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IMPACT ON SOCIETY

Dennis Spangenberg

Immutable objects in C#

Dennis Spangenberg

- 11 years professional C# .net experience
- Topicus.finance Mortgages
- Stay up-to-date
- Use technique / syntax which im not familair with
- .net Gilde

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Contents

- What is an immutable object?
- Why do I need immutable objects?
- Immutable objects and records
- Practical fun with immutable objects

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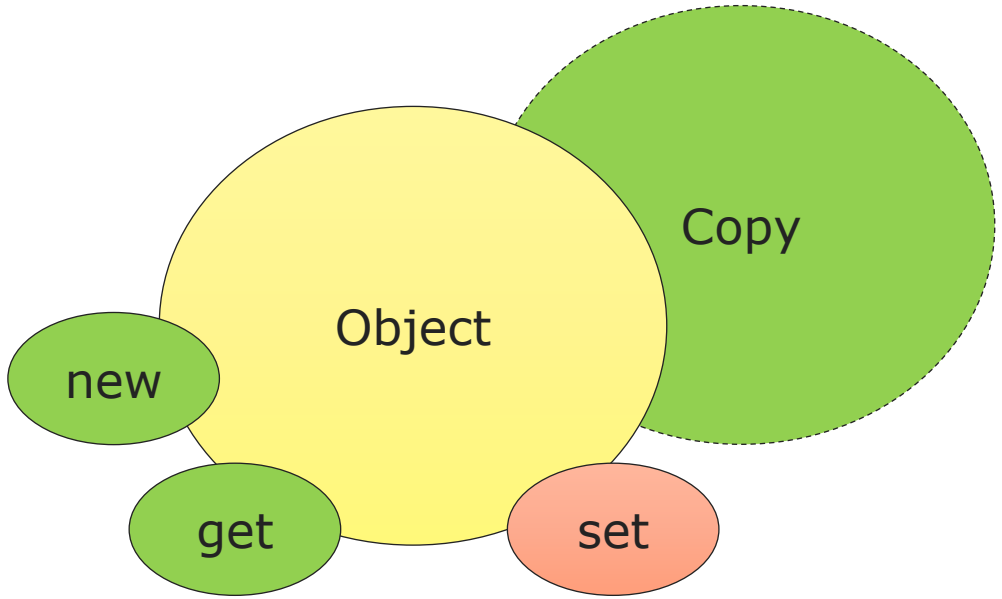
What is an immutable object?

What is an immutable object?

An immutable object (or unchangeable object) is an object whose state cannot be modified after it is created



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C# example of an immutable object

- C# .net version independent example
- Property only can be set on creation

```
public class ImmutableObject
{
    public readonly string Property;

    5 references
    public ImmutableObject(string property)
    {
        Property = property;
    }
}
```


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Immutable is read-only

- The compiler will give errors
- It will be less likely to make mistakes

```
var immutableObject = new ImmutableObject( property: "Something");
immutableObject.Property = "Something else";
```


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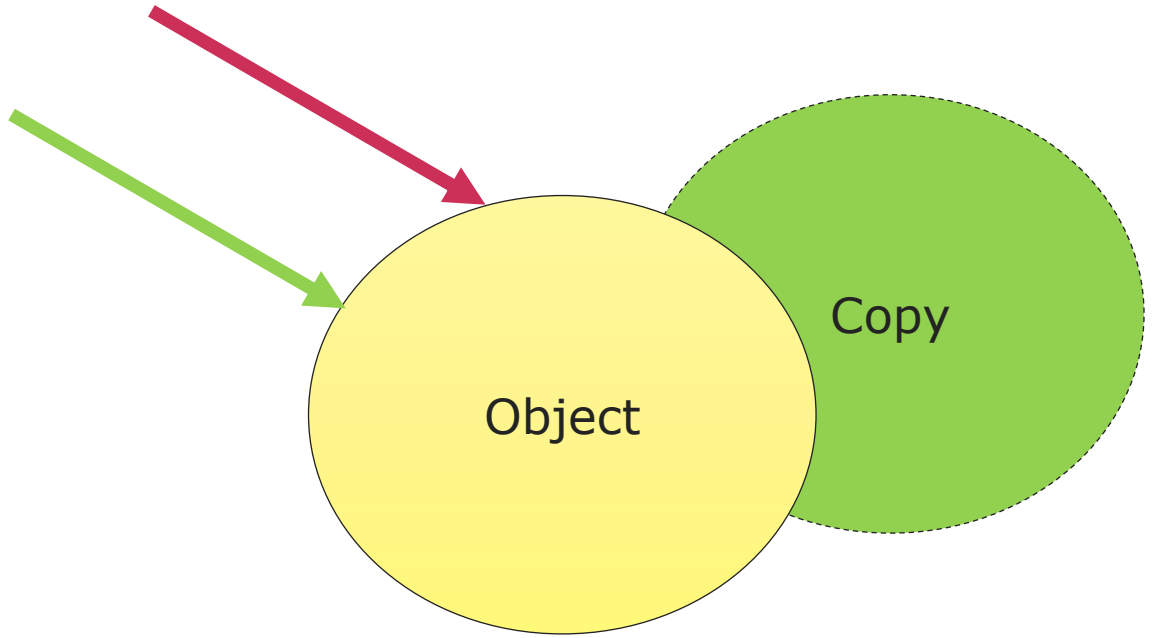
Other advantages

- You only can copy or reference an immutable object
- Thread safe



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Weak vs strong immutability

- Weak: Some properties are still mutable

```
public class WeakImmutableObject
{
    public readonly string Property;

    2 references
    public string Mutable { get; set; }

    5 references
    public WeakImmutableObject(string property, string mutable)
    {
        Mutable = mutable;
        Property = property;
    }
}
```

```
var immutableObject = new WeakImmutableObject( property: "Something",  mutable: "Mutable");
immutableObject.Mutable = "Changed";
immutableObject.Property = "Something else";
```


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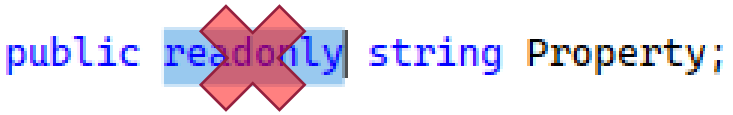
Why do I need immutable objects?

Easy to work with

- Personal experience
- Easy to understand
- Easy to test
- Easy to break…

Common development mistakes

- Making immutable object weak or mutable
- Copying objects instead of referencing



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Make test to determine if immutable objects stay immutable

```
public class ImmutableTestObject
{
    public readonly string Property;

    //programming error: this should be readonly
    4 references | 0 changes | 0 authors, 0 changes
    public string Immutable { get; private set; }

    2 references | 0 changes | 0 authors, 0 changes
    public ImmutableTestObject(string property, string immutable)
    {
        Property = property;
        Immutable = immutable;
    }

    1 reference | 0 changes | 0 authors, 0 changes
    public ImmutableTestObject SetMutable(string immutable)
    {
        //programming error
        Immutable = immutable;

        return new ImmutableTestObject(Property, immutable);
    }
}
```

```
public void ImmutableChanged()
{
    var immutable1 = new ImmutableTestObject(property: "Test" , immutable: "Me");
    var immutable2 = immutable1.SetMutable("This");

    Assert.That(immutable1.Immutable, Is.Not.EqualTo(immutable2.Immutable));
}
```


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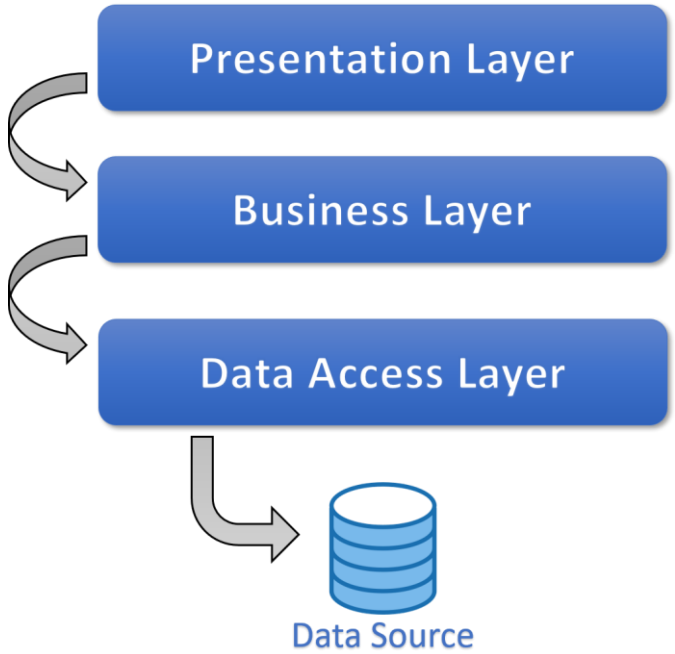
Apply to software architecture

- Multitier architecture
- Use immutable object for input and output
- Don’t use immutable object for (database) entities



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Immutable objects and records

Boilerplate code

- **boilerplate code**, or simply **boilerplate**, are sections of code that are repeated in multiple places with little to no variation.

```
public class ImmutableObject
{
    public readonly string Property;

    5 references
    public ImmutableObject(string property)
    {
        Property = property;
    }
}
```


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Immutable objects in C# 9

- Since C# 9 we have records
- .net 5 and up supported
- Records reduce boilerplate code for immutable object

```
public record ImmutableRecord(string Property);
```

Side by side

```
public class ImmutableObject
{
    public readonly string Property;

    5 references
    public ImmutableObject(string property)
    {
        Property = property;
    }
}
```

```
public record ImmutableRecord(string Property);
```

```
var immutableObject = new ImmutableObject(property: "Something");
immutableObject.Property = "Something else";

var immutableRecord = new ImmutableRecord(Property: "Something");
immutableRecord.Property = "Something else";
```


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Weather Forecast example

```
public class WeatherForecast
{
    1 reference
    public DateTime Date { get; set; }

    2 references
    public int TemperatureC { get; set; }

    0 references
    public int TemperatureF => 32 + (int)(TemperatureC / 0.5556);

    1 reference
    public string? Summary { get; set; }
}
```

```
public record WeatherForcastRecord(DateTime Date, int TemperatureC, string? Summary)
{
    0 references
    public int TemperatureF => 32 + (int)(TemperatureC / 0.5556);
}
```


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Less risk on progamming errors with records

- Records take effort to make mutable

```
public record ImmutableRecord(string Property);
```

```
public record MutableRecord(string Property)
{
    public string Property = Property;
}
```

```
var mutableRecord = new MutableRecord( Property: "Something");
mutableRecord.Property = "Something else";
```


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Weak immutable record

```
var weakImmutableRecord = new WeakImmutableRecord("Jane", "Doe");
weakImmutableRecord.First = "John";
weakImmutableRecord.Last = "Deer";
```

```
public record WeakImmutableRecord(string First, string Last)
{
    1 reference
    public string Last { get; set; } = Last;
}
```


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Fun with records

Value equality (1/3)

- Records are comparible by default
- On properties the values are compared

```
[Test]
0 references | pangspang, 2 hours ago | 1 author, 1 change
public void RecordEquality()
{
    var immutable1 = new ImmutableRecord( Property: "Test");
    var immutable2 = new ImmutableRecord( Property: "Test");

    Assert.That(immutable1, Is.EqualTo(immutable2));
}
```

```
[Test]
0 references | pangspang, 2 hours ago | 1 author, 1 change
public void RecordReference()
{
    var immutable1 = new ImmutableRecord( Property: "Test");
    var immutable2 = new ImmutableRecord( Property: "Test");

    Assert.That(immutable1, Is.Not.SameAs(immutable2));
}
```

Value equality (2/3)

✓ RecordEquality

```
public void RecordEquality()
{
    var immutable1 = new ImmutableRecord( Property: "Test");
    var immutable2 = new ImmutableRecord( Property: "Test");

    Assert.That(immutable1, Is.EqualTo(immutable2));
}
```

⛔ ObjectEquality

```
public void ObjectEquality()
{
    var immutable1 = new ImmutableObject( property: "Test");
    var immutable2 = new ImmutableObject( property: "Test");

    Assert.That(immutable1, Is.EqualTo(immutable2));
}
```


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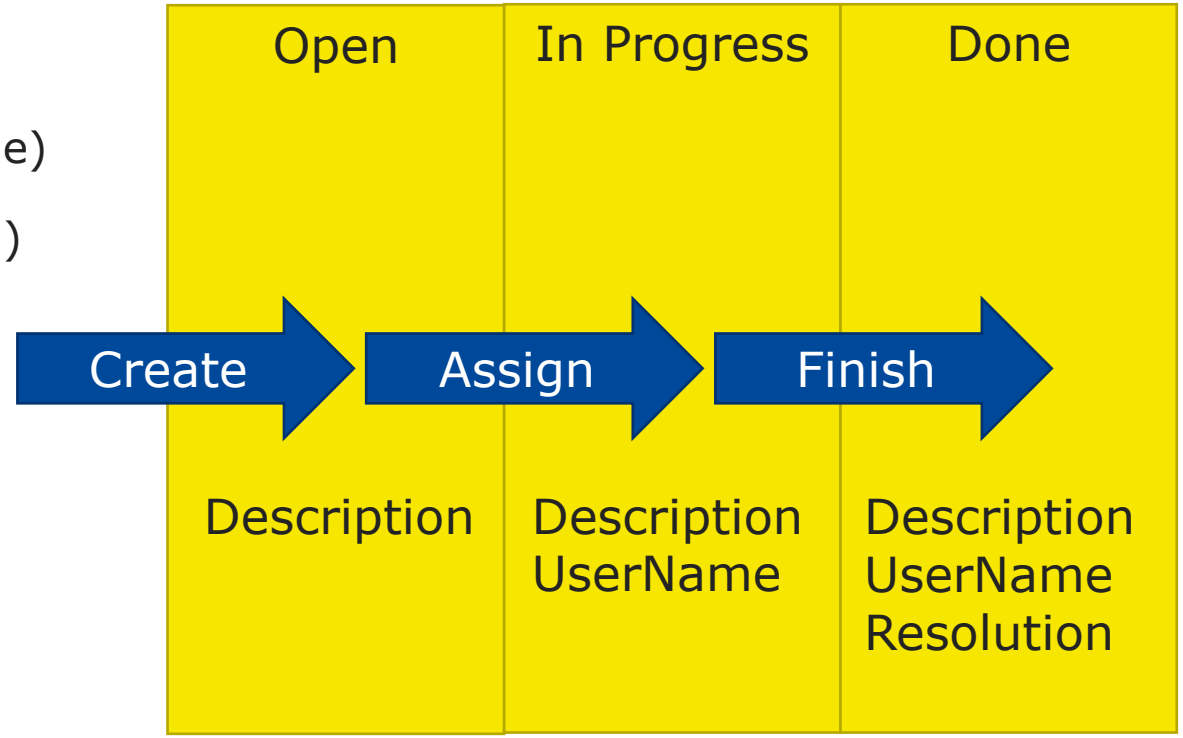
Value equality (3/3)

- Override Equals
- Override Hashcode
- Override '=='
- Implementation changes when adding more properties

```
public class ValueEqualityImmutableObject
{
    public readonly string Property;
    public readonly string OtherProperty;

    2 references | 0 changes | 0 authors, 0 changes
    public ValueEqualityImmutableObject(string property, string otherProperty)
    {
        Property = property;
        OtherProperty = otherProperty;
    }

    0 references | 0 changes | 0 authors, 0 changes
    public override bool Equals(object? obj)
    {
        if (obj == null && obj is not ValueEqualityImmutableObject)
            return false;

        var other = obj as ValueEqualityImmutableObject;

        return Property == other.Property && OtherProperty == other.OtherProperty;
    }

    0 references | 0 changes | 0 authors, 0 changes
    public override int GetHashCode()
    {
        return HashCode.Combine(Property, OtherProperty);
    }
}
```

Using records as statemachine with events

- Kanban board
  - with 3 lanes (Open, In Progress, Done)
  - with 3 actions (Create, Assign, Finish)
- Tickets can be in a lane
  - The lane defines which properties need to be there
- Actions can be applied on tickets



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Ticket

- Ticket is abstract
- Ticket is inherited
- Ticket implementation have specific properties

```
public abstract record Ticket
{
    2 references | - changes | -authors, -changes
    public record Empty : Ticket;

    4 references | - changes | -authors, -changes
    public record Open(
        string Description
        ) : Ticket;

    7 references | - changes | -authors, -changes
    public record InProgress(
        string Description,
        string UserName
        ) : Ticket;

    2 references | - changes | -authors, -changes
    public record Done(
        string Description,
        string UserName,
        string Resolution
        ) : Ticket;
}
```

Ticketevent

- Events only contain the property needed
- The type of the event gives context

```
public abstract record TicketEvent
{
    2 references | - changes | -authors, -changes
    public record Create(
        string Description
        ) : TicketEvent;

    4 references | - changes | -authors, -changes
    public record Assign(
        string UserName
        ) : TicketEvent;

    2 references | - changes | -authors, -changes
    public record Finish(
        string Resolution
        ) : TicketEvent;
}
```

Move tickets with events

- Switch with pattern matching (C# 9)
- New ticket if state changes
  - destructor is called
  - new record is initialized

```
public Ticket Move(Ticket state, TicketEvent @event) =>
    @event switch
    {
        TicketEvent.Create(var description:string)
            => state is Ticket.Empty
                ? new Ticket.Open(description)
                : state,
        TicketEvent.Assign assign
            => Assign(state, assign),
        TicketEvent.Finish(var resolution:string)
```

Assign

- 2 actions
  - newly in progress
  - reassign to other user
- Reassign works with “with”

  Copy of original, only changes the property

```
public Ticket Assign(Ticket state, TicketEvent.Assign assignEvent) =>
    state switch
    {
        Ticket.Open(var description :string) =>
            new Ticket.InProgress(description, assignEvent.UserName),
        Ticket.InProgress inProgress =>
            inProgress with { UserName = assignEvent.UserName },
```

The end

- Wrap up:
  - What are immutable objects
  - How can I use them in my .net projects
  - With some cool examples ☺
- Code examples: https://github.com/pangspang/ImmutableObjectInCSharp
- Join the #net-gilde (slack)
- I’m Dennis Spangenberg, any questions?

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