvarchar(4000),@p4 nvarchar(4000),@p5 nvarchar(4000),@p6 nvarchar(4000),@p7
nvarchar(4000),@p8 nvarchar(4000),@p9 nvarchar(4000),@p10 nvarchar(4000),@p11 nvarchar(4000),@p12 nvarchar(4000),@p13
nvarchar(4000),@p14 nvarchar(4000),@p15
nvarchar(4000)',@p1=185,@p0=N'http://sample.com/blogs/dogs',@p3=186,@p2=N'http://sample.com/blogs/cats',@p4=N'The Horse
Blog',@p5=N'http://sample.com/blogs/horses',@p6=N'The Snake Blog',@p7=N'http://sample.com/blogs/snakes',@p8=N'The Fish
Blog',@p9=N'http://sample.com/blogs/fish',@p10=N'The Koala Blog',@p11=N'http://sample.com/blogs/koalas',@p12=N'The Parrot
Blog',@p13=N'http://sample.com/blogs/parrots',@p14=N'The Kangaroo Blog',@p15=N'http://sample.com/blogs/kangaroos'
```

DBCONTEXT POOLING (2.0)

- Works in conjunction with ASP.NET Core 2
- Creates a pool of DbContext instances
- Resets the Change Tracker between uses

```
services.AddDbContextPool<BloggingContext>( options =>
options.UseSqlServer(connectionString));
```

CONNECTION RESILIENCY

- Built in retry mechanism defined by relational database providers
  - SqlServerRetryingExecutionStrategy
    - Optimized for SQL Server and SQL Azure
- Custom Execution Strategy
  - Specify retry count and max delay

- Throws RetryLimitExceededException
  - Actual exception is inner exception

```
optionsBuilder.UseSqlServer(connectionString, options=>options.EnableRetryOnFailure());
```

CONCURRENCY

- SQL Server uses Timestamp (rowversion) properties (a byte[] in C#)
- Updates and Deletes are modified
  - Where <pk> = @p1 and <timestamp> = @p2
- Error throws DbUpdateConcurrencyException
  - Provides access to entities not updated/deleted
- Developer decides how to handle concurrency errors

```
public abstract class EntityBase
{
    //…
    [Timestamp]
    public byte[] TimeStamp { get; set; }
}
```

GLOBAL QUERY FILTERS (2.0)

- Model level filters defined directly on the model
- Automatically applied to any queries on that type
  - Also applied to indirect queries (e.g. using Include or ThenInclude)
  - Can be used for soft deletes or multi-tenancy
  - Override with IgnoreQueryFilters()

```
public class BloggingContext : DbContext
{
    public DbSet<Post> Posts { get; set; }
    public int TenantId {get; set; }
    protected override void OnModelCreating(ModelBuilder modelBuilder)
    {
        modelBuilder.Entity<Post>().HasQueryFilter(
            p => !p.IsDeleted && p.TenantId == this.TenantId );
    }
}
```

STRING INTERPOLATION WITH RAW SQL QUERIES (2.0)

- Implemented in FromSql and ExecuteSqlCommand
- C# string interpolation items get converted into SQL parameters

```
var city = "London";
var contactTitle = "Sales Representative";
using (var context = CreateContext())
{
  context.Set<Customer>()
    .FromSql($@"SELECT * FROM ""Customers""
        WHERE ""City"" = {city} AND
           ""ContactTitle"" = {contactTitle}")
    .ToArray();
  }
```

```
@p0='London' (Size = 4000)
@p1='Sales Representative' (Size = 4000)

SELECT *
FROM ""Customers""
WHERE ""City"" = @p0
    AND ""ContactTitle"" = @p1
```

POPULATING MODELS WITH RAW SQL QUERIES

- Models can be populated from raw SQL using FromSql on DbSet<T>
  - All fields must be returned and the names must match
- Useful for times when Sprocs or UDFs perform better than LINQ/EF
- Can be mixed with LINQ statements*

- Can also populate POCOs that are not tables (Changing in 2.1)
  - Must be in the Context as a DbSet<T>
  - Must have a primary key defined

DBQUERY TYPES

- Do not have keys defined
- Are read-only (cannot be inserted, deleted or updated)
- Can be returned directly by queries.

- Usage scenarios:
  - Mapping to views without primary keys
  - Mapping to tables without primary keys
  - Mapping to queries defined in the model
  - Serving as the return type for FromSql() queries

HELPER FUNCTIONS (EF.FUNCTIONS)

- Implemented at the database provider level
- Like Query Operator (2.0)
  - You must add in the % yourself
- DateFunctions (2.1)
- FreeText (2.1)
- Contains (2.2)

```
var customers =
    from c in context.Customers where
        EF.Functions.Like(c.Name, "a%");
    select c;

//creates this query
SELECT [c].[Id], [c].[Name]
FROM [Customers] AS [c]
WHERE [c].[Name] LIKE N'a%';
```

FIELD MAPPING/BACKING FIELDS

- Allows EF to read and/or write to fields instead of properties
- Conventions
  - [m]_<camel-cased property name>
  - [m]_<property name>
- Fluent API
  - modelBuilder.Entity<Blog>()
    .Property(b=>b.Url)
    .HasField("_theUrl")
- Used when materializing objects
  - Public getters/setters (if they exist) used at other times
- Can control when the fields are used
  - Field
  - FieldDuringConstruction
  - Property

EF CORE SUPPORTS MIXED EVALUATION (CHANGES IN 3.0)

- EF Core supports queries being evaluated on the server and the client
  - What executes where is provider specific
- Useful for including C# functions into the LINQ query/project
- Be careful where the client functions are injected
- Can't "disable" – can only set EF to throw exceptions
  - Automate testing is vital for discovery

```
optionsBuilder.UseSqlServer(connectionString)
   .ConfigureWarnings(
       warnings=>warnings.Throw(
              RelationalEventId.QueryClientEvaluationWarning));
```

MIGRATIONS

EF CORE CONTEXT MIGRATIONS

- Used to modify schema of based on model and SQL Code
  - Can also scaffold existing database into Context and Models
- Supports more than one DbContext in a project
  - E.g. ApplicationDbContext (ASP.NET Identity) and MyDomainModelContext
- Can also create SQL script representing changes to the database

EF CORE MIGRATIONS

- No longer stores a hash in the DB
  - <Context>ModelSnapshot.cs

- Run from the command line (or package manager console)
  - dotnet ef migrations [options] [add || list || remove || script]
  - dotnet ef database update [update || drop] [options]

- Reverse Engineer a Database:
  - dotnet ef dbcontext scaffold [arguments] [options]

CHANGE TRACKING EVENTS (2.1)

- StateChanged and Tracked events

```
public BloggingContext()
{
     ChangeTracker.StateChanged += ChangeTracker_StateChanged;
     ChangeTracker.Tracked += ChangeTracker_Tracked;
}

private void ChangeTracker_Tracked(object sender, EntityTrackedEventArgs e)
{
    //See Demo
}

private void ChangeTracker_StateChanged(object sender, EntityStateChangedEventArgs e)
{
   //See Demo
}
```

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Questions?

Thank You!

Learn more at https://docs.microsoft.com/en-us/ef/

Get the code: https://github.com/skimedic/presentations/tree/master/DOTNETCORE/EFCoreSamples