Module 26:
"Null Object"
(with Unit Testing)

Agenda

- Introductory Example: Animal Sounds
- Challenges
- Pattern: Null Object
- Implementing the Null Object Pattern
- Overview of Null Object
- Background: Unit Testing
- Null Object in Unit Testing

Introductory Example: Animals Sounds

```
class AnimalFactory : IAnimalFactory
{
    public IAnimal Create( string description )
    {
        ...

        if (_animalTypes.TryGetValue(processedDescription,
             out Type animalType))
        {
            return Activator.CreateInstance(animalType) as IAnimal;
        }
        return null;
    }
    ...
}
```

```
interface IAnimal
{
    string Name { get; }
    void MakeSound();
}
```

Challenges

- C# has specialized syntax for null-checks, but could we relieve the client of that burden?
- What if a component needs an object to compile and run, but during unit tests that object should be "inactive"?

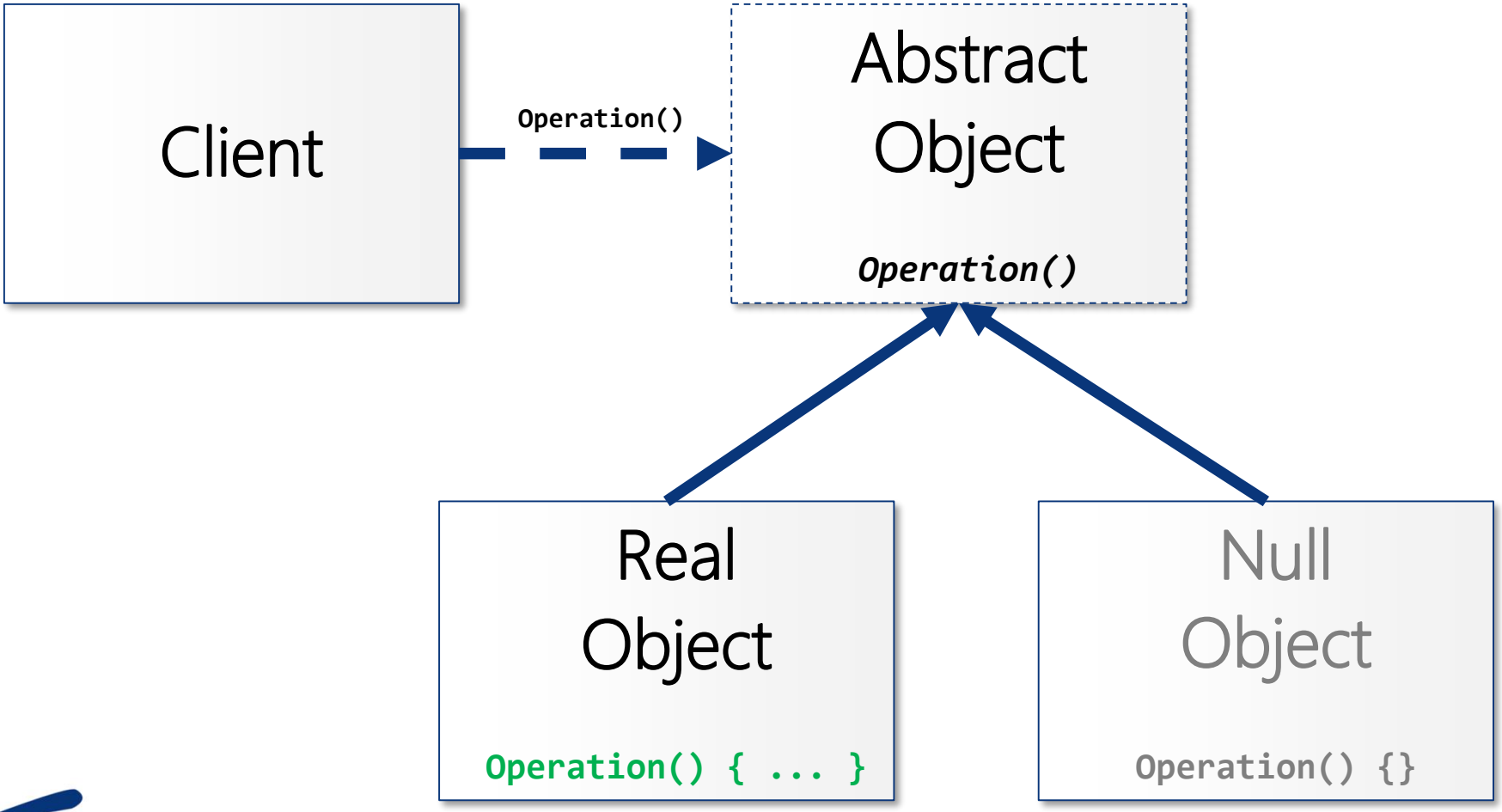
Pattern: Null Object

- *Provide an object as a surrogate for the lack of an object of a given type. The Null Object provides intelligent "do-nothing" behavior, hiding the details from its collaborators.*

- Outline
  - Abstract the handling of null references away from the client
  - Create an object with do-nothing behavior in a well-defined interface expected by the client

- Origin: Bobby Woolf (1998)

Overview of Null Object Pattern



Overview of Null Object Pattern

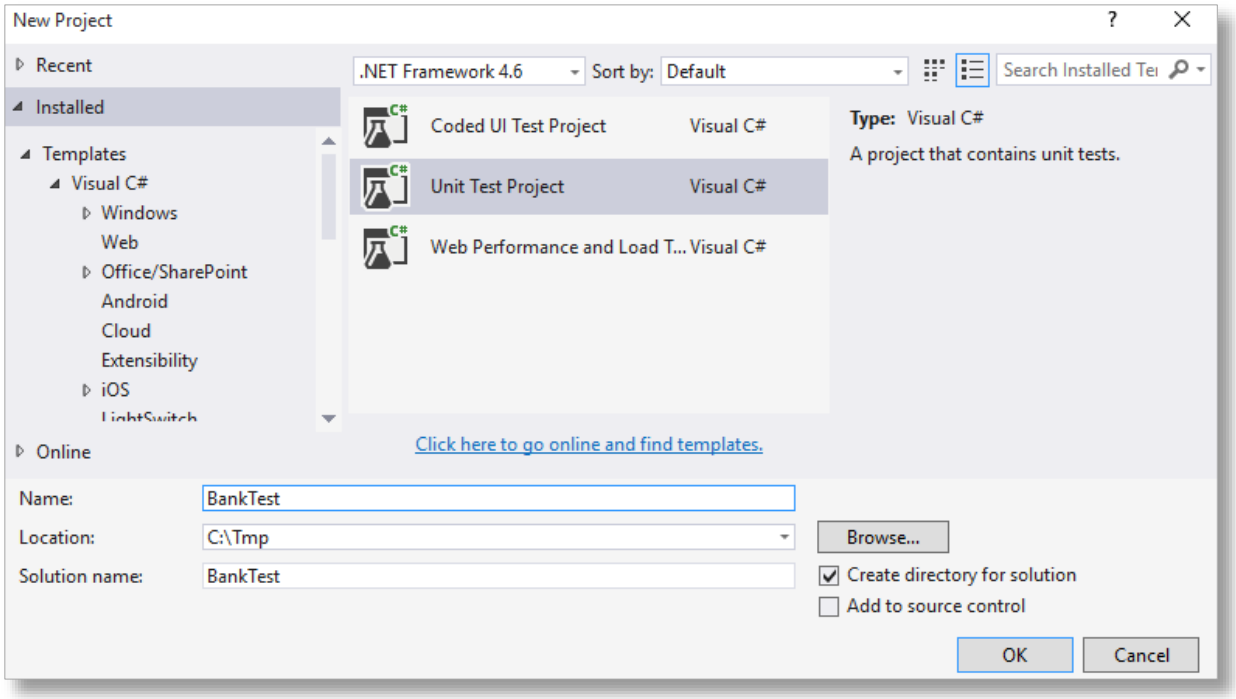
- Client
  - Needs a collaborator exposing `Operation()`
- Abstract Object
  - Interface or abstract class specifying the abstract `Operation()`
- Real Object
  - Concrete class implementing the Abstract Object interface
  - Supplied appropriate behavior in `Operation()` used by Client
- Null Object
  - Concrete class implementing the Abstract Object interface
  - Can be substituted for Real Object in the context of Client
  - Implements the `Operation()` to do nothing / neutral behavior
  - The exact neutral behavior depends on what Client expects

Background: Unit Testing

- Automatic "white-box" testing of classes
  - Developers can run tests in Visual Studio
  - Tests can run automatically when code is checked in
- Unit tests
  - Captures a code-based "specification" of functionality
  - Drives safe refactoring
  - Assists regression testing
- Unit testing frameworks for C# include
  - MSTest
  - NUnit
  - MbUnit
  - xUnit.net
  - …

Unit Testing in Visual Studio

- Visual Studio includes MSTest
  - Unit Test Project



- Create business logic project(s) "as usual"
- Create Unit Test Project with a reference to business logic project(s)
- Author test classes and methods in test project

Test Classes and Test Methods

- Test methods must be marked with the **`[TestMethod]`** attribute
  - Cannot have parameters and returns **`void`**, **`Task`**, or **`Task<T>`**

```
[TestClass]
public class BankAccountTest
{
    [TestMethod]
    public void TestDeposit()
    {
        BankAccount account = new BankAccount();
        account.Deposit(87);
        Assert.AreEqual(87, account.Balance);
    }
}
```

- Test classes must be marked with the **`[TestClass]`** attribute

Using the **`Assert`** Class and Attributes

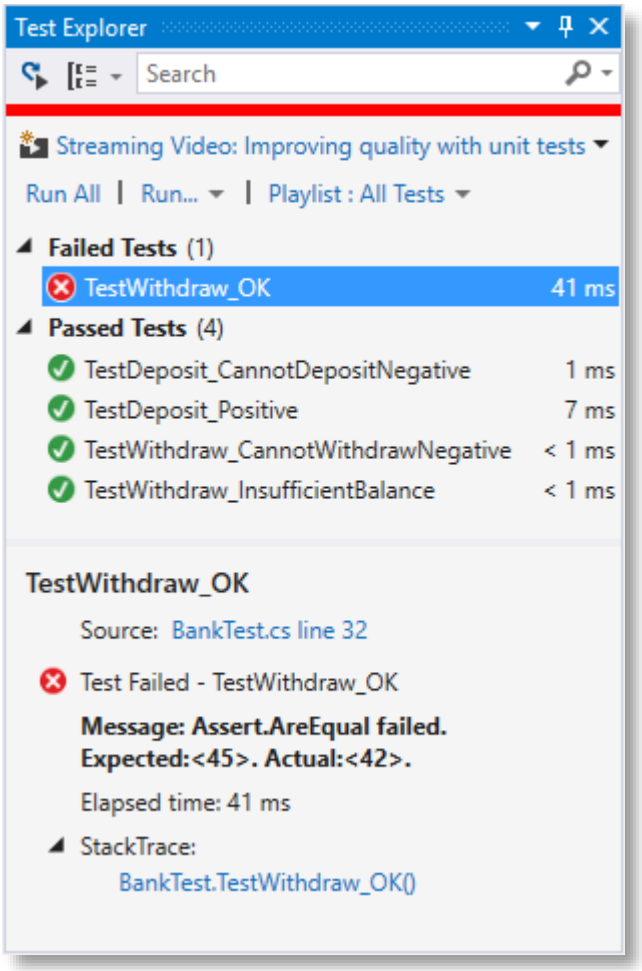
- The `Microsoft.VisualStudio.TestTools.UnitTesting` namespaces includes e.g.
  - `Assert.`
    - `AreEqual()`
    - `AreNotEqual()`
    - `Fail()` …
  - `[ExpectedException]` attribute

```
[TestMethod]
[ExpectedException(typeof(ArgumentOutOfRangeException))]
public void TestWithdraw()
{
    BankAccount account = new BankAccount();
    account.Withdraw(87);
}
```

- `[TestInitialize]` + `[TestCleanup]` attributes

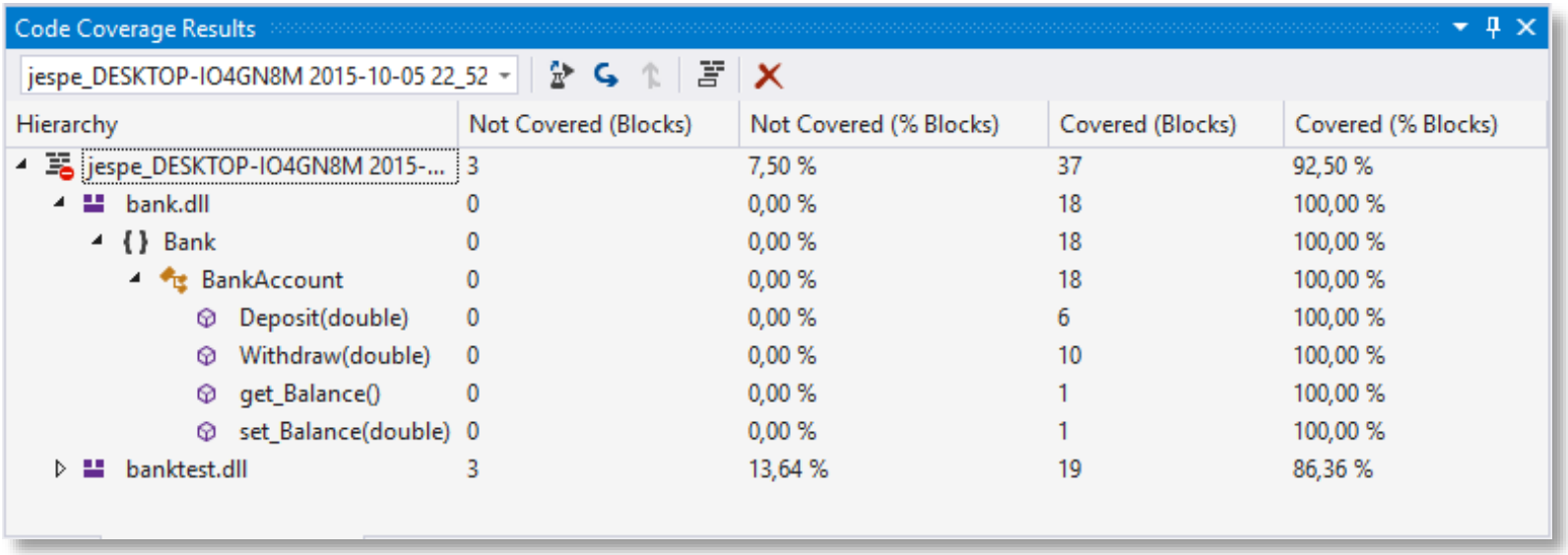
Running the Tests

- Test Explorer
  - `Test` -> `Windows` -> `Test Explorer`
- Status annotations in source code in editor



Code Coverage Analyzer

- Some versions of Visual Studio have additional testing tools
  - `Test > Analyze Code Coverage > All Tests`
  - …



Hierarchy	Not Covered (Blocks)	Not Covered (% Blocks)	Covered (Blocks)	Covered (% Blocks)
jespe_DESKTOP-IO4GN8M 2015-...	3	7,50 %	37	92,50 %
bank.dll	0	0,00 %	18	100,00 %
Bank	0	0,00 %	18	100,00 %
BankAccount	0	0,00 %	18	100,00 %
Deposit(double)	0	0,00 %	6	100,00 %
Withdraw(double)	0	0,00 %	10	100,00 %
get_Balance()	0	0,00 %	1	100,00 %
set_Balance(double)	0	0,00 %	1	100,00 %
banktest.dll	3	13,64 %	19	86,36 %

Test-Driven Development (TDD)

- Test-Driven Development (TTD)
  - Write unit tests before class itself
  - Class is complete when all units tests pass
  - Additional features and/or bug fixes incur yet more unit tests etc.

- Visual Studio has "TDD-friendly" IntelliSense mode
  - **CTRL-ALT-Space** toggles between modes

Null Object in Unit Testing

- Null Objects are extremely useful in unit testing
  - "mock", "stub", ...

```
private class NullLogger : ILogger
{
    public void Enter( string callerMemberName ) { }
    public void Error( string message ) { }
    public void Error( Exception exception ) { }
    public void Exit( string callerMemberName = null ) { }
    public void Info( string message ) { }
    public void Info( Exception exception ) { }
}
```

- Null objects and factories can be set up in `[TestInitialize]`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