betsson group

Building Rich Domain Models with DDD and TDD

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Betsson Dev'talk #3

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Ivan Paulovich

Developer

betsson group

Microsoft® Most Valuable Professional

MVP

Reconnect

30+ Microsoft Certifications

paulovich.net

@ivanpaulovich

Betsson Wallet Team

- Seniors Developers
- Agile Team
- Business Oriented
- .NET – SQL Server – Angular

- Stockholm Office
- We are hiring!

How to shoot yourself in the foot:

1. Design your application starting from the data model.
2. Create your domain model by reverse engineering.
3. Pretend that you're doing TDD and start testing your domain classes.
    - Particularly getters and setters.
4. Now start testing the logic with Integration Tests and get stuck by test data and related issues.
5. Declare that TDD provides no benefit and only slows you down.
6. Comment tests in your Continuous Integration process.
7. Keep on whining.

Alberto Brandolini

Domain-Driven Design

Test-Driven Development

Focus on Unit Tests

Tiny Domain Objects

Frequent Rewriting

Frequent Short Cycles

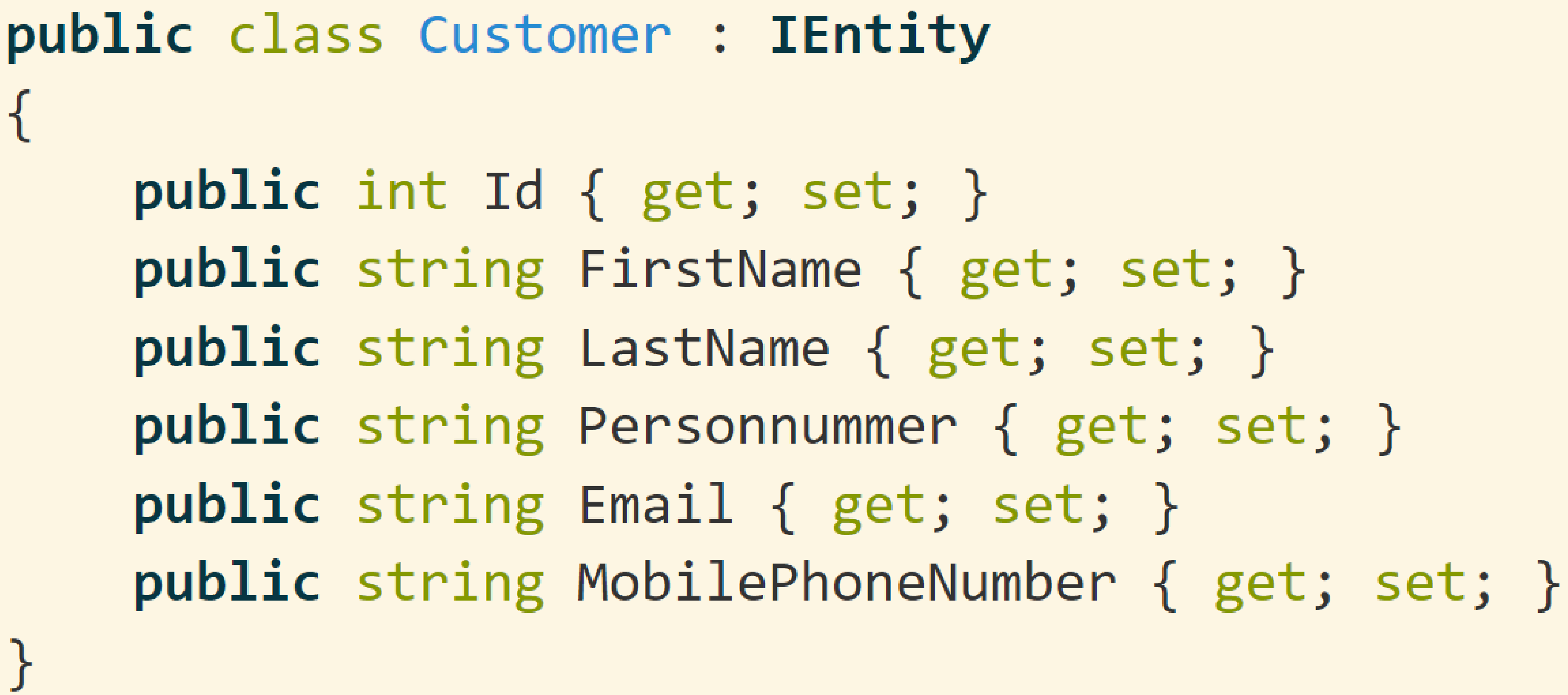
Exploratory Programming

Quick Feedback

Self Explanatory Coding

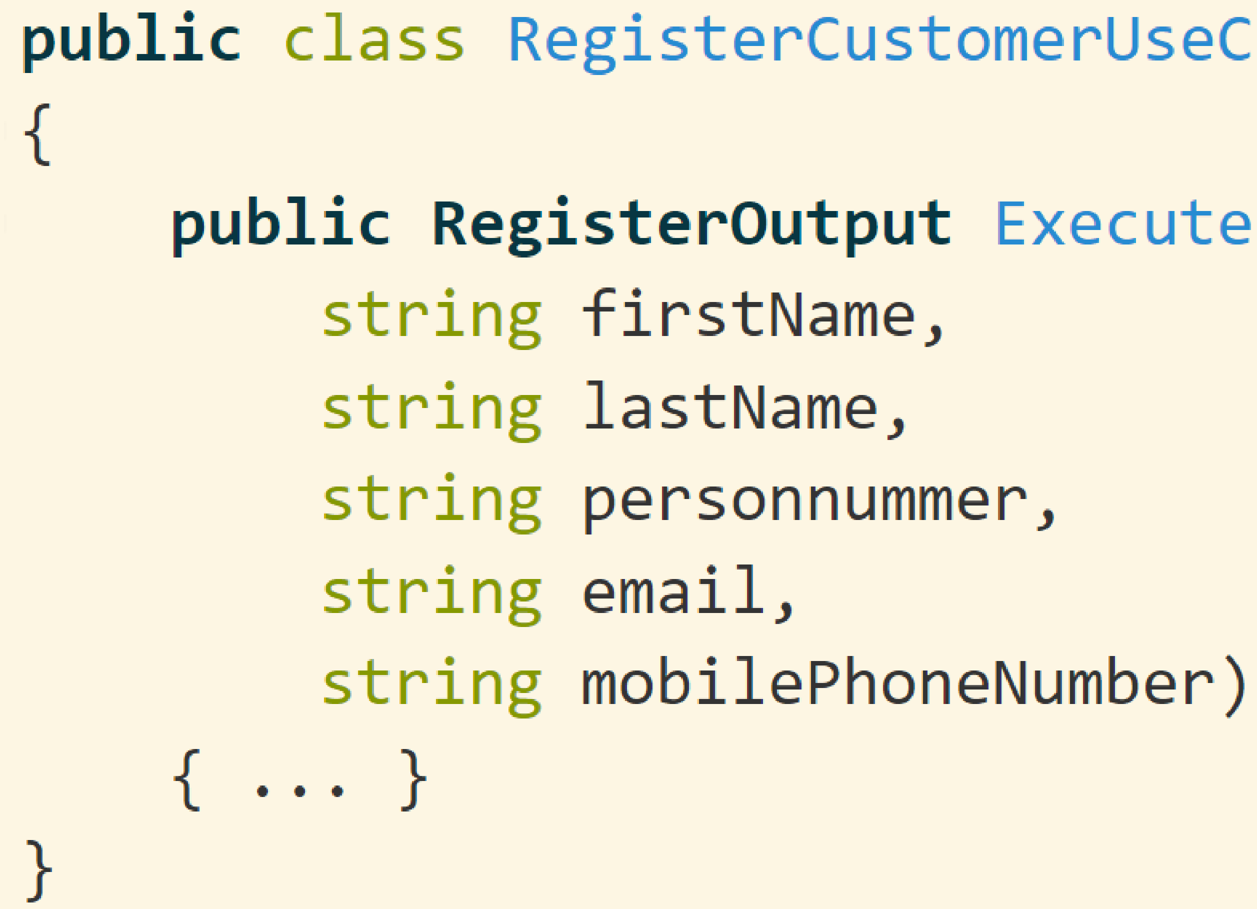
Confidence to Change

A Customer Entity with Primitive Obsession...



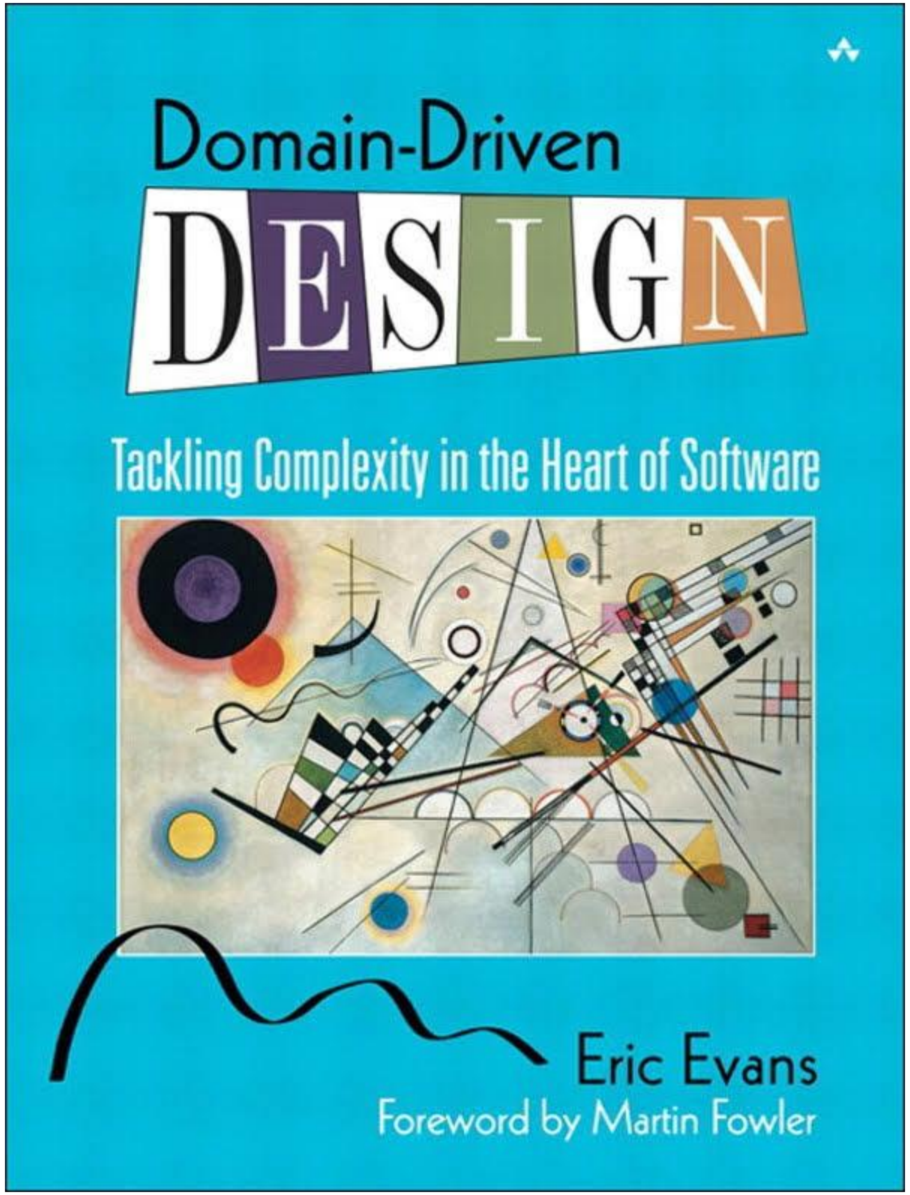
```
public class Customer : IEntity
{
    public int Id { get; set; }
    public string FirstName { get; set; }
    public string LastName { get; set; }
    public string Personnummer { get; set; }
    public string Email { get; set; }
    public string MobilePhoneNumber { get; set; }
}
```

Primitive Obsession Leads to Services Like..



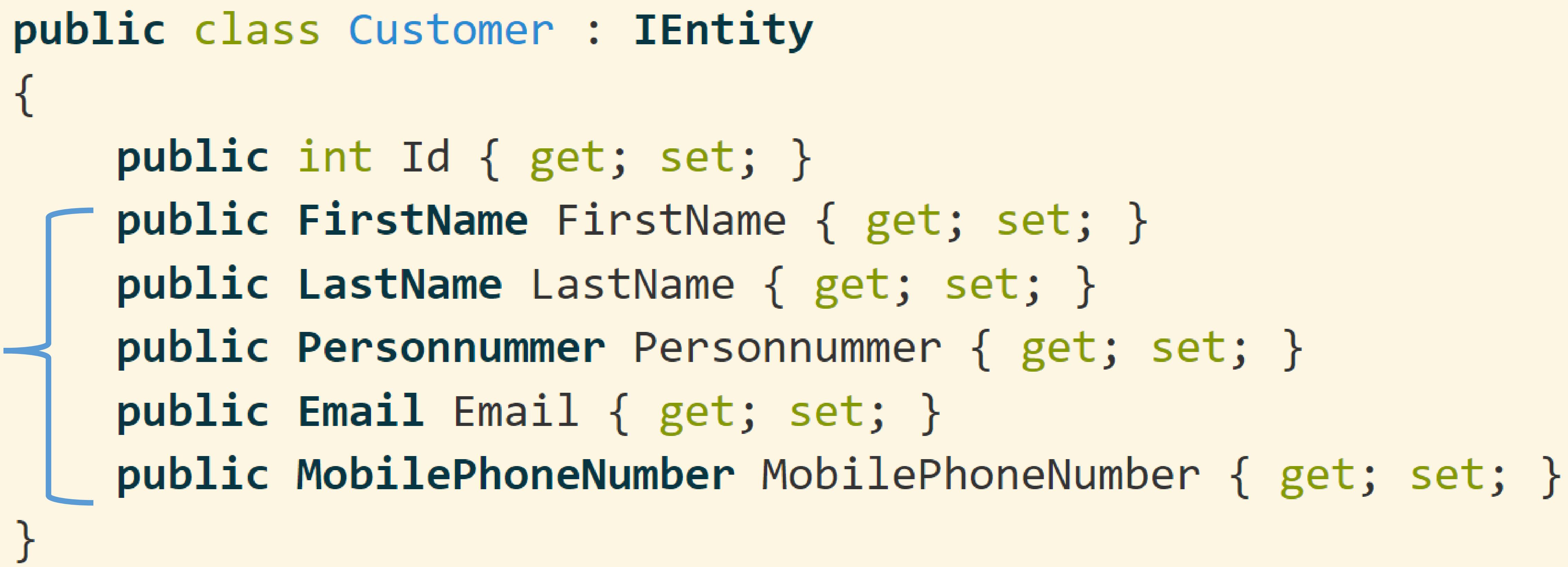
```
public class RegisterCustomerUseCase
{
    public RegisterOutput Execute(
        string firstName,
        string lastName,
        string personnummer,
        string email,
        string mobilePhoneNumber)
    { ... }
}
```

- Needs to verify for required parameters, Data Format and Data Range.
- Services are unnecessary Big and Fat.
- Easy to confuse one parameter with the another.


Domain-Driven
DESIGN
Tackling Complexity in the Heart of Software
Eric Evans
Foreword by Martin Fowler

- Not a technology.
- Not a methodology.
- Set of principles and patterns for focusing the design effort where it matters most.

A Customer Entity Using Value Objects..



```
public class Customer : IEntity
{
    public int Id { get; set; }
    public FirstName FirstName { get; set; }
    public LastName LastName { get; set; }
    public Personnummer Personnummer { get; set; }
    public Email Email { get; set; }
    public MobilePhoneNumber MobilePhoneNumber { get; set; }
}
```

Business Rules Enforced Through Value Objects

```
public class RegisterCustomerUseCase
{
    public RegisterOutput Execute(
        FirstName firstName,
        LastName lastName,
        Personnummer personnummer,
        Email email,
        MobilePhoneNumber mobilePhoneNumber)
    { ... }
}
```

- The simple existence of a Value Object means that it is valid.
- No need to verify parameters values on every method.
- **Services are thinner and smaller when using Value Objets.**

DDD express the Model with
Value Objects, Entities and Services.

Some Entities act as root of Aggregates.

An Example with Some Use Cases

- A customer can register a new account using its personal details.
- Allow a customer to deposit funds into an existing account.
- Allow to withdraw from an existing account.
- Do not allow to withdraw more than the current balance.

Customer 5557-8

Account Number 4444-6 (Day-to-Day)

Date	Description	Debit (SEK)	Credit (SEK)	Balance (SEK)
01-08-2018	Initial Balance			50,000
03-08-2018	Withdrawn	10,000		40,000
07-08-2018	Withdrawn	5,000		35,000
17-09-2018	Deposited		7,000	42,000

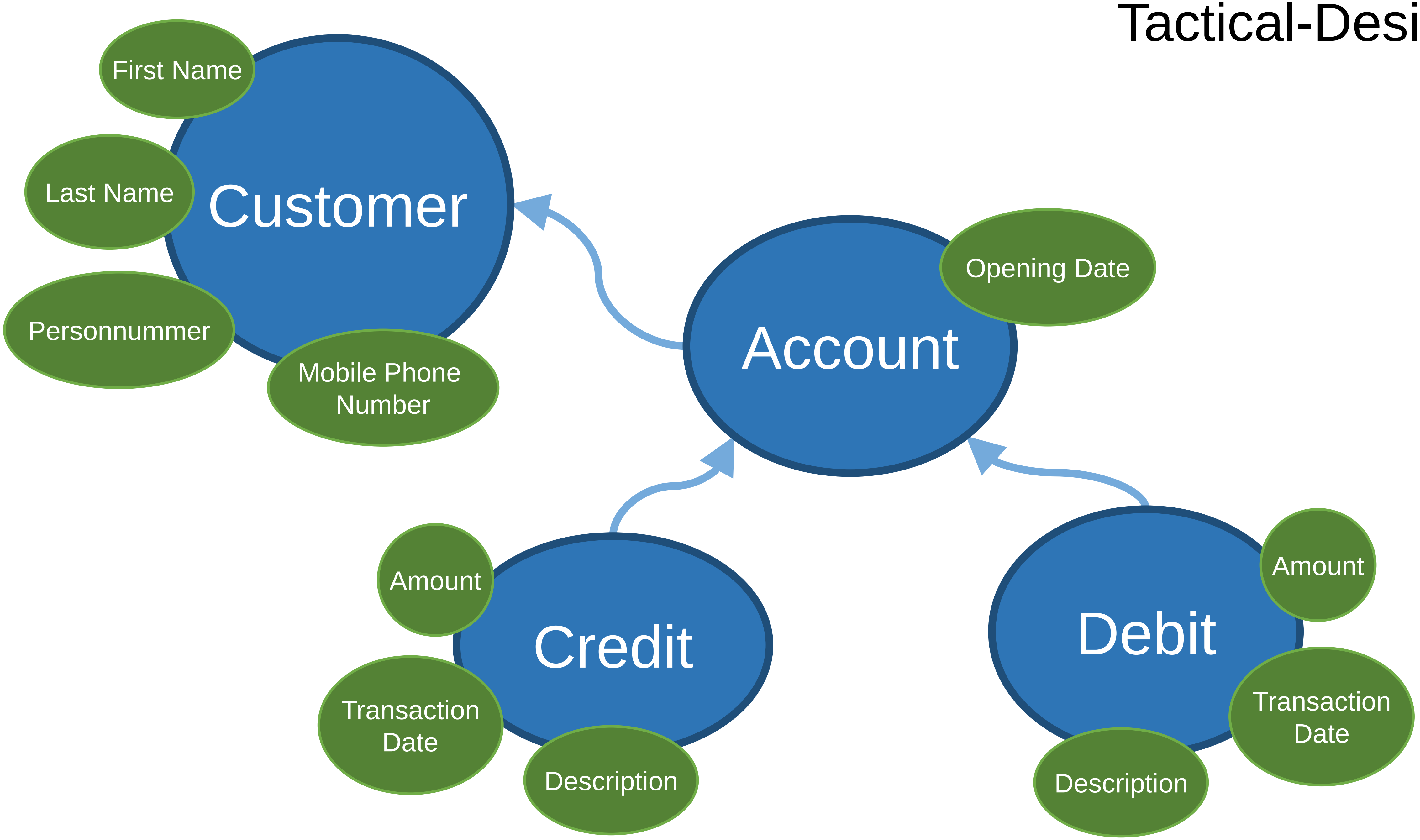
Account Number 7777-0 (Savings)

Date	Description	Debit (SEK)	Credit (SEK)	Balance (SEK)
01-09-2018	Initial Balance			10,000

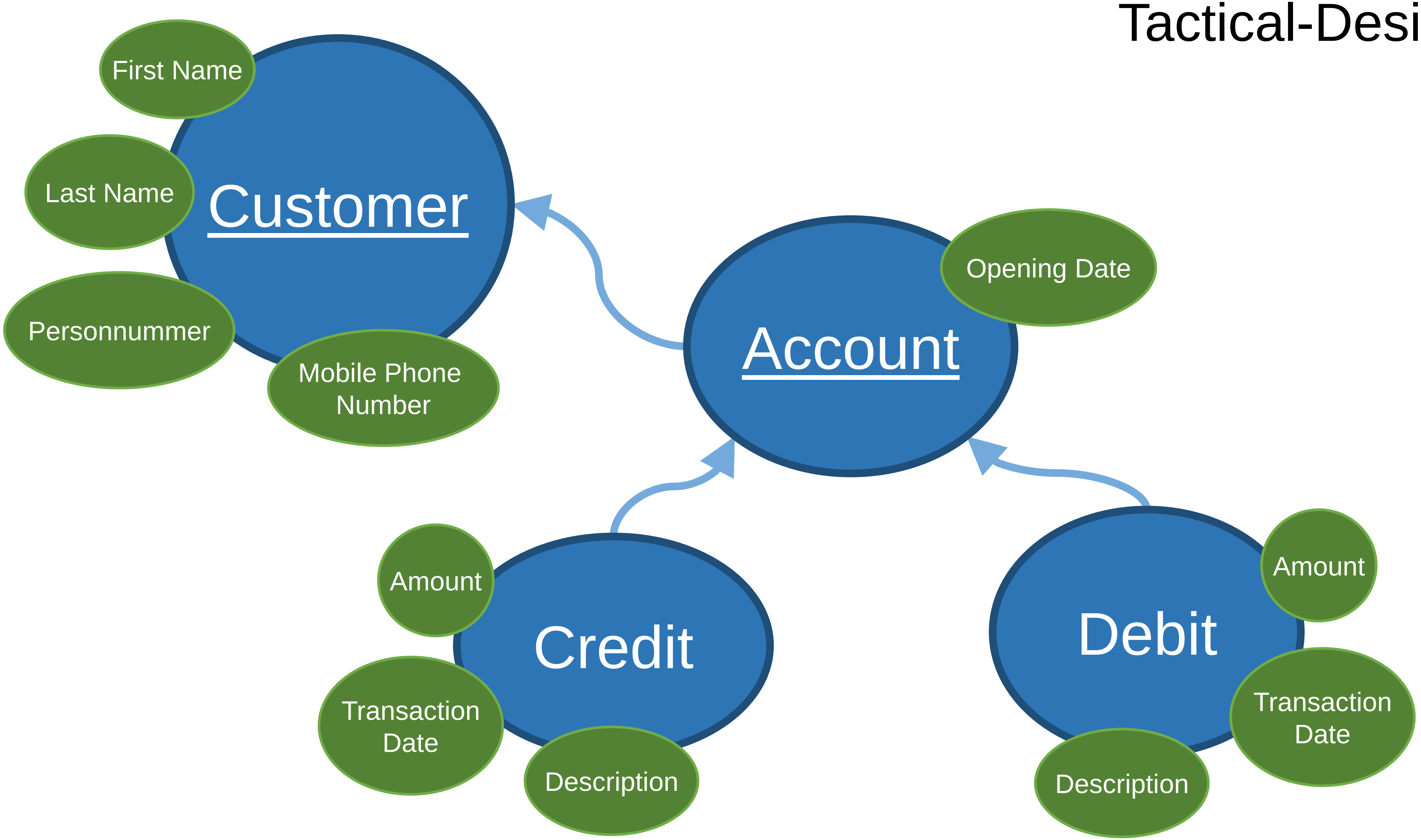
Some Noums and Verbs are Useful

- A **customer** can **register** a new account using its personal details.
- Allow a **customer** to **deposit** funds into an existing account.
- Allow to **withdraw** from an existing **account**.
- Do not allow to **withdraw** more than the current balance.

Tactical-Design



Tactical-Design



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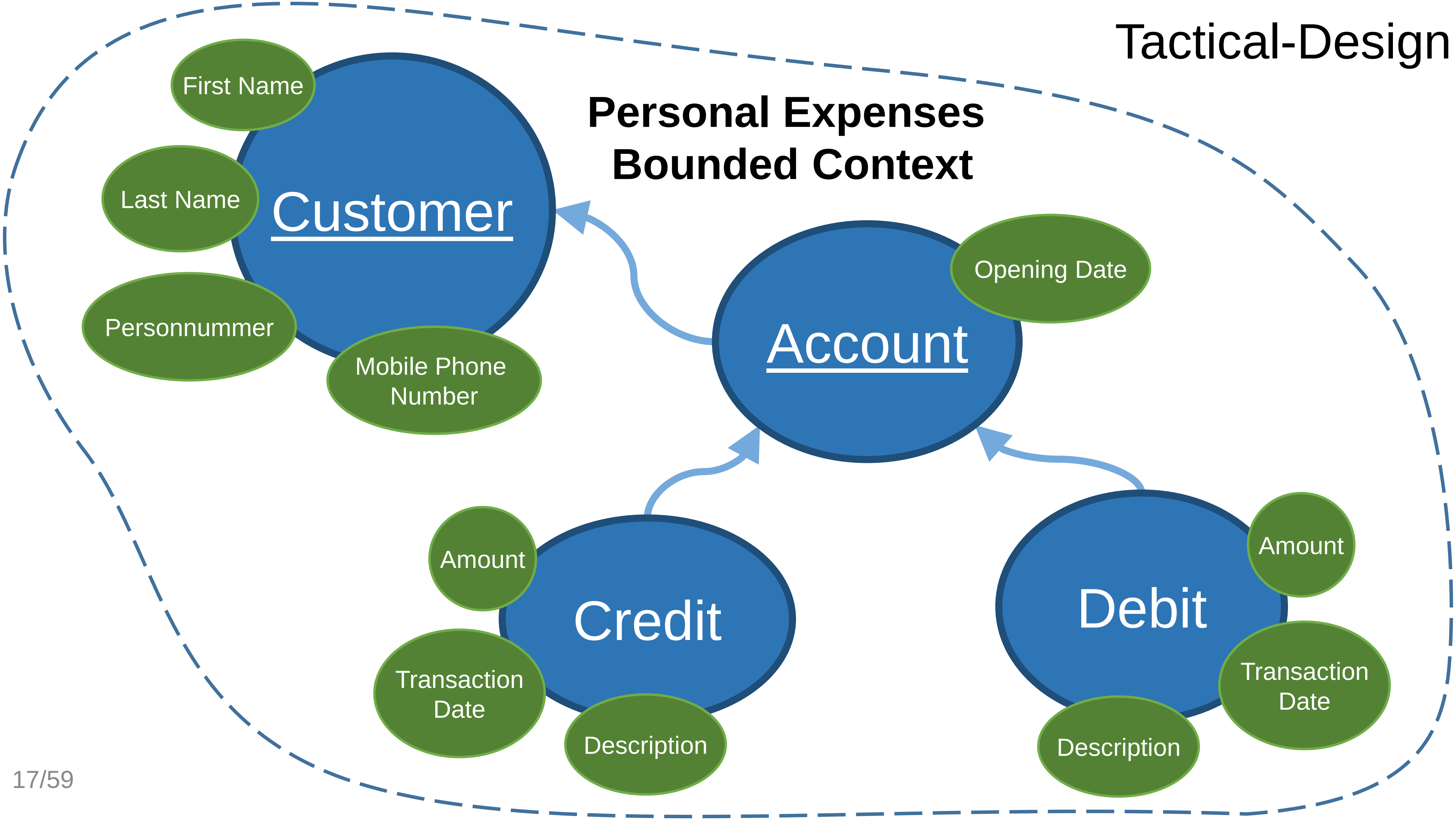
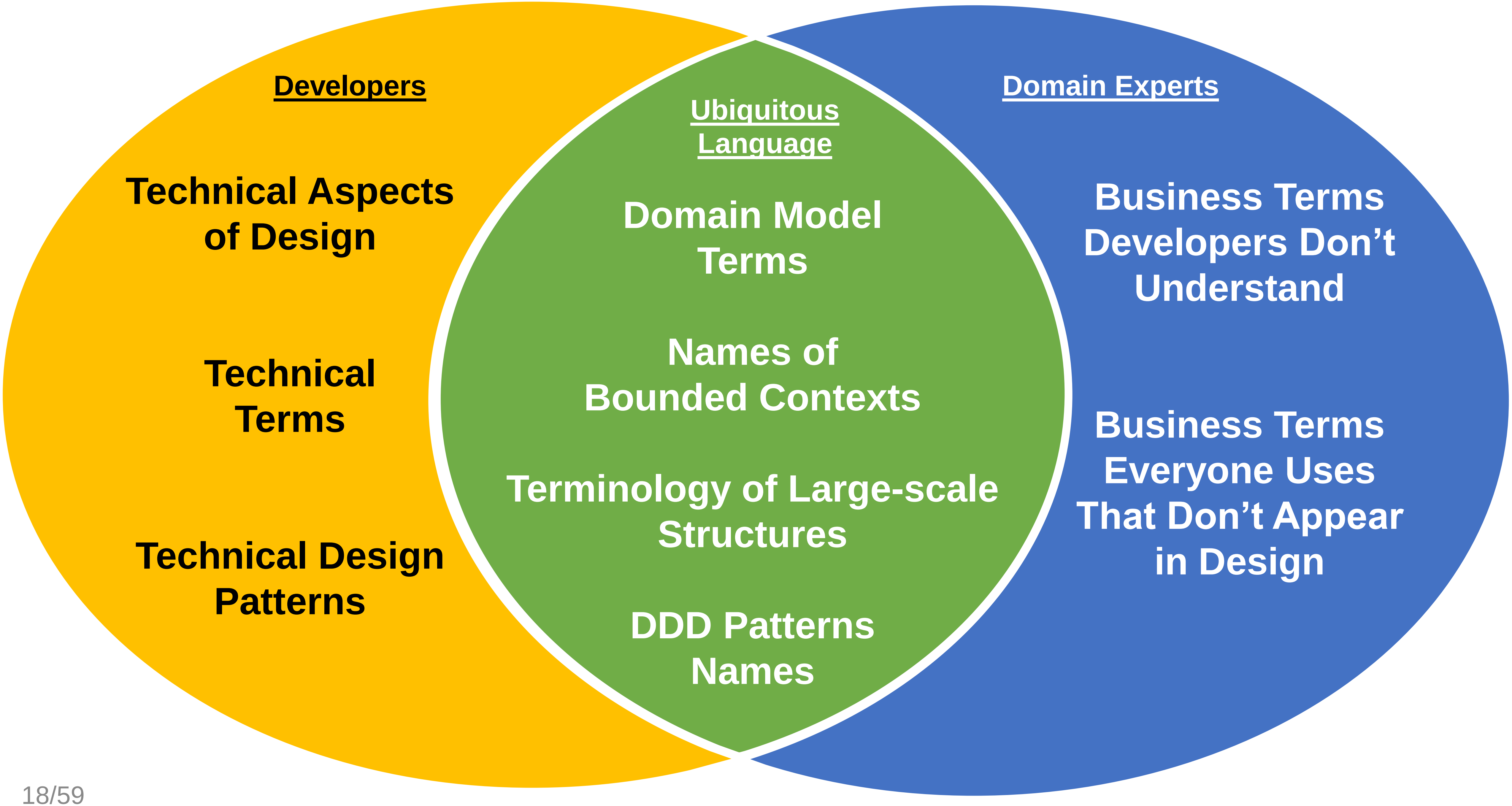




Developers

Technical Aspects of Design

Technical Terms

Technical Design Patterns

Ubiquitous Language

Domain Model Terms

Names of Bounded Contexts

Terminology of Large-scale Structures

DDD Patterns Names

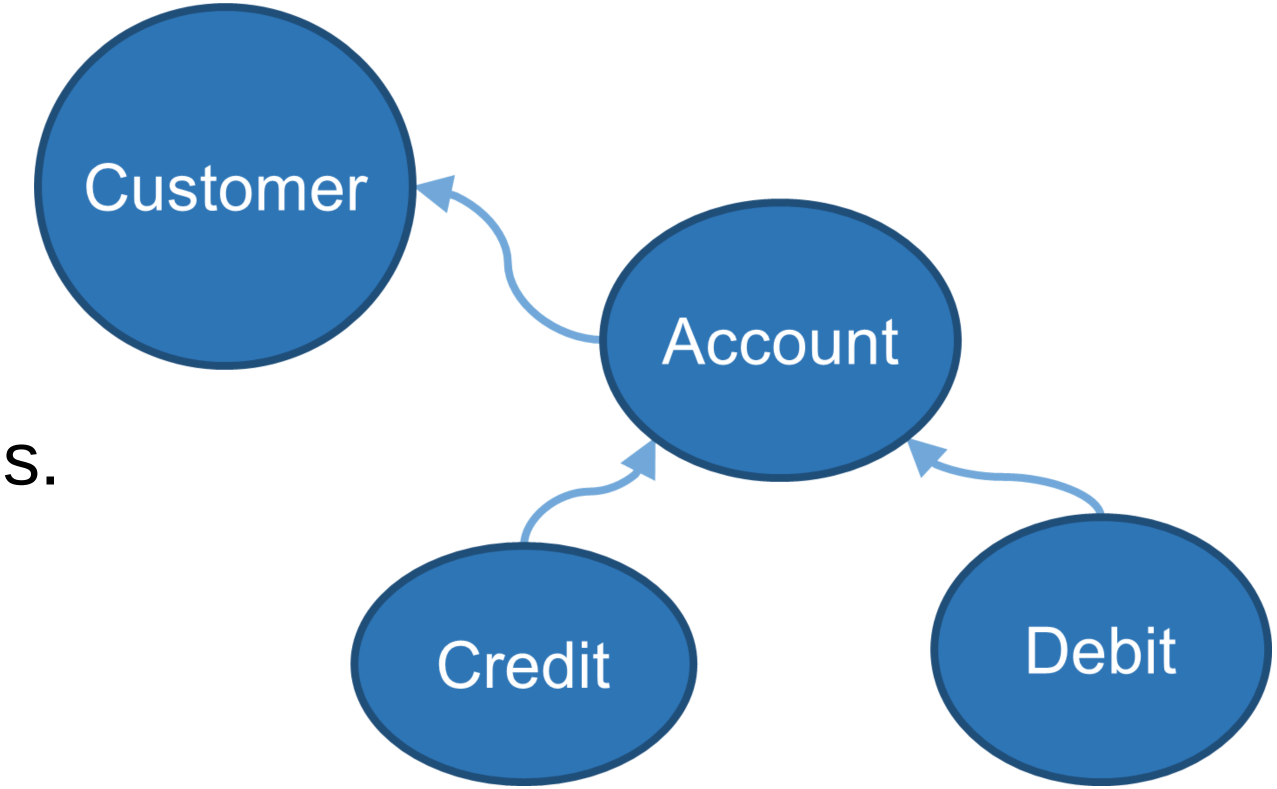
Domain Experts

Business Terms Developers Don’t Understand

Business Terms Everyone Uses That Don’t Appear in Design

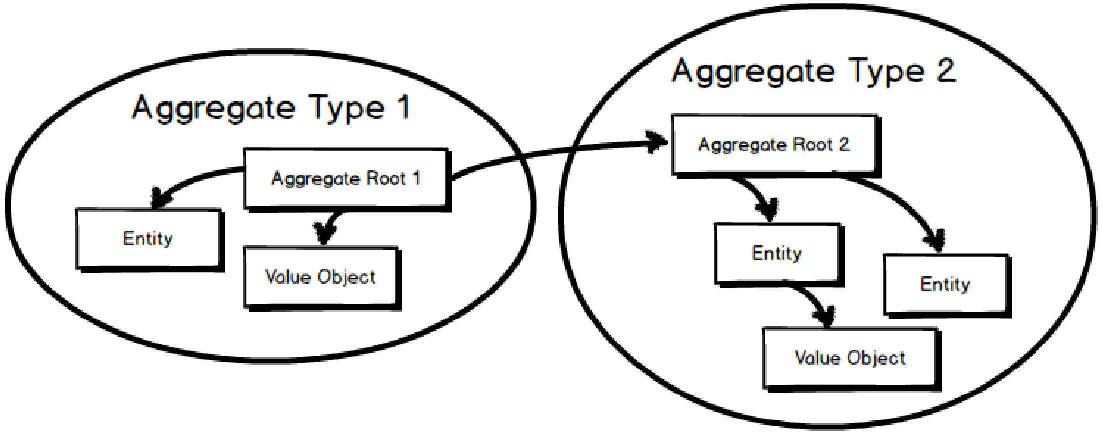
Entities

- Have a unique identity.
- Are mutable or not.
- Refer others entities by their IDs.



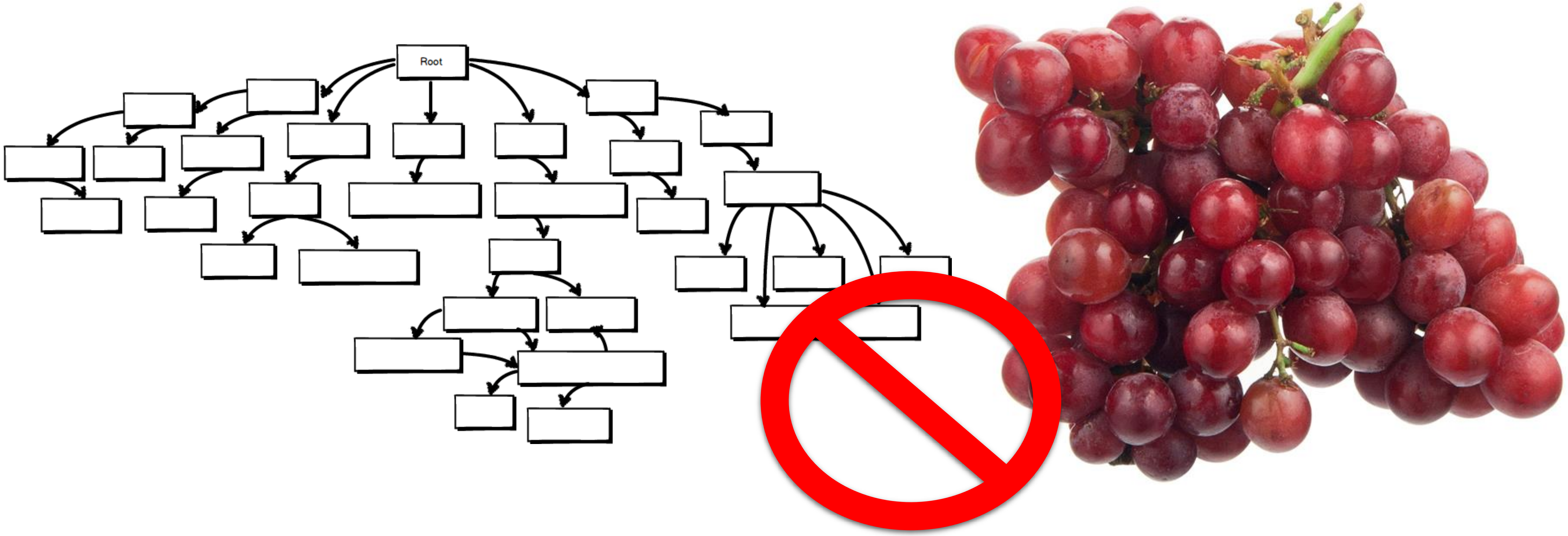
Aggregate Roots (Are Entities)

- Refer other aggregates by identity only.
- Scope of consistency inside the aggregate boundaries.
- Eventual consistency between aggregates.
- Aggregates **are small.**



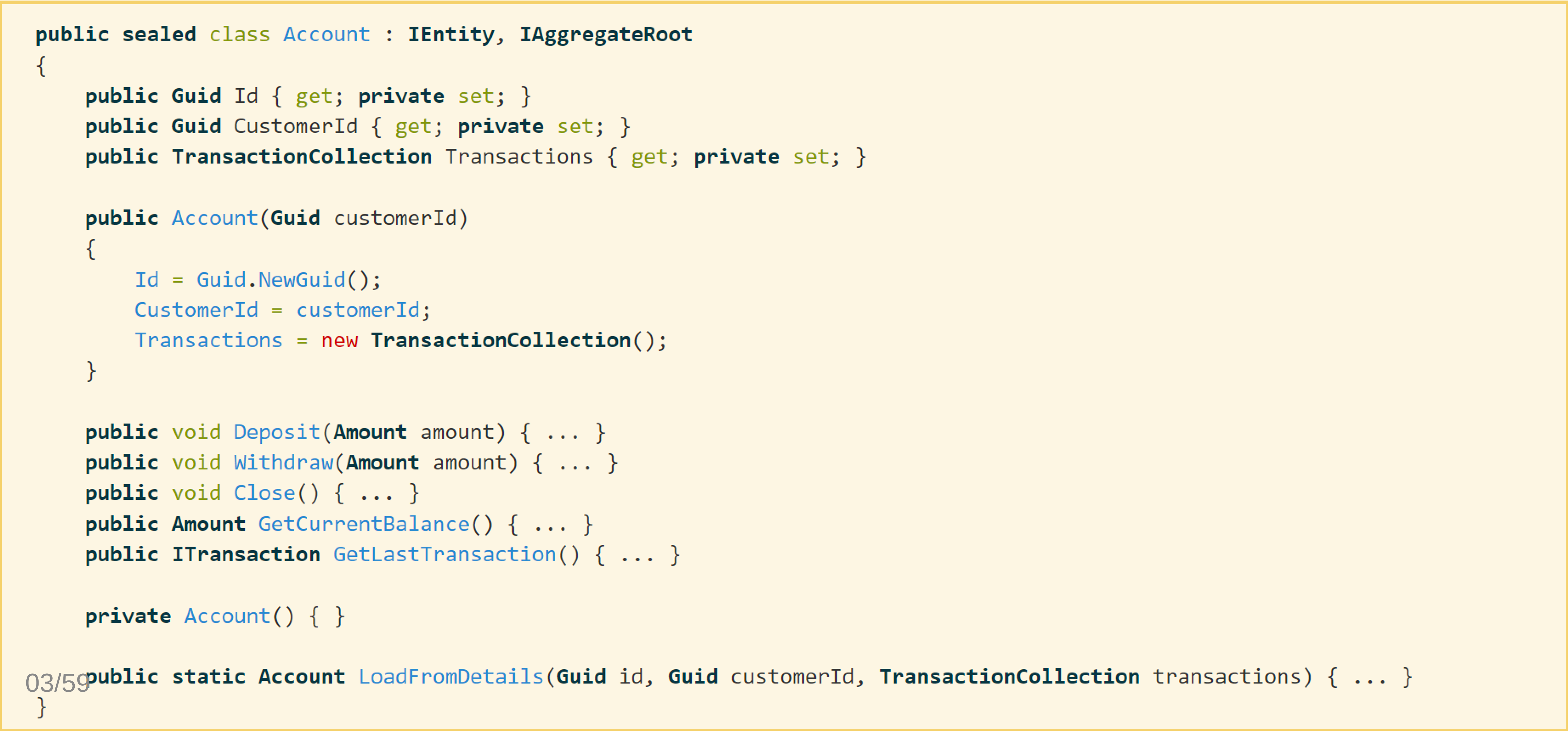
- Aggregates implement behaviors.
- Entity + Repository ~ Aggregate
- One Aggregate Root for every Entity is a Code Smell.

An Aggregate Root is not your Entire Model



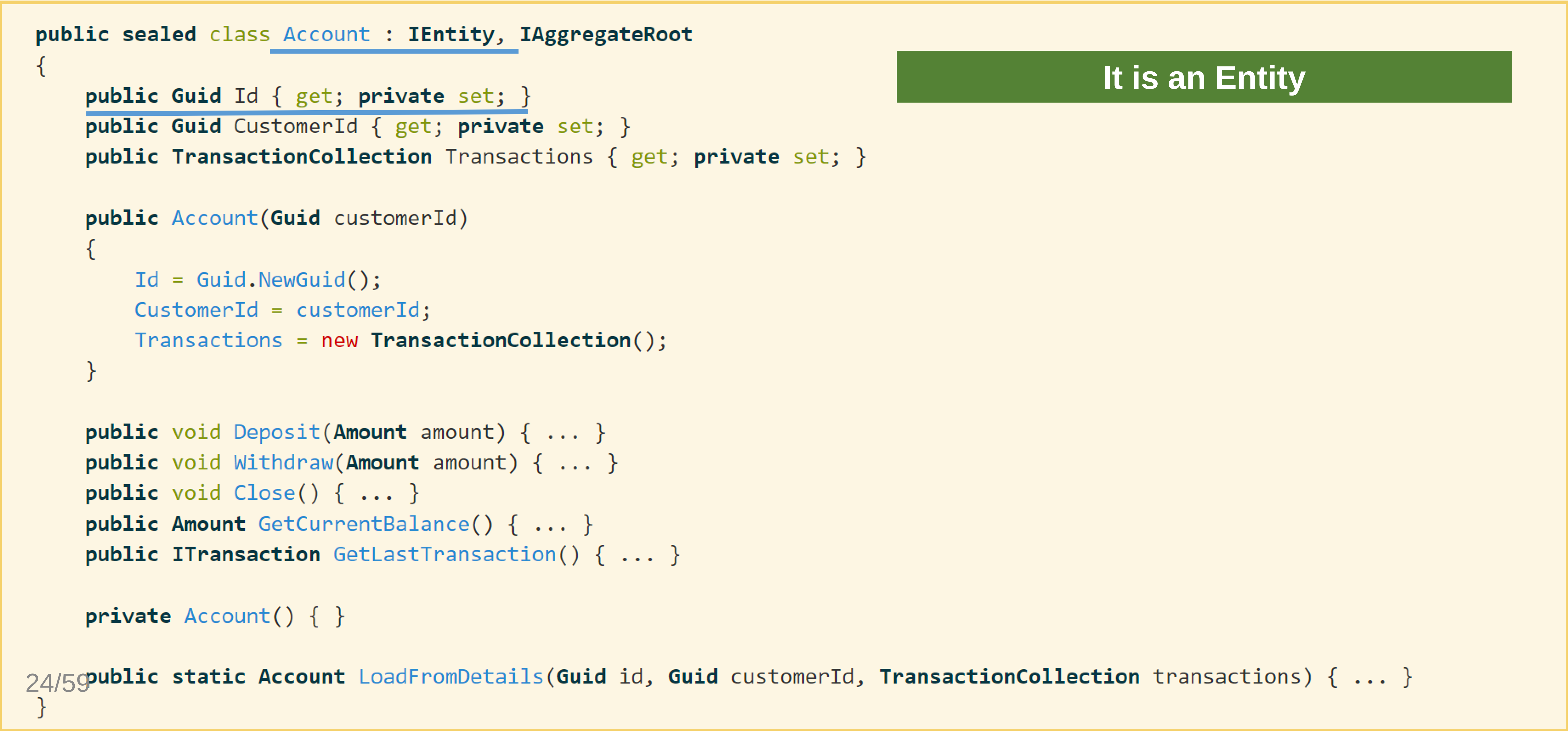
An Aggregate Root

Account Aggregate Root



```
public sealed class Account : IEntity, IAggregateRoot
{
    public Guid Id { get; private set; }
    public Guid CustomerId { get; private set; }
    public TransactionCollection Transactions { get; private set; }

    public Account(Guid customerId)
    {
        Id = Guid.NewGuid();
        CustomerId = customerId;
        Transactions = new TransactionCollection();
    }

    public void Deposit(Amount amount) { ... }
    public void Withdraw(Amount amount) { ... }
    public void Close() { ... }
    public Amount GetCurrentBalance() { ... }
    public ITransaction GetLastTransaction() { ... }

    private Account() { }

    public static Account LoadFromDetails(Guid id, Guid customerId, TransactionCollection transactions) { ... }
}
```

Account Aggregate Root



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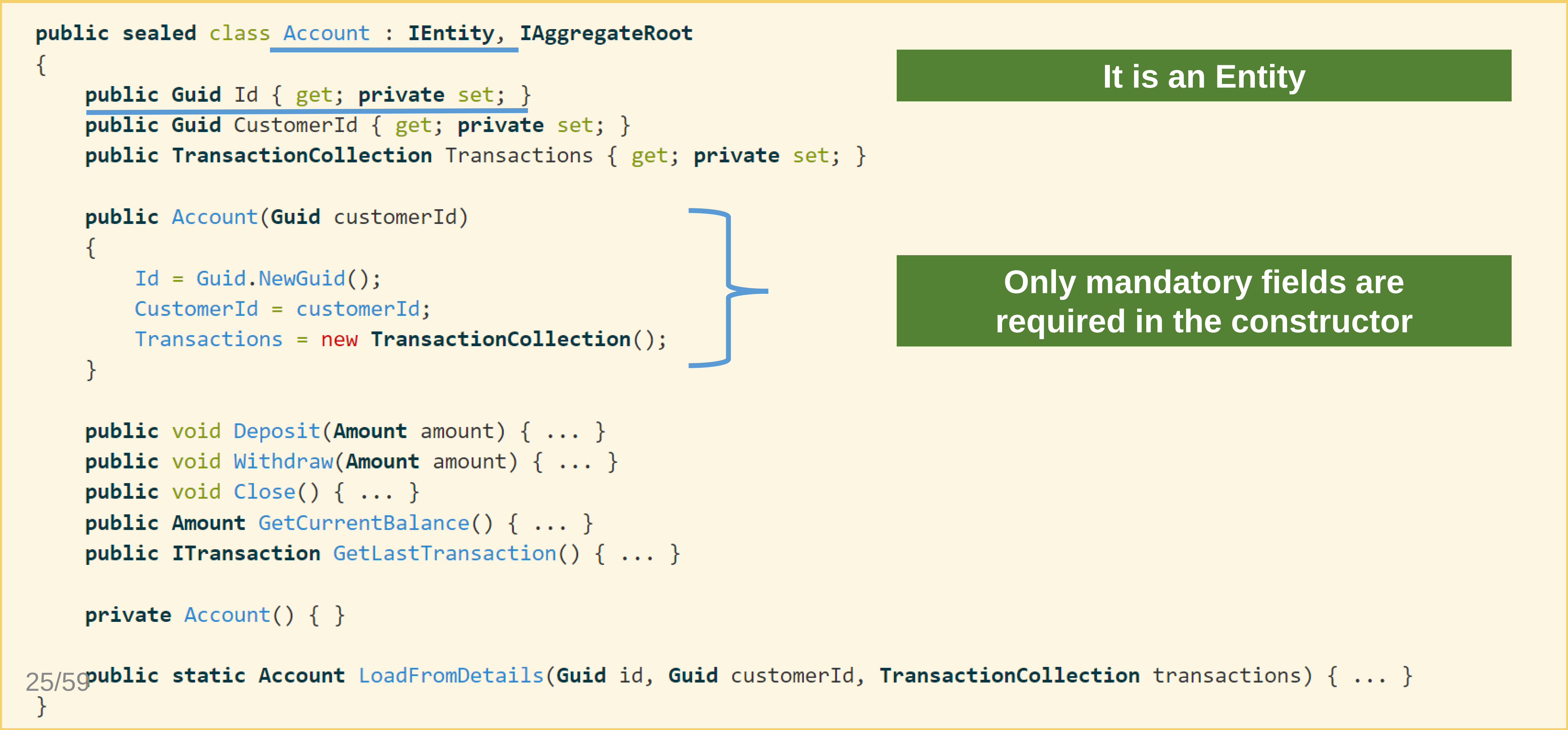
It is an Entity

Account Aggregate Root



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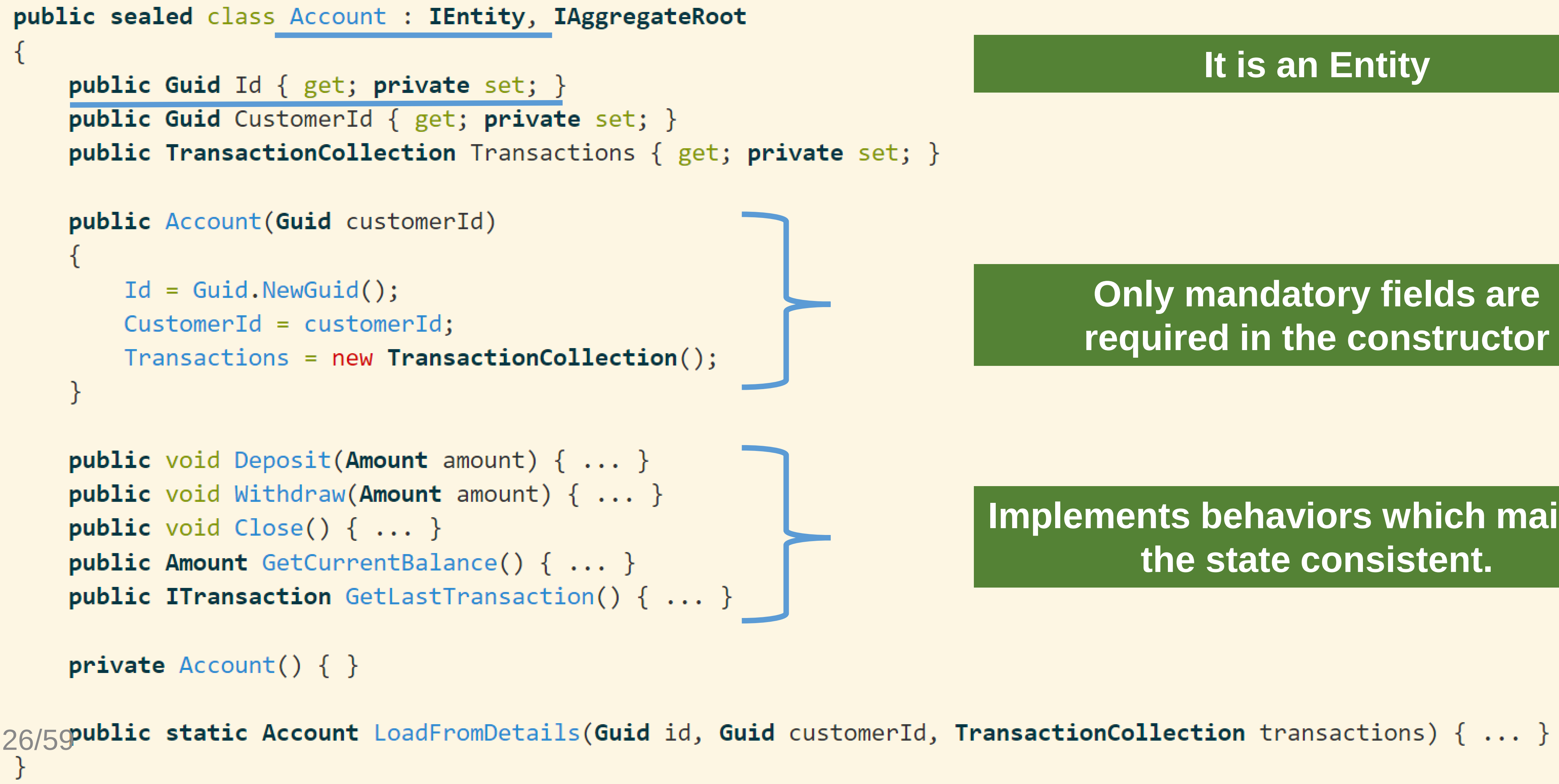
It is an Entity

Only mandatory fields are required in the constructor

Account Aggregate Root



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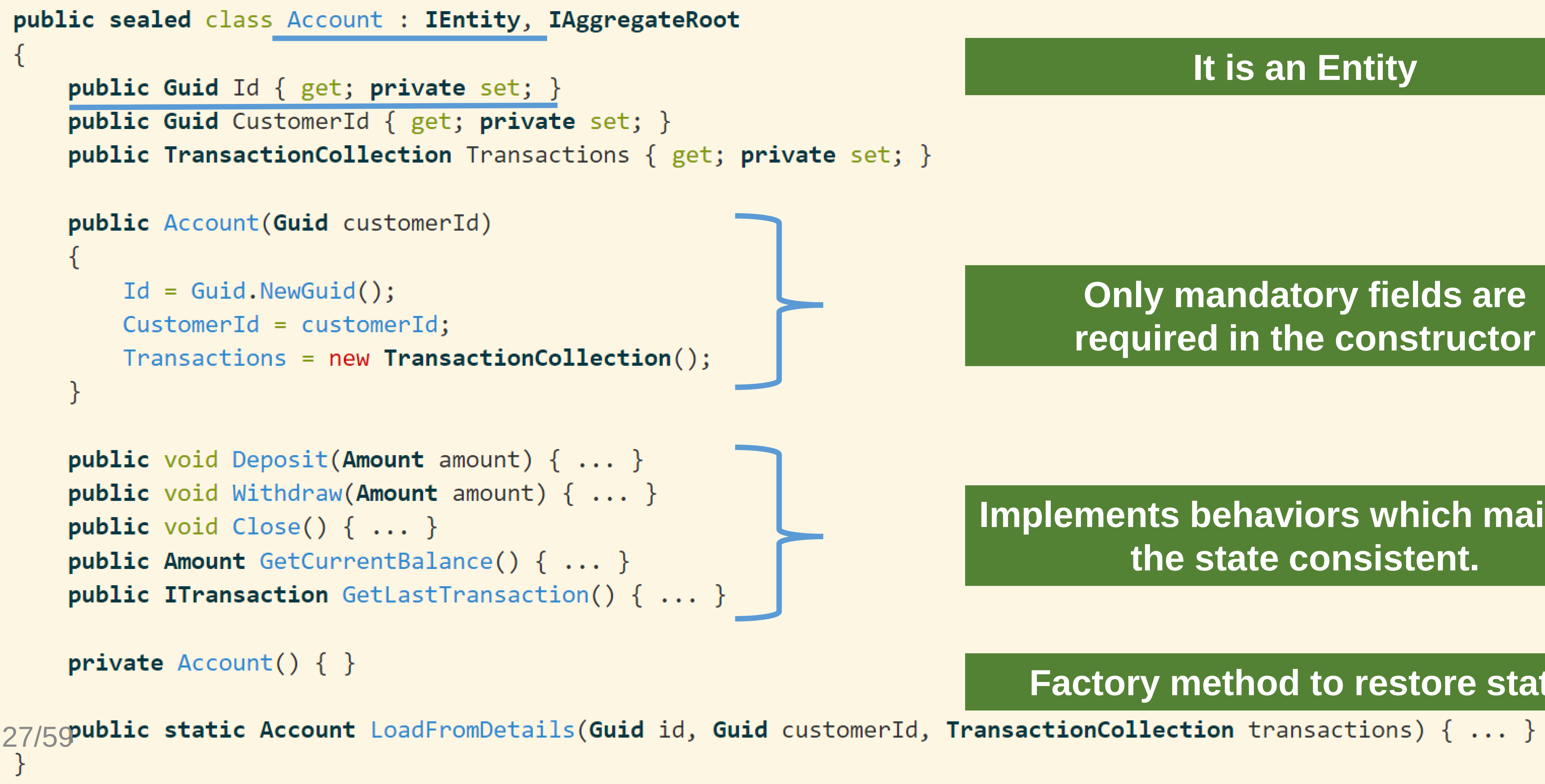
It is an Entity

Only mandatory fields are required in the constructor

Implements behaviors which maintain the state consistent.

Account Aggregate Root



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```

It is an Entity

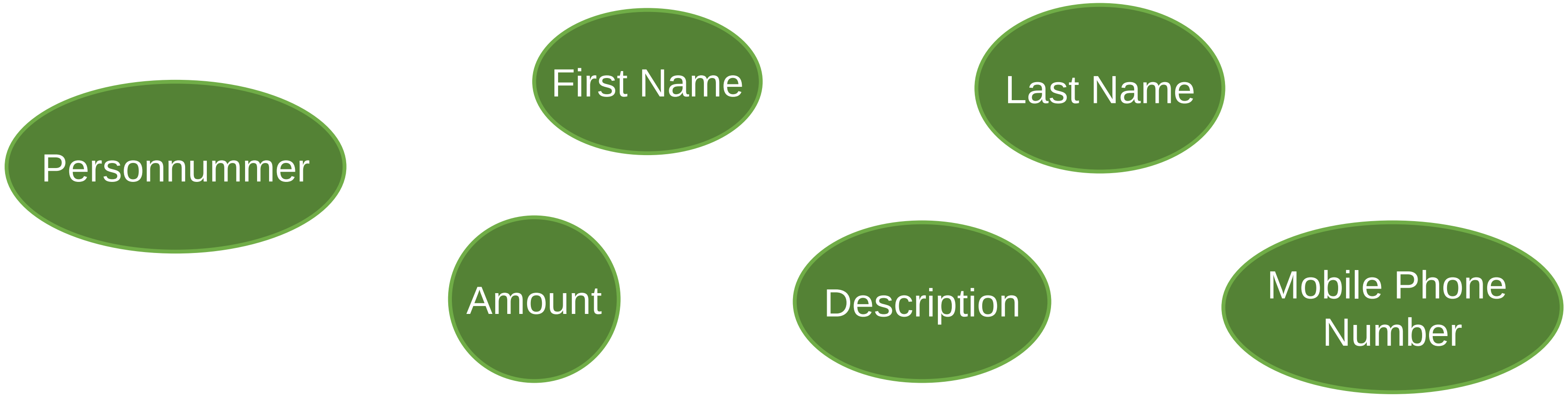
Only mandatory fields are required in the constructor

Implements behaviors which maintain the state consistent.

Factory method to restore state.

Value Objects

- Immutable.
- Have no explicit identity.
- Unique by the comparison of the attributes.
- Used to describe, measure or quantify an Entity.



First Name

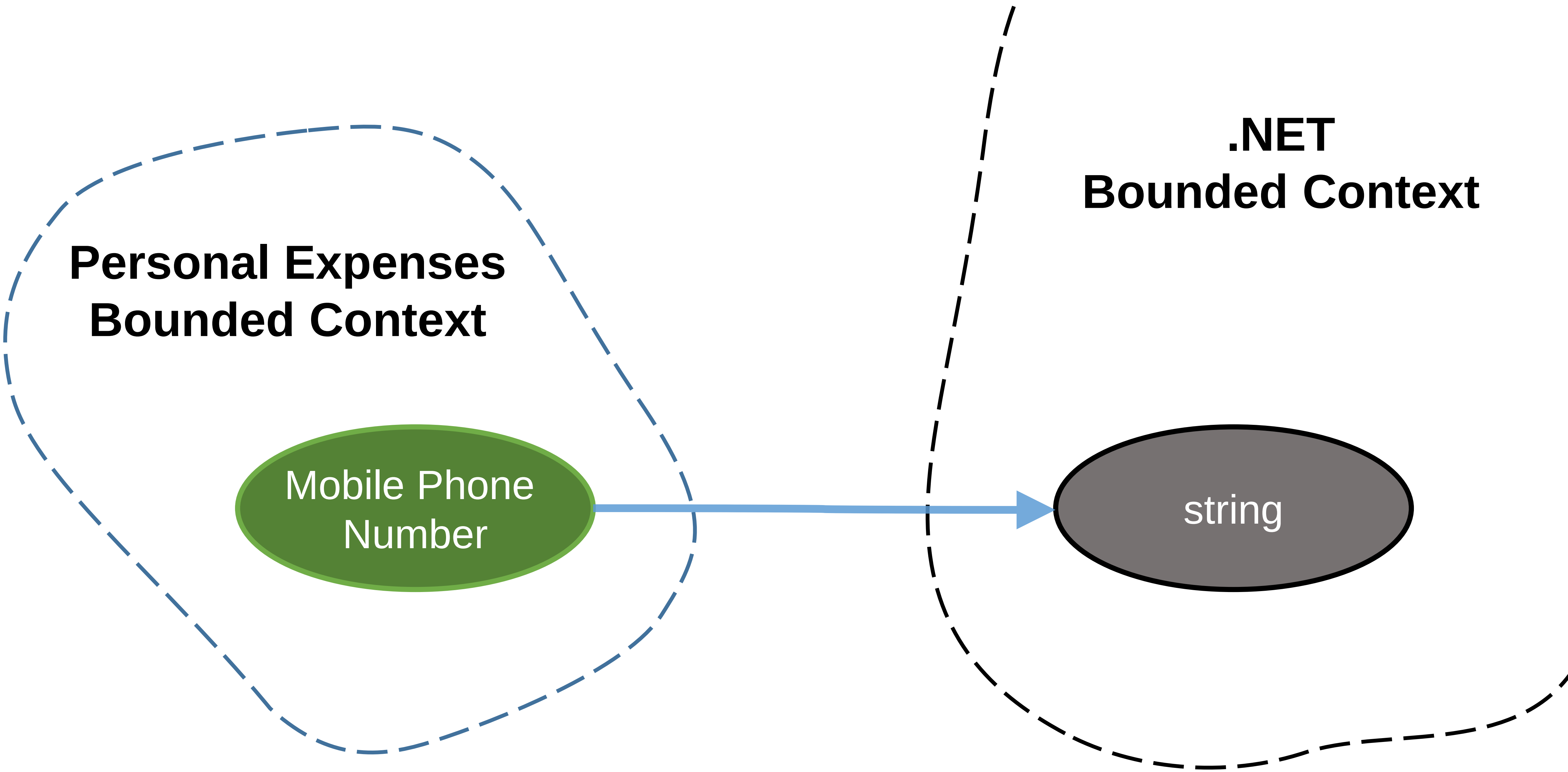
Last Name

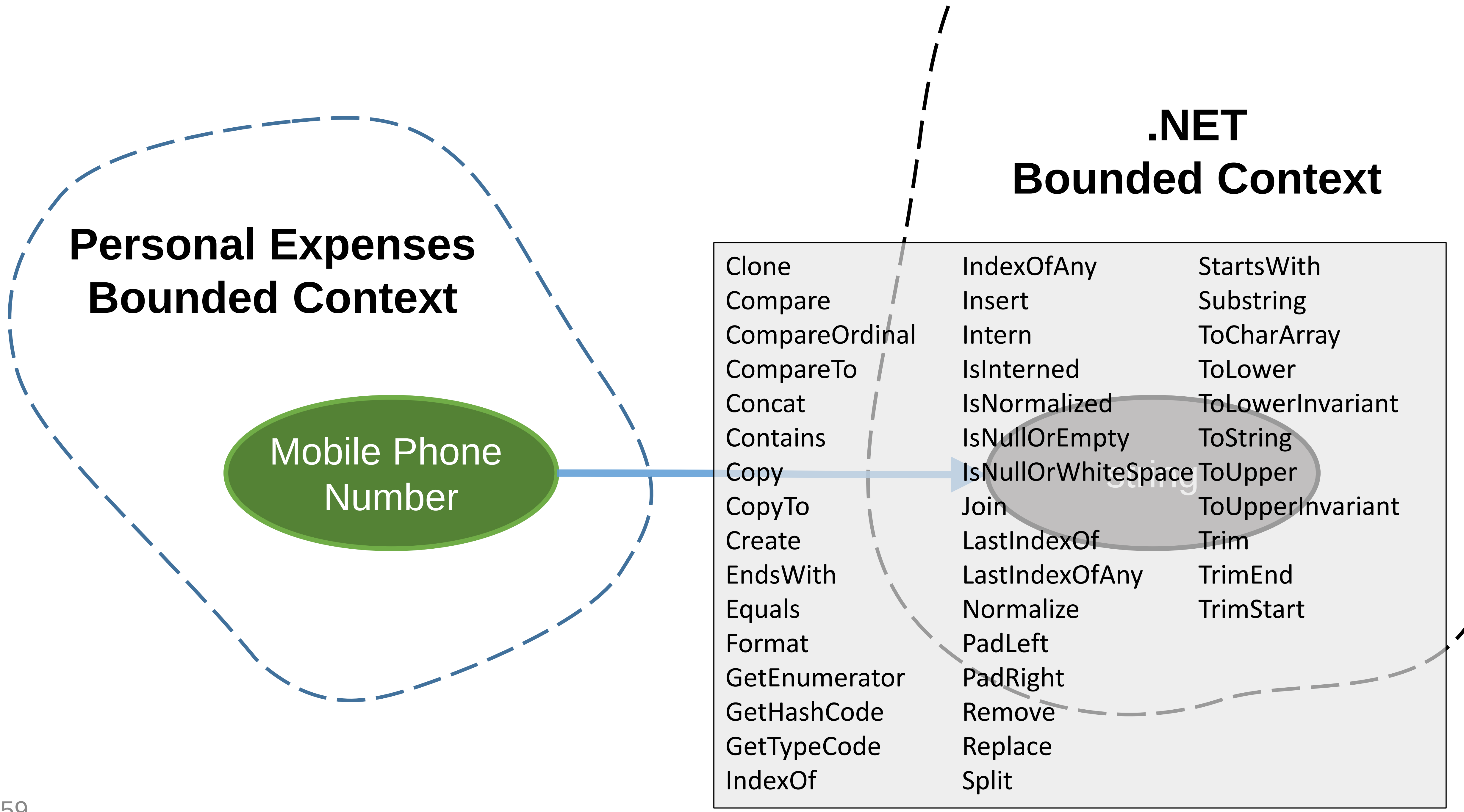
Personnummer

Amount

Description

Mobile Phone Number


.NET
Bounded Context
Personal Expenses
Bounded Context
Mobile Phone
Number
string



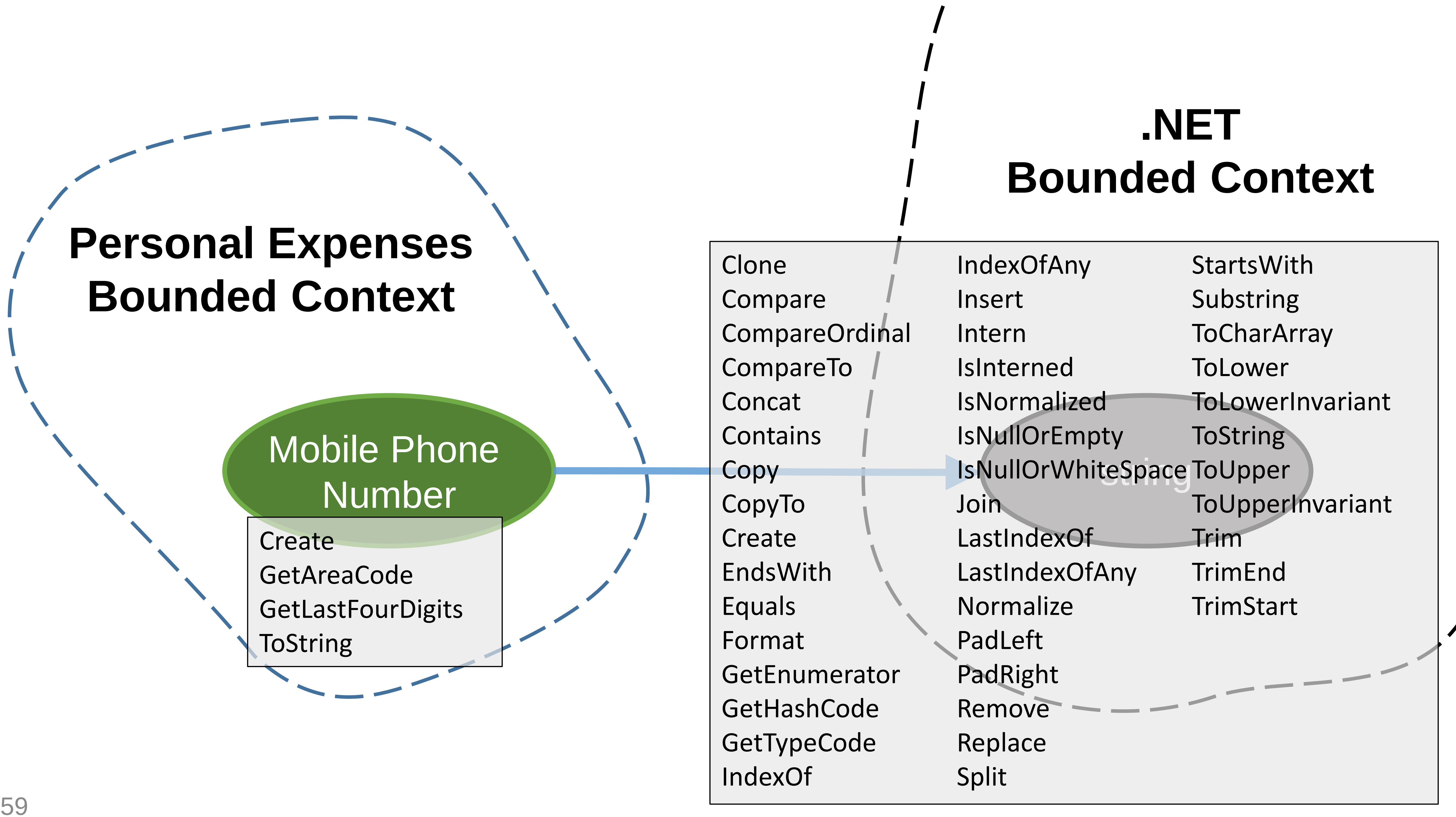
Personal Expenses Bounded Context

.NET Bounded Context

Mobile Phone Number

String

Clone
Compare
CompareOrdinal
CompareTo
Concat
Contains
Copy
CopyTo
Create
EndsWith
Equals
Format
GetEnumerator
GetHashCode
GetTypeCode
IndexOf
IndexOfAny
Insert
Intern
IsInterned
IsNormalized
IsNullOrEmpty
IsNullOrWhiteSpace
Join
LastIndexOf
LastIndexOfAny
Normalize
PadLeft
PadRight
Remove
Replace
Split
StartsWith
Substring
ToCharArray
ToLower
ToLowerInvariant
ToString
ToUpper
ToUpperInvariant
Trim
TrimEnd
TrimStart



Personal Expenses Bounded Context

.NET Bounded Context

Create
GetAreaCode
GetLastFourDigits
ToString

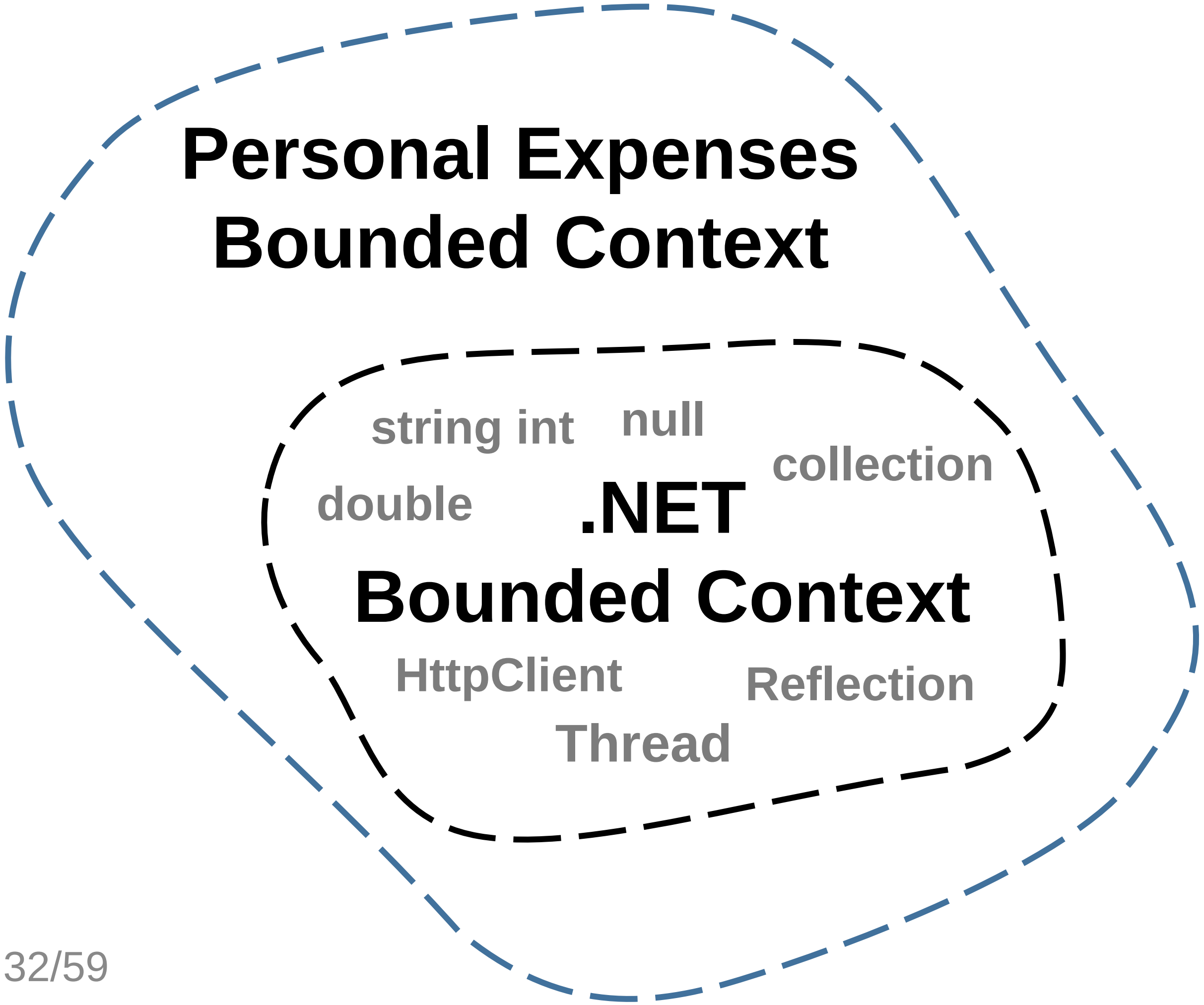
Clone
Compare
CompareOrdinal
CompareTo
Concat
Contains
Copy
CopyTo
Create
EndsWith
Equals
Format
GetEnumerator
GetHashCode
GetTypeCode
IndexOf

IndexOfAny
Insert
Intern
IsInterned
IsNormalized
IsNullOrEmpty
IsNullOrWhiteSpace
Join
LastIndexOf
LastIndexOfAny
Normalize
PadLeft
PadRight
Remove
Replace
Split

StartsWith
Substring
ToCharArray
ToLower
ToLowerInvariant
ToString
ToUpper
ToUpperInvariant
Trim
TrimEnd
TrimStart

Without Value Objects

We bring the .NET Framework Complexity
into our Bounded Context.



Personal Expenses Bounded Context

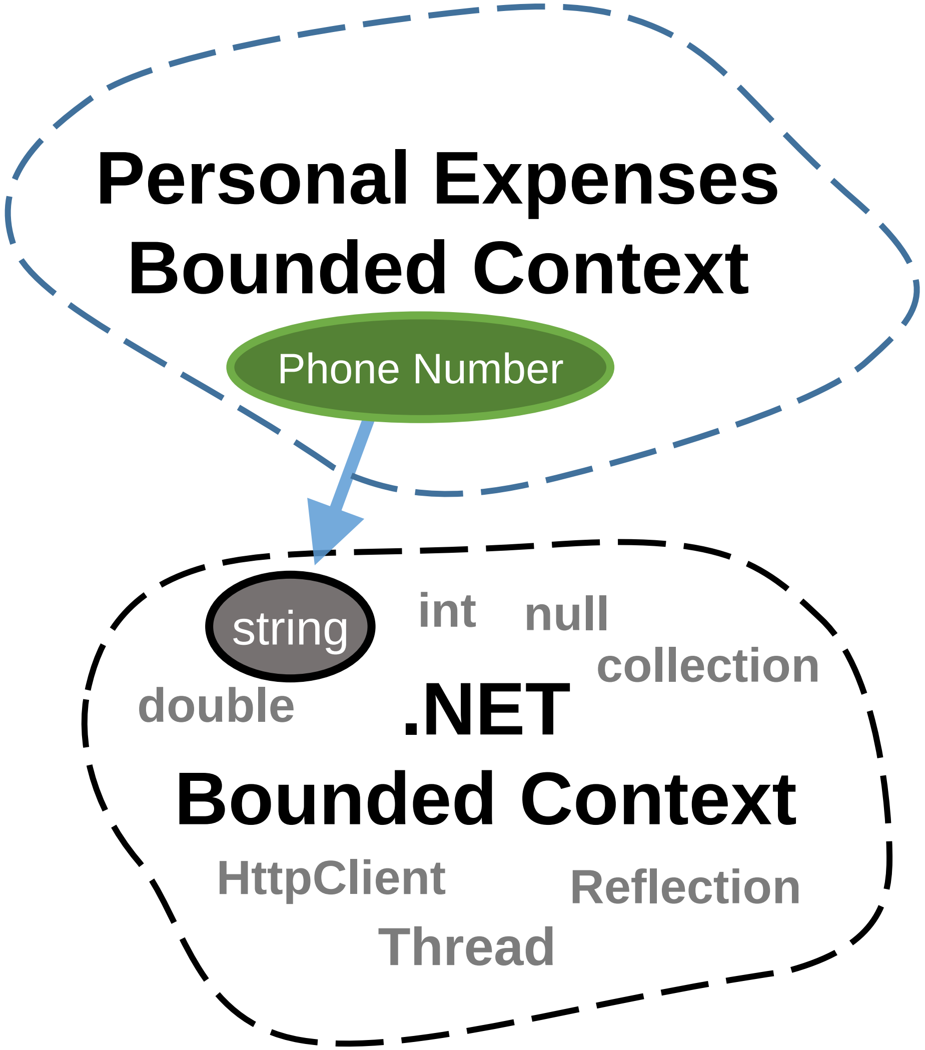
string int null collection double

.NET Bounded Context

HttpClient Reflection Thread

With Value Objects

We only pay for the complexity
we really use



Personal Expenses Bounded Context

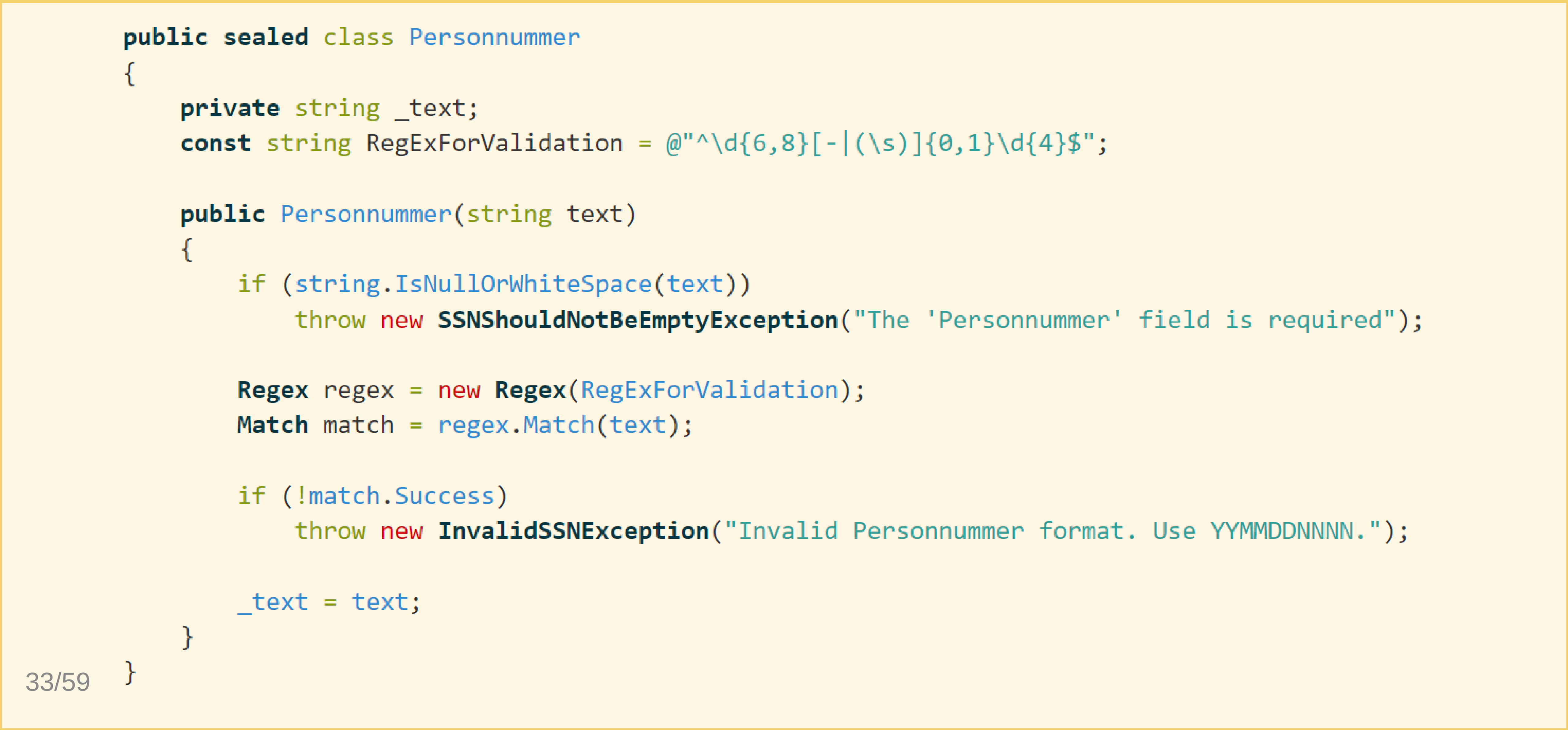
Phone Number

string int null collection double

.NET Bounded Context

HttpClient Reflection Thread

Personnummer Value Object



```
public sealed class Personnummer
{
    private string _text;
    const string RegExForValidation = @"^\d{6,8}[-|(\s)]{0,1}\d{4}$";

    public Personnummer(string text)
    {
        if (string.IsNullOrWhiteSpace(text))
            throw new SSNShouldNotBeEmptyException("The 'Personnummer' field is required");

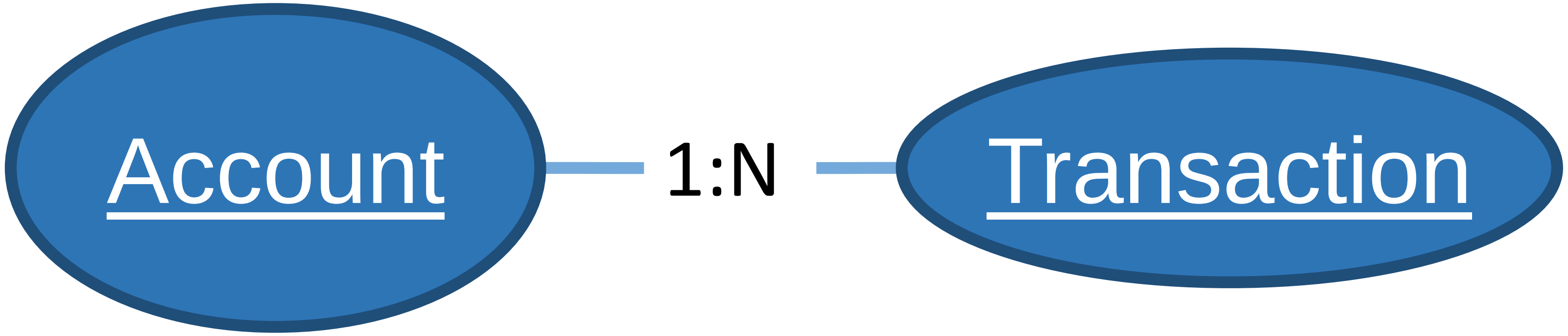
        Regex regex = new Regex(RegExForValidation);
        Match match = regex.Match(text);

        if (!match.Success)
            throw new InvalidSSNException("Invalid Personnummer format. Use YYMMDDNNNN.");

        _text = text;
    }
}
```

First-Class Collections

- Each collection should be wrapped in its own class[1].
- Classes that contains collections do not contains any other variable.
- Behaviors have a home.
- When necessary return immutable collection copies.



[1] The ThoughtWorks Anthology: Essays on Software Technology and Innovation (Pragmatic Programmers), 2008

First-Class TransactionCollection

```
public sealed class TransactionCollection
{
    private readonly IList<ITransaction> _transactions;

    public TransactionCollection()
    {
        _transactions = new List<ITransaction>();
    }

    public void Add(ITransaction transaction) { ... }
    public void Add(IEnumerable<ITransaction> transactions) { ... }
    public Amount GetBalance() { ... }

    public IReadOnlyCollection<ITransaction> ToReadOnlyCollection() { ... }
    public ITransaction CopyOfLastTransaction() { ... }
}
```

First-Class TransactionCollection

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    public IReadOnlyCollection<ITransaction> ToReadOnlyCollection() { ... }
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}
```
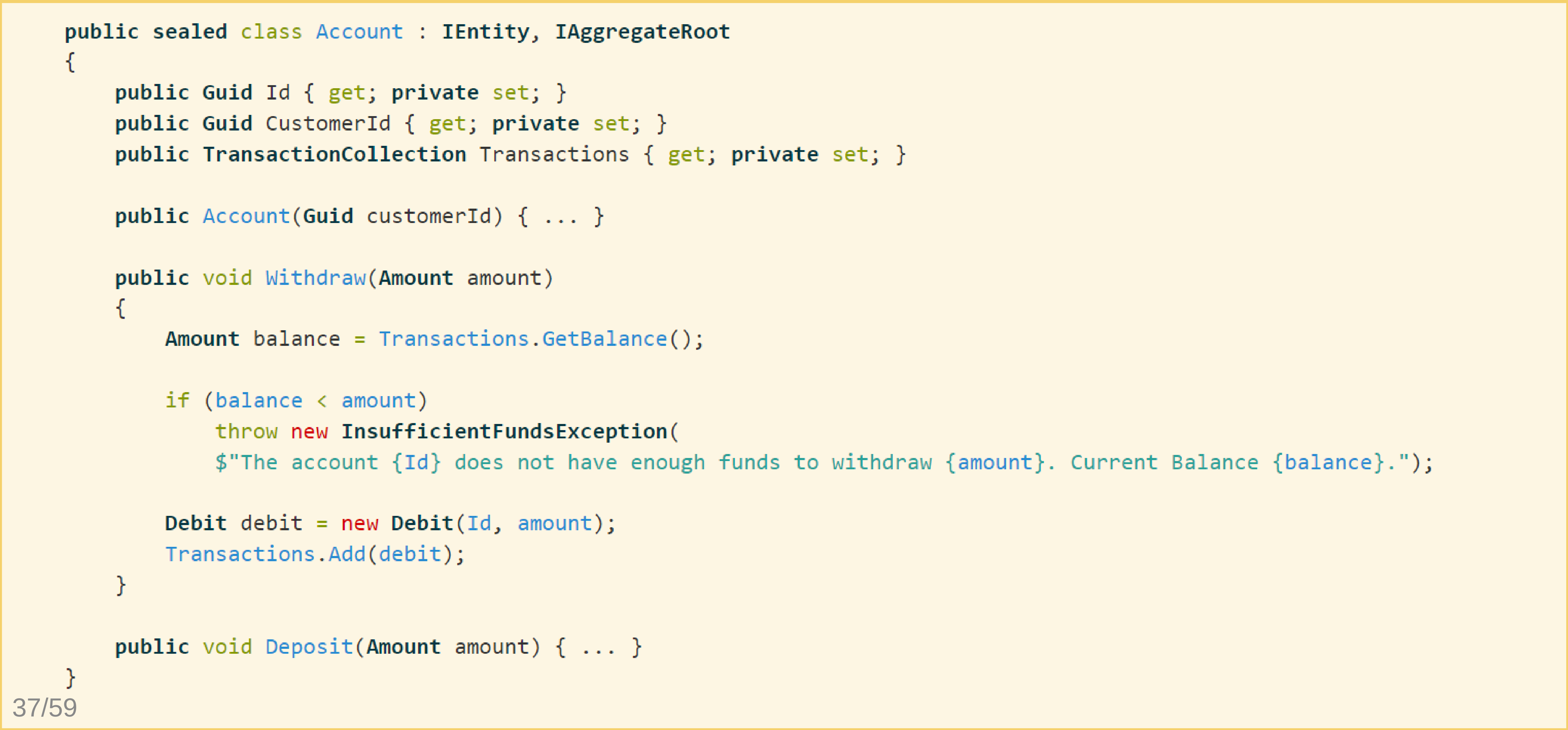

Copy collections and mutable objects when passing them between objects.[1]

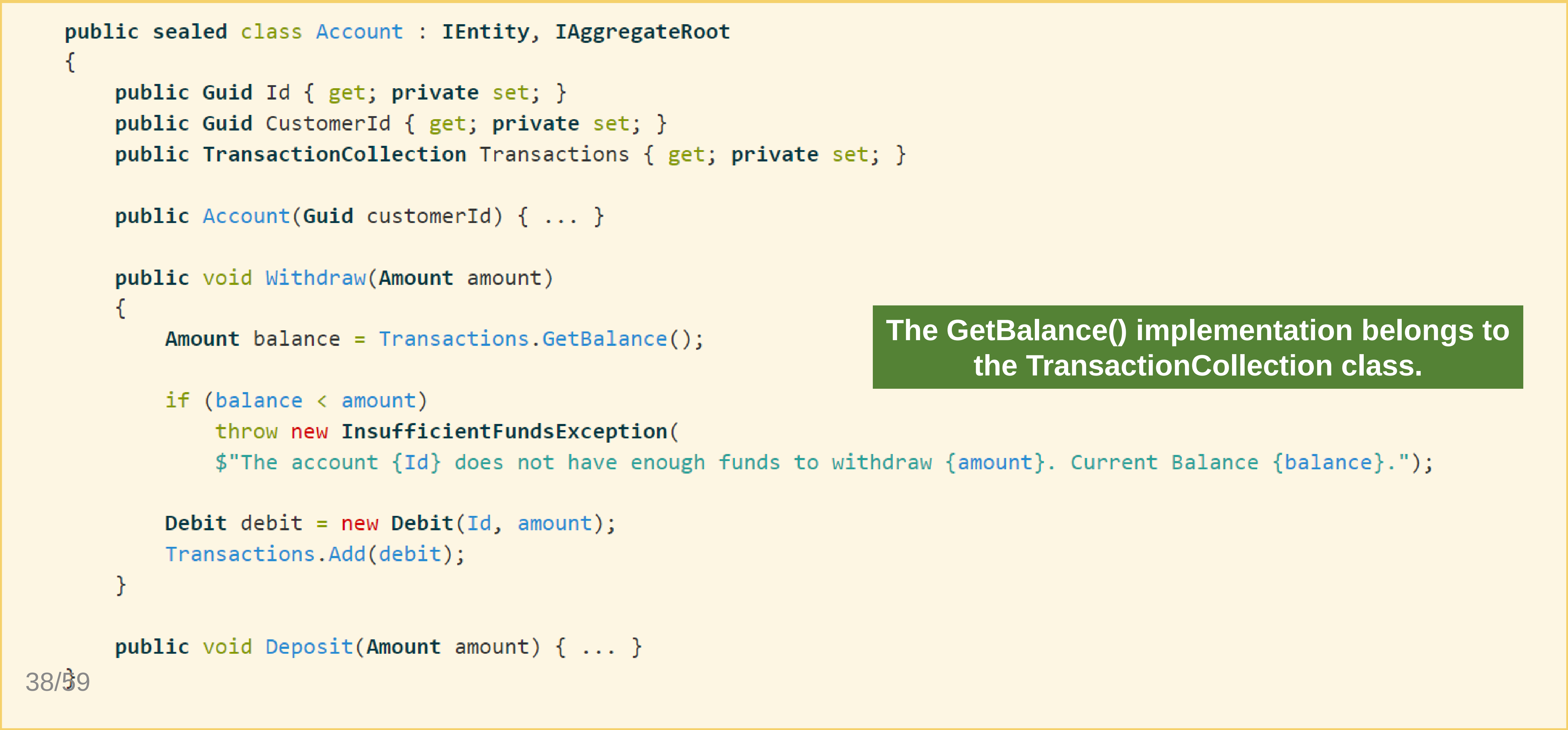
[1] Growing Object-Oriented Software Guided by Tests, 2010

How to Use the TransactionCollection Class



```
    public sealed class Account : IEntity, IAggregateRoot
    {
        public Guid Id { get; private set; }
        public Guid CustomerId { get; private set; }
        public TransactionCollection Transactions { get; private set; }

        public Account(Guid customerId) { ... }

        public void Withdraw(Amount amount)
        {
            Amount balance = Transactions.GetBalance();

            if (balance < amount)
                throw new InsufficientFundsException(
                $"The account {Id} does not have enough funds to withdraw {amount}. Current Balance {balance}.");

            Debit debit = new Debit(Id, amount);
            Transactions.Add(debit);
        }

        public void Deposit(Amount amount) { ... }
    }
```

How to Use the TransactionCollection Class



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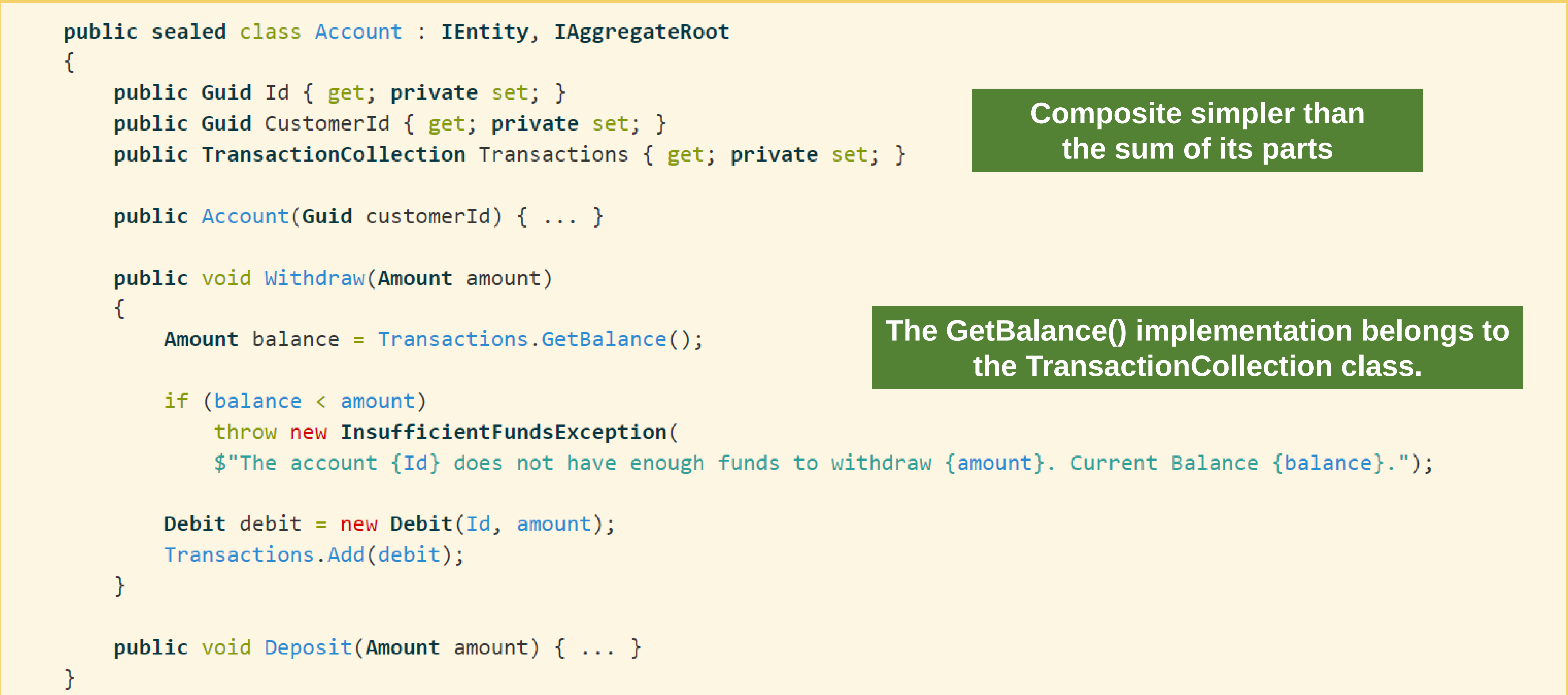
    }

    public void Deposit(Amount amount) { ... }
}
```

The GetBalance() implementation belongs to the TransactionCollection class.

How to Use the TransactionCollection Class



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        if (balance < amount)
            throw new InsufficientFundsException(
            $"The account {Id} does not have enough funds to withdraw {amount}. Current Balance {balance}.");

        Debit debit = new Debit(Id, amount);
        Transactions.Add(debit);
    }

    public void Deposit(Amount amount) { ... }
}
```
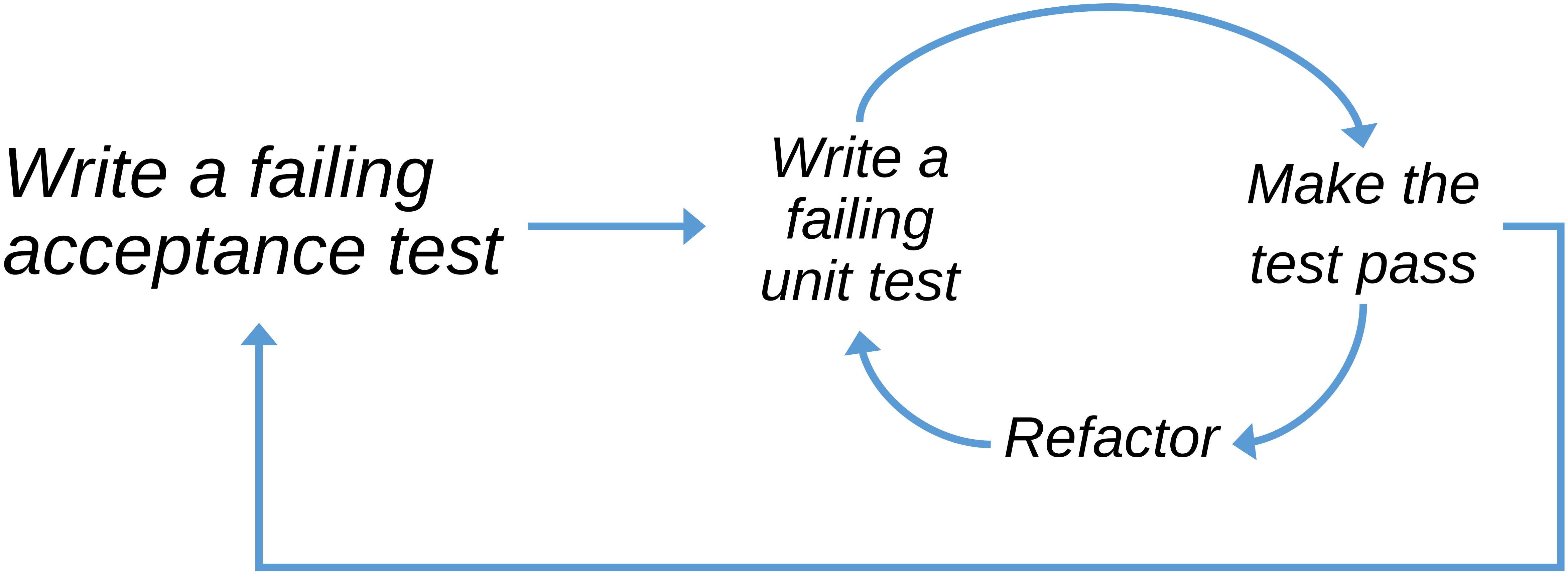

Composite simpler than the sum of its parts

The GetBalance() implementation belongs to the TransactionCollection class.

Inner and outer feedback loops in TDD



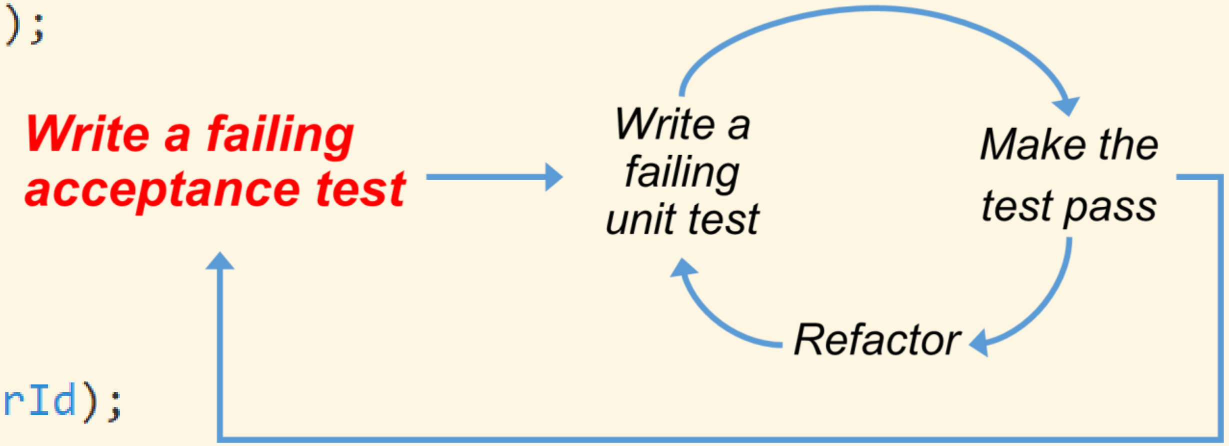
Write a failing acceptance test

Write a failing unit test

Make the test pass

Refactor

```
[Fact]
public void Deposit_Should_Change_Balance_When_Account_Is_New()
{
    //
    // Arrange
    Guid expectedCustomerId = Guid.Parse("ac608347-74ac-4607-abc2-7b95cdc8a122");
    Amount expectedAmount = new Amount(400m);

    //
    // Act
    Account sut = new Account(expectedCustomerId);
    sut.Deposit(expectedAmount);
    Amount balance = sut.GetCurrentBalance();

    //
    // Assert
    Assert.Equal(expectedCustomerId, sut.CustomerId);
    Assert.Equal(expectedAmount, balance);
    Assert.Single(sut.Transactions.ToReadOnlyCollection());
}
```



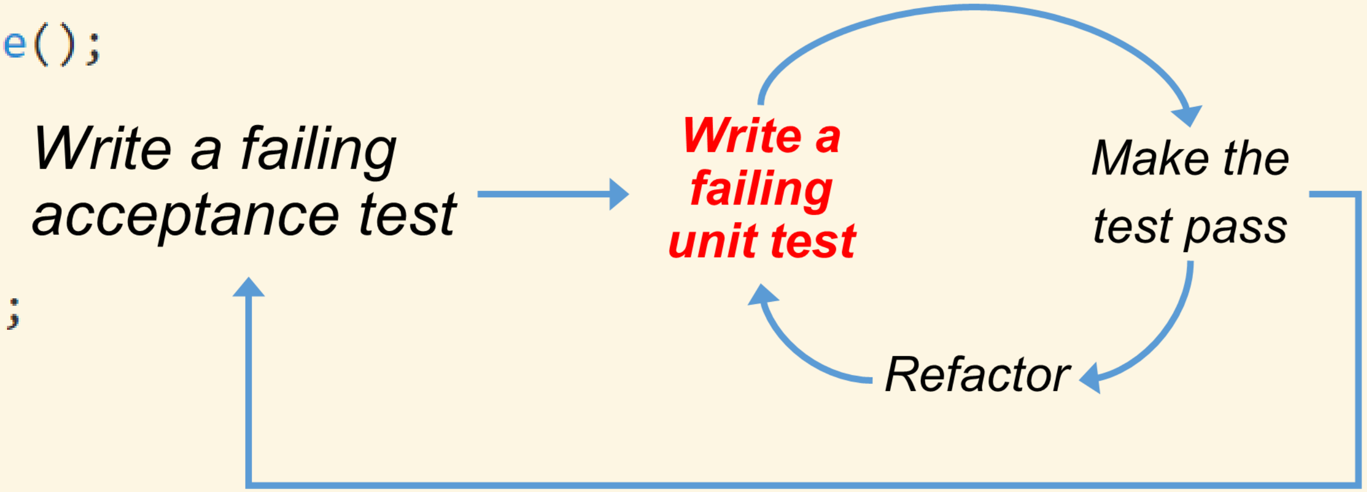
Write a failing acceptance test

Write a failing unit test

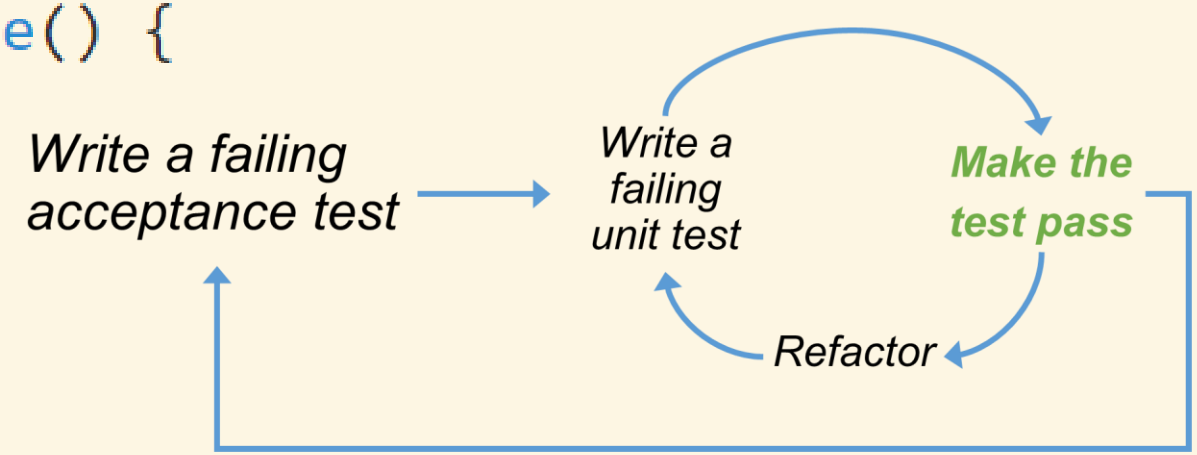
Make the test pass

Refactor

```
[Fact]
public void Deposit_Should_Change_Balance_Equivalent_Amount()
{
    //
    // Arrange
    Guid expectedCustomerId = Guid.Parse("ac608347-74ac-4607-abc2-7b95cdc8a122");
    Amount expectedAmount = new Amount(400m);

    //
    // Act
    Account sut = new Account(expectedCustomerId);
    sut.Deposit(expectedAmount);
    Amount balance = sut.GetCurrentBalance();

    //
    // Assert
    Assert.Equal(expectedAmount, balance);
}
```



```
public sealed class Account : IEntity, IAggregateRoot
{
    public Account(Guid customerId) {  }

    private Amount balance;

    public void Deposit(Amount amount) {
        balance = amount;
    }

    public Amount GetCurrentBalance() {
        return balance;
    }
}
```



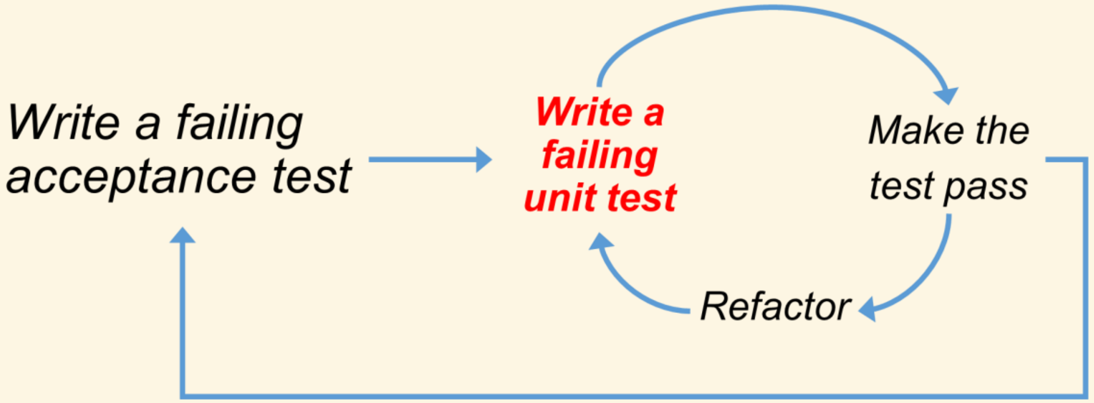
Write a failing acceptance test

Write a failing unit test

Make the test pass

Refactor

```
[Fact]
public void Deposit_Should_Add_Single_Transaction()
{
    //
    // Arrange
    Guid expectedCustomerId = Guid.Parse("ac608347-74ac-4607-abc2-7b95cdc8a122");
    Amount expectedAmount = new Amount(400m);

    //
    // Act
    Account sut = new Account(expectedCustomerId);
    sut.Deposit(expectedAmount);

    //
    // Assert
    Assert.Single(sut.Transactions.ToReadOnlyCollection());
}
```



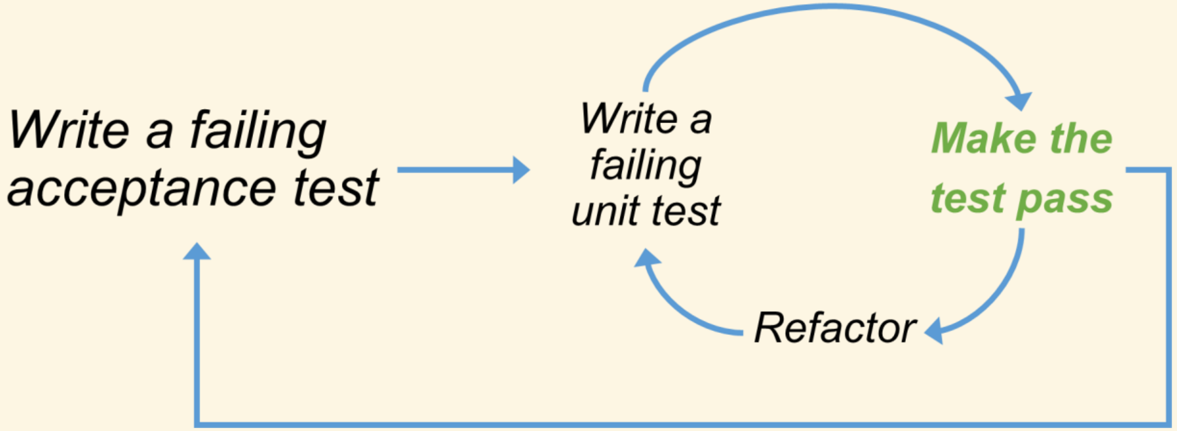
Write a failing acceptance test

Write a failing unit test

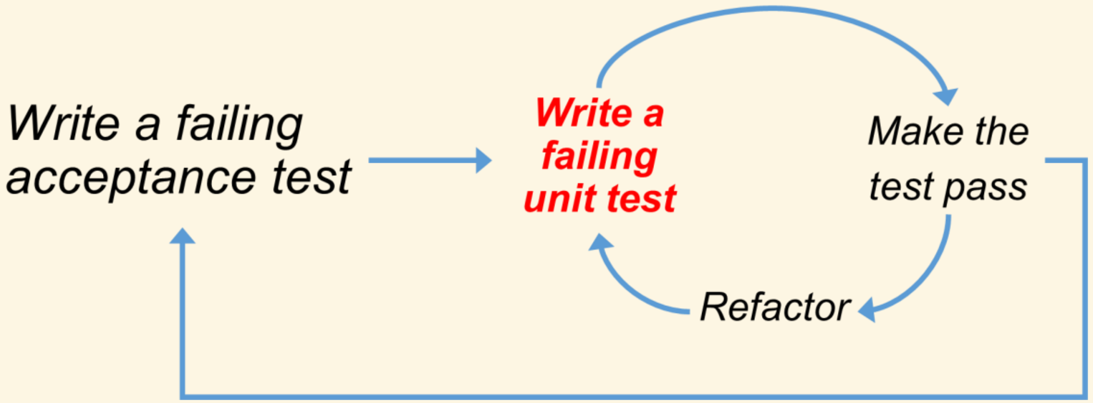
Make the test pass

Refactor

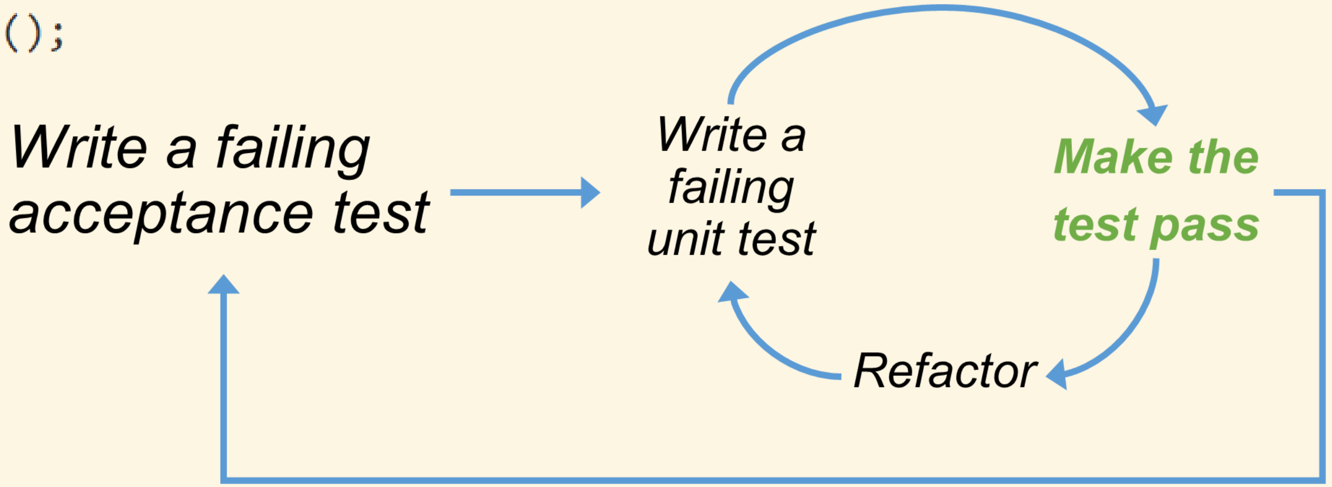
```
public sealed class Account : IEntity, IAggregateRoot
{
    public Account(Guid customerId) {  }

    public void Deposit(Amount amount) {
        Credit credit = new Credit(Id, amount);
        Transactions.Add(credit);
    }

    public Amount GetCurrentBalance() {
        Amount balance = Transactions.GetBalance();
        return balance;
    }
}
```



```
[Fact]
public void NewAccount_Should_Return_The_Correct_CustomerId()
{
    //
    // Arrange
    Guid expectedCustomerId = Guid.Parse("ac608347-74ac-4607-abc2-7b95cdc8a122");
    Amount expectedAmount = new Amount(400m);

    //
    // Act
    Account sut = new Account(expectedCustomerId);

    //
    // Assert
    Assert.Equal(expectedCustomerId, sut.CustomerId);
}
```



```csharp
public sealed class Account : IEntity, IAggregateRoot
{
    public Guid Id { get; private set; }
    public Guid CustomerId { get; private set; }
    public TransactionCollection Transactions { get; private set; }

    public Account(Guid customerId) {
        Id = Guid.NewGuid();
        CustomerId = customerId;
        Transactions = new TransactionCollection();
    }

    public void Deposit(Amount amount) {
        Credit credit = new Credit(Id, amount);
        Transactions.Add(credit);
    }

    public Amount GetCurrentBalance() {
        Amount balance = Transactions.GetBalance();
        return balance;
    }
}
```



Write a failing acceptance test

Write a failing unit test

Make the test pass

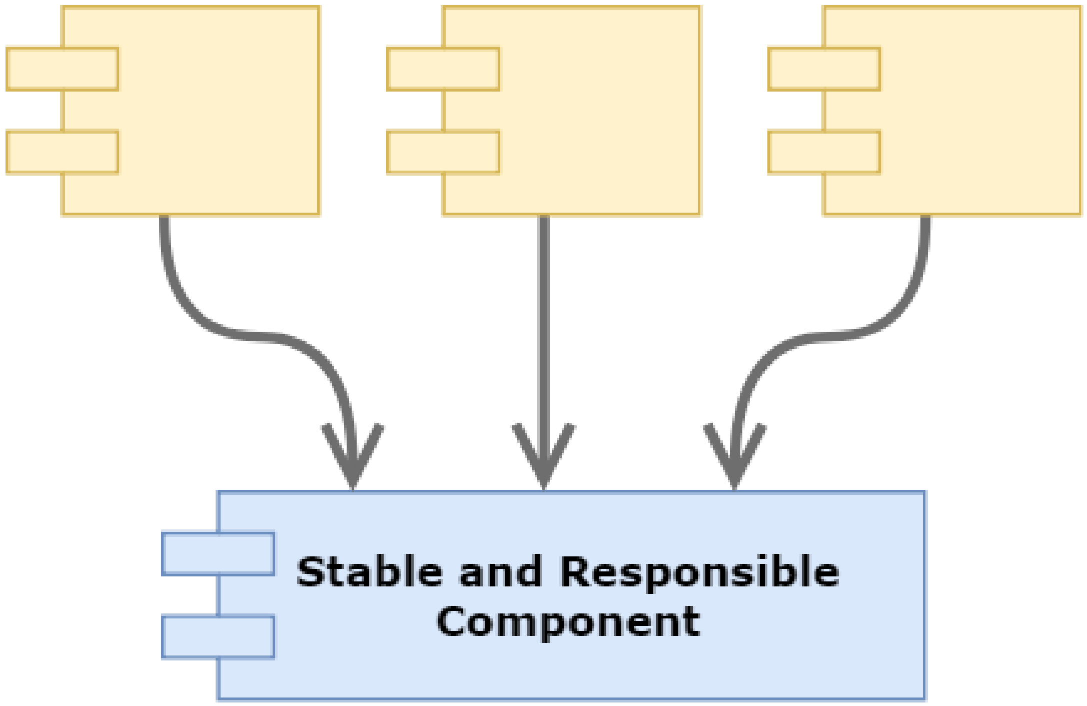
Refactor

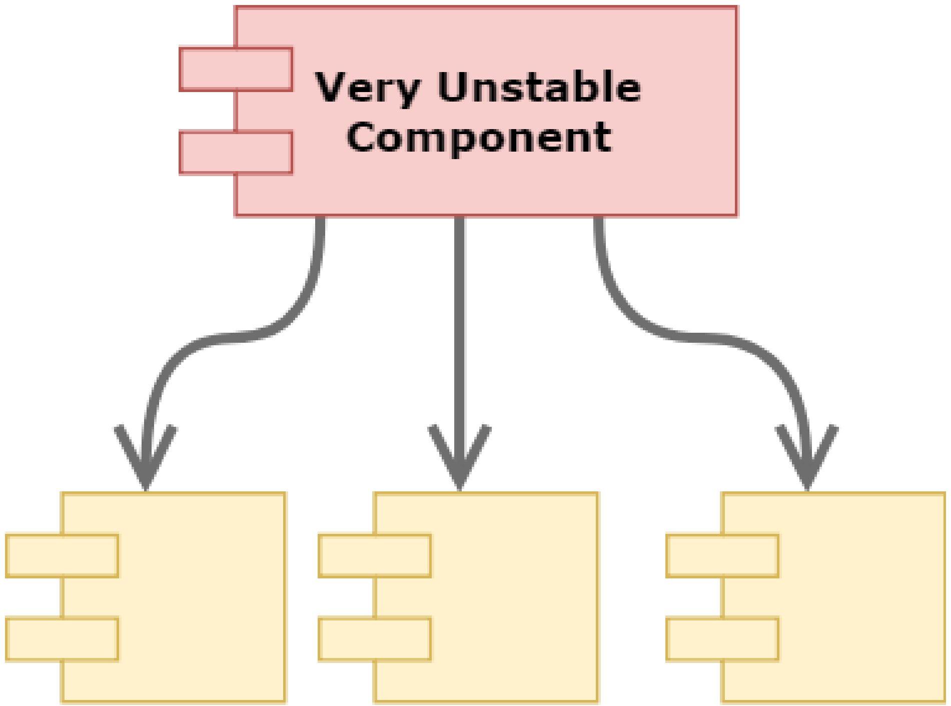
Opinionated DDD/TDD

- Sometimes I implement too much of the Domain Model. Then return covering it with unit tests.
  - By knowing the DDD patterns I underestimate the TDD value then I'm slapped in the face.
- My goal is to maintain a high test coverage on the Domain Model.
- If testing is hard. It is an architectural issue!

I won’t reverse engineer my data model to create a domain model.

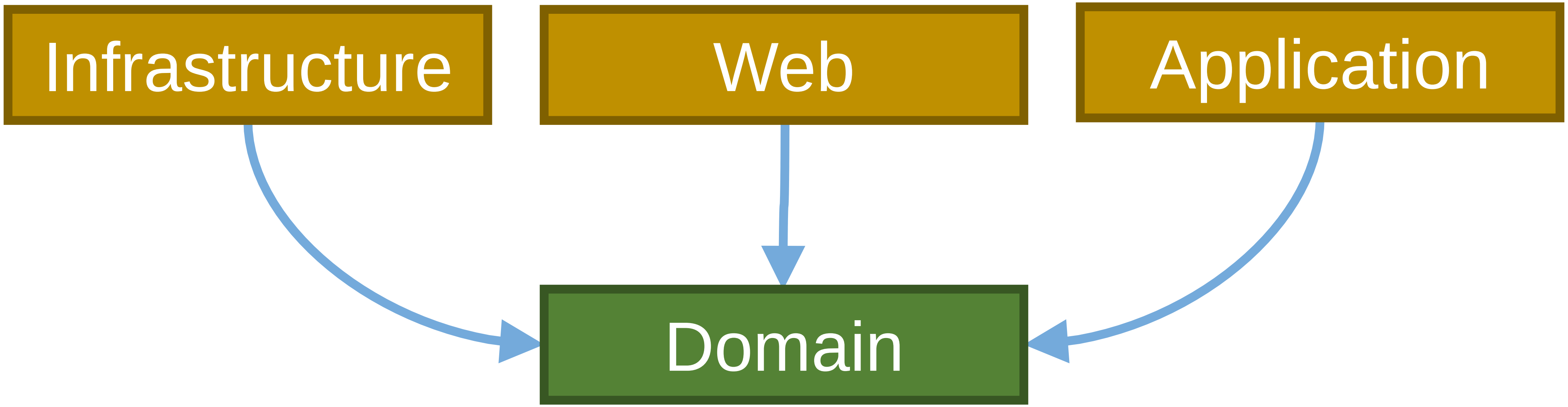
The Stable Dependencies Principle[1]



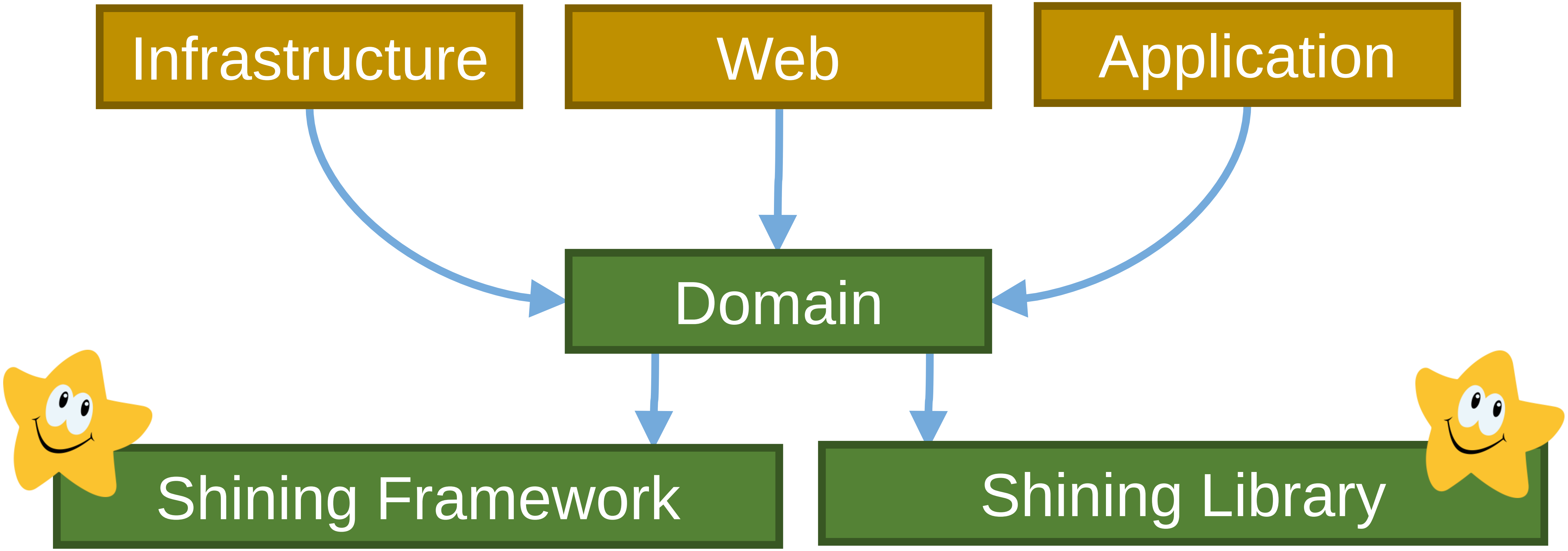


[1] Clean Architecture, Robert C. Martin, 2017

The Stable Dependencies Principle



The Stable Dependencies Principle



Infrastructure

Web

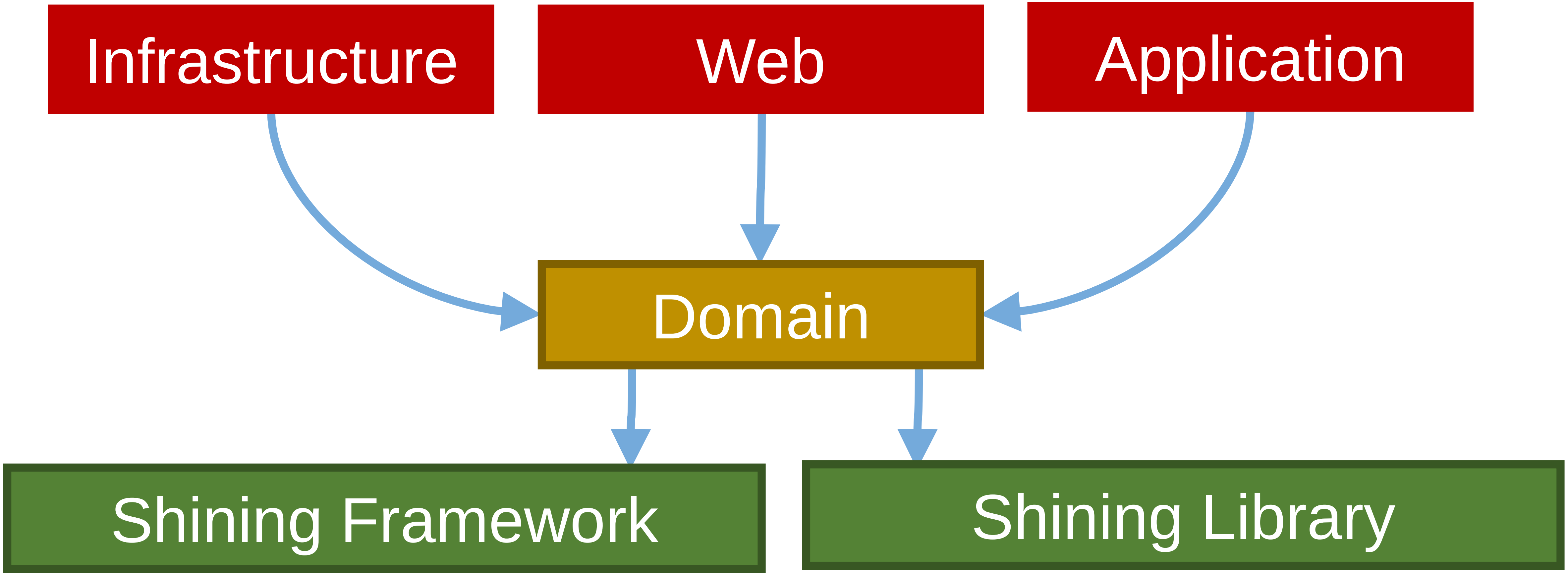
Application

Domain

Shining Framework

Shining Library

The Stable Dependencies Principle



Infrastructure

Web

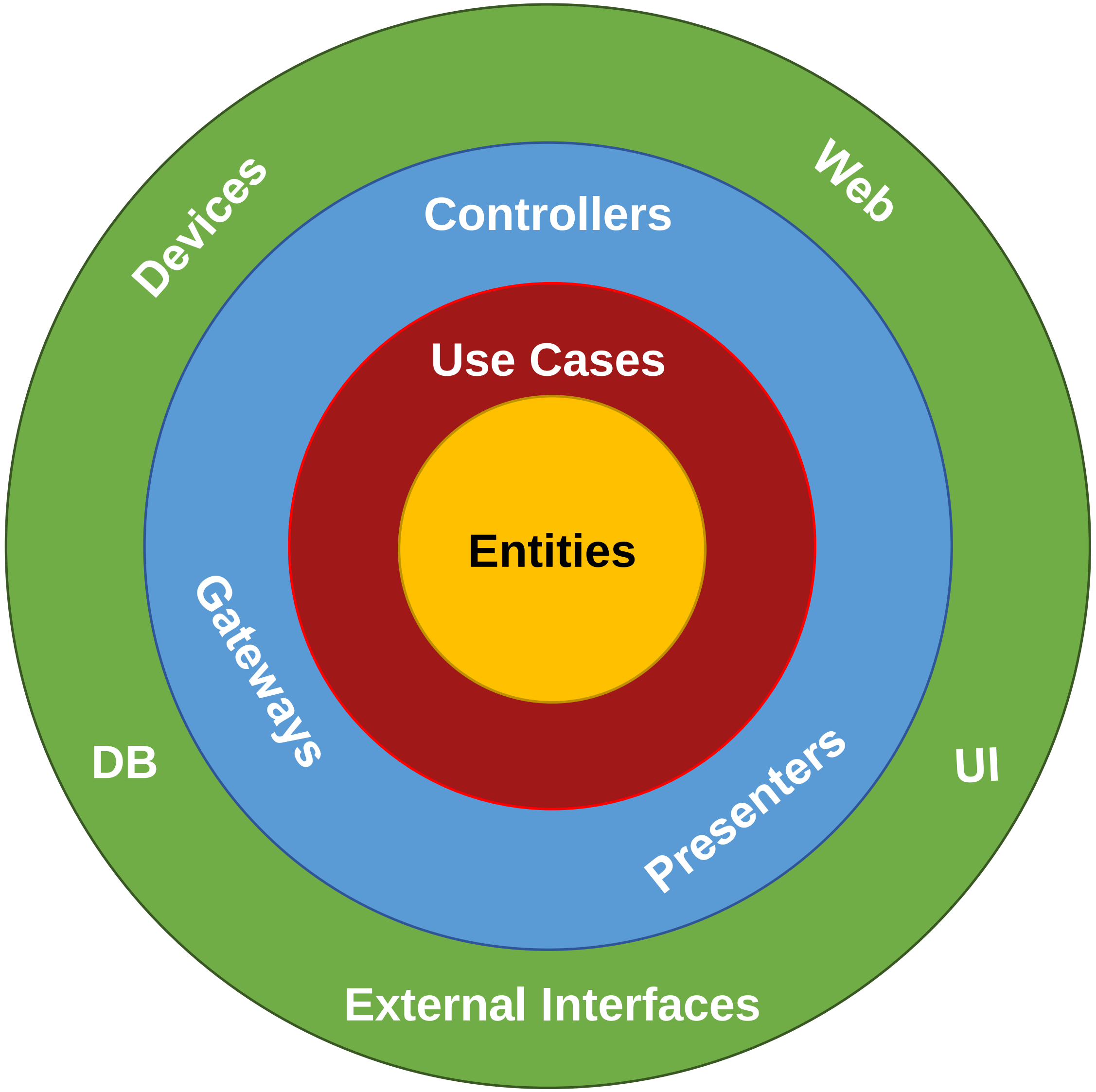
Application

Domain

Shining Framework

Shining Library

Isolate the Domain with a Layered Architecture



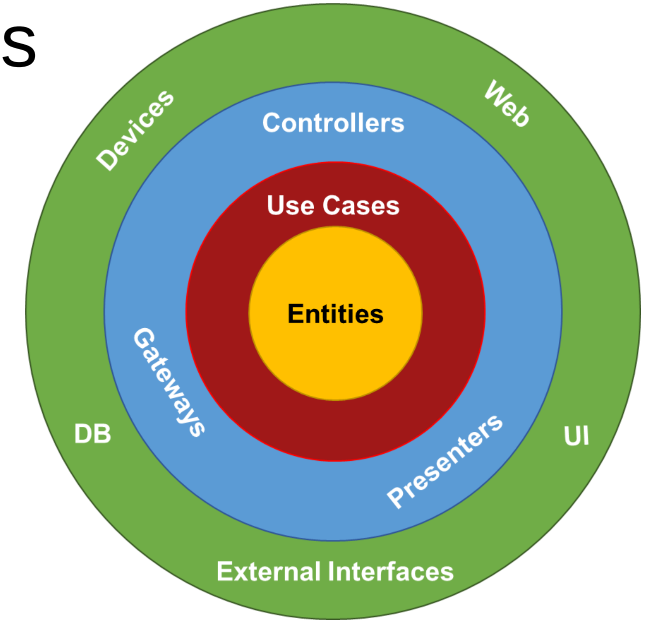
Testing Strategies

Outside In

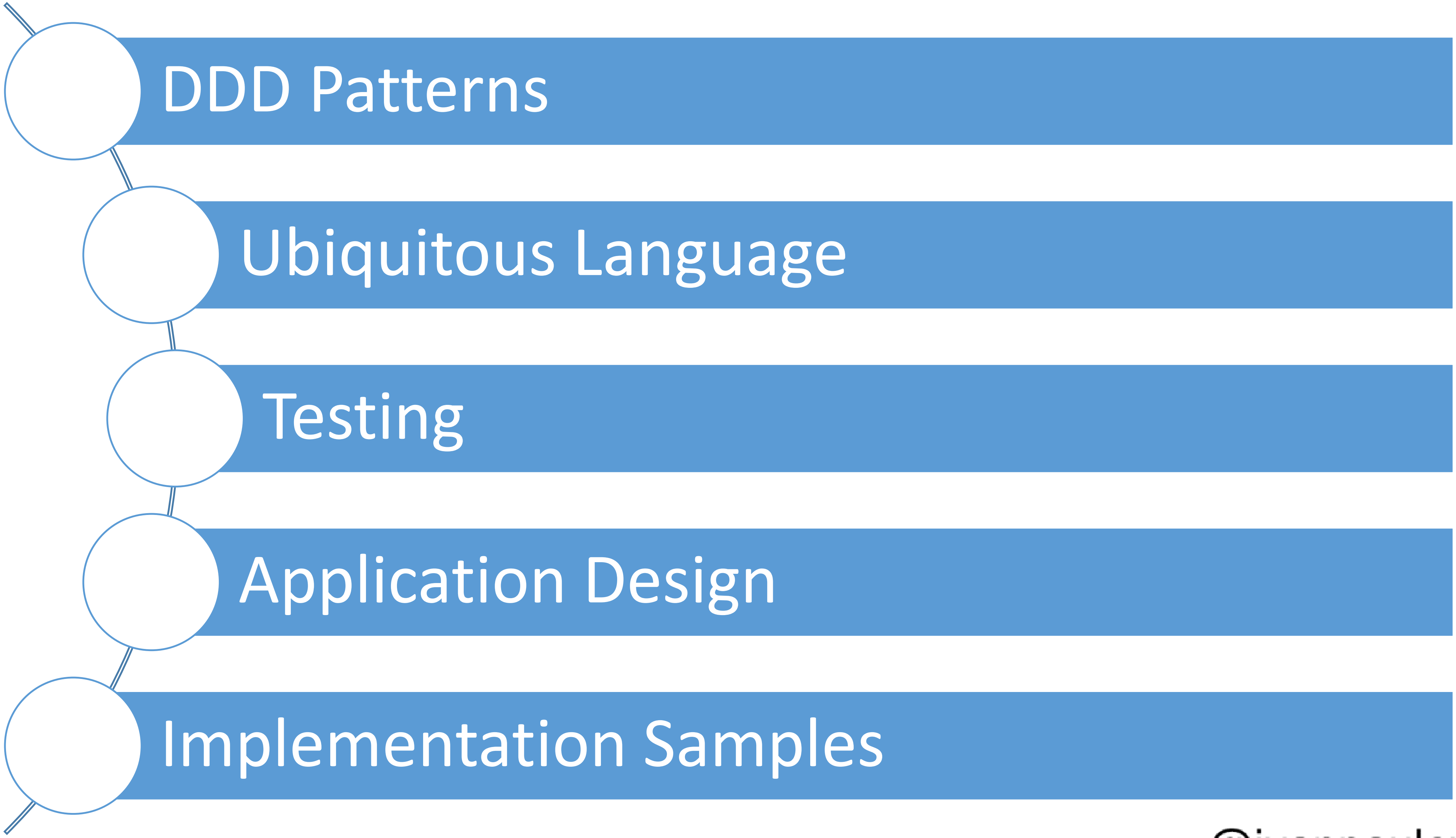
Controllers > Use Cases > Aggregates > Value Objects

Inside Out

1. Aggregates > Value Objects
2. Use Cases
3. Controllers

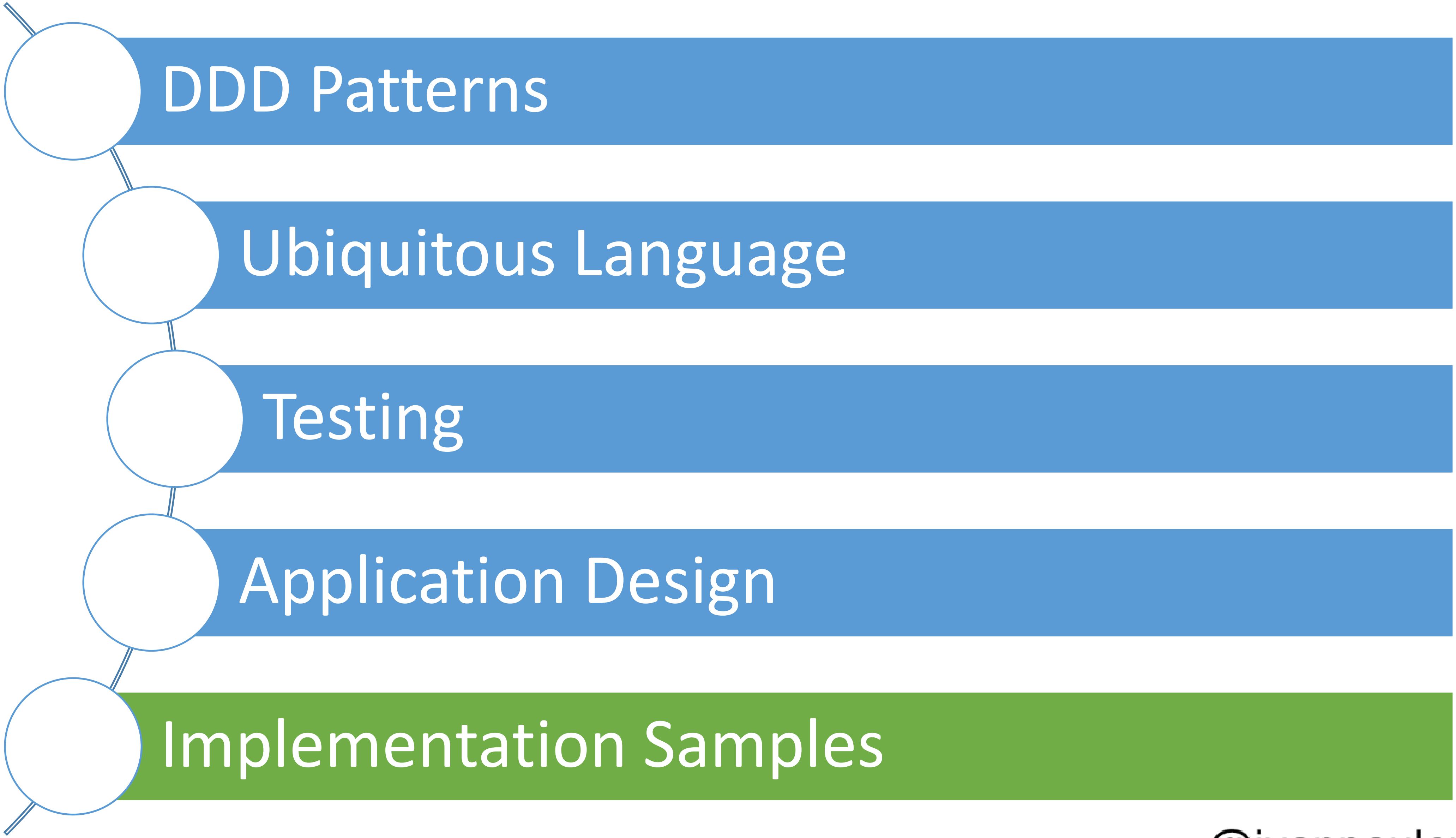


Quick Review



- DDD Patterns
- Ubiquitous Language
- Testing
- Application Design
- Implementation Samples

Quick Review



- DDD Patterns
- Ubiquitous Language
- Testing
- Application Design
- Implementation Samples

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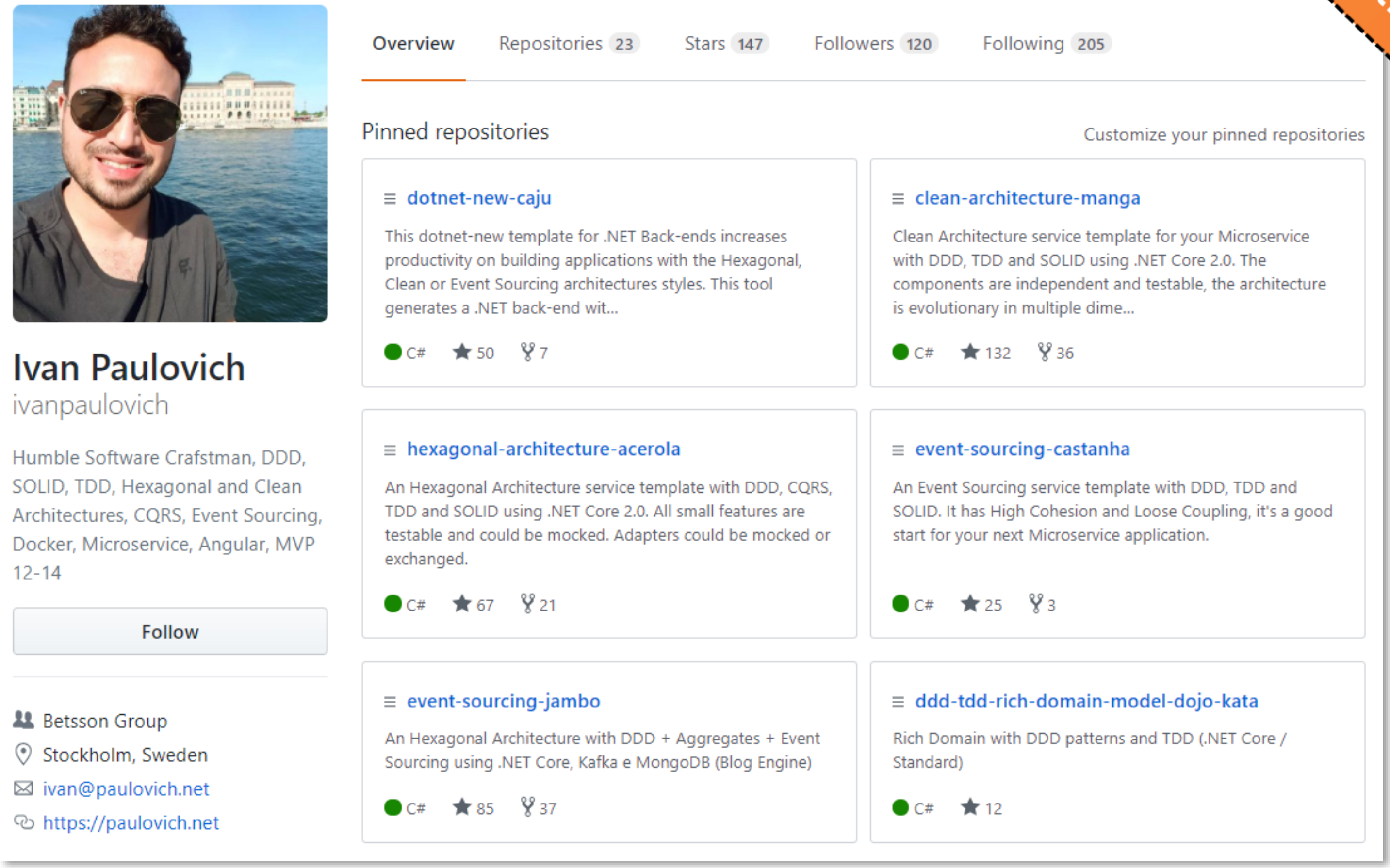
Implementation Samples

- Clean Architecture
- Hexagonal Architecture
- Event Sourcing
- DDD
- TDD
- Microservices



Ivan Paulovich
ivanpaulovich

Humble Software Crafstman, DDD, SOLID, TDD, Hexagonal and Clean Architectures, CQRS, Event Sourcing, Docker, Microservice, Angular, MVP 12-14

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An Event Sourcing service template with DDD, TDD and SOLID. It has High Cohesion and Loose Coupling, it's a good start for your next Microservice application.
● C# ★ 25 3

≡ event-sourcing-jambo
An Hexagonal Architecture with DDD + Aggregates + Event Sourcing using .NET Core, Kafka e MongoDB (Blog Engine)
● C# ★ 85 37

≡ ddd-tdd-rich-domain-model-dojo-kata
Rich Domain with DDD patterns and TDD (.NET Core / Standard)
● C# ★ 12

@ivanpaulovich

Resources

- Domain-driven Design, Eric J. Evans, 2003
- The ThoughtWorks Anthology: Essays on Software Technology and Innovation (Pragmatic Programmers), 2008
- Clean Architecture, Robert C. Martin, 2017
- Growing Object-Oriented Software, Guided by Tests, 1st Edition, 2009
- Secure by Design, Dan Bergh Johnsson, Daniel Deogun, Daniel Sawano, 2018
- Domain-Driven Design Quickly, 2007
- Effective Aggregate Design, Vaughn Vernon, 2011