Testing

Unit Tests, Mocking, Integration Tests, Selenium

SoftUni Team

Technical Trainers

Software University

SoftUni

Software University

https://softuni.bg

Table of Contents

Have a Question?

Software University

sli.do

#csharp-web

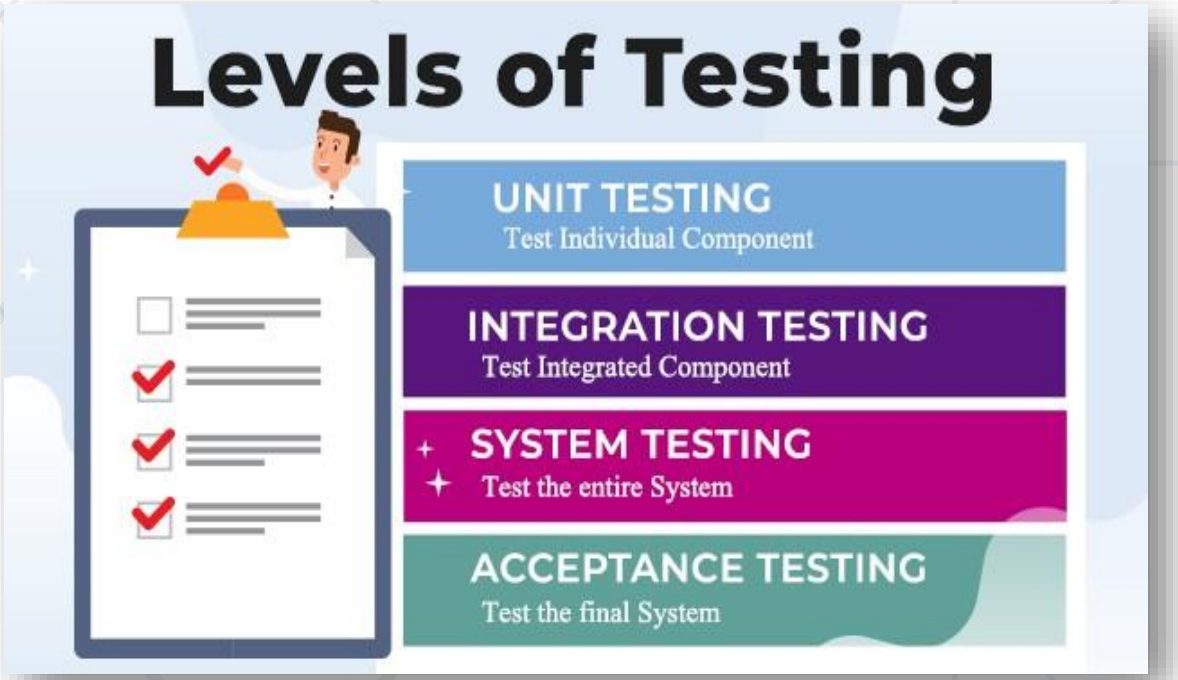
Testing

Testing

- **Testing** is an important part of the application lifecycle
  - New features need to be verified, before delivered to the clients
  - Testing checks whether software **conforms to the requirements**, aims to **find defects**
- **Testing** is a wide area of application development
  - There are several **levels** of testing, many **concepts** of development and **different types** of testing
- **Web applications** also need testing for "**unintentional features**"
  - Controllers, Services, Custom Components, etc.
  - Every component of the application must be tested

Main Test Levels

- Different **components** of the application are tested on different levels:
  - **Unit tests**
    - Test single component
    - Created by developers
  - **Integration tests**
    - Test interaction between components (e. g. APIs)
    - Created by developers / QA automation engineers
  - **System tests** / **end-to-end tests**
    - Test the entire system (created by QA automation engineers)



More Test Levels

Software University

Test Level	Description
Unit Testing	Tests **individiual parts** of the code, independent from the infrastructure
Component Testing	Testing of **multiple functionalities** (a single component)
Integration Testing	Testing of all **integrated modules** to verify the combined functionality
System Testing	Tests the **system** as a **whole**, once all the components are integrated
Regression Testing	Ensures that a fixed bug **won't happen again**
Acceptance Testing	Tests if the **product** meets the **client**'s **requirements**. Purely done by QAs
Load / Stress Testing	Test the application's limits by attempting **large data processing** and introduci ng **abnormal circumstances** and **conditions**
Security Testing	Test if the application has any **security flaws** and **vulnerabilities**
Other Types of Testing	Manual, automation, UI, performance, black box, end-to-end testing, A/B, etc

Test Concepts

- There are also different concepts and practices of test development
  - **Code-first** approach (The usual Development)
  - **Test-first** approach (Test-Driven Development)
- Each has its own **advantages** and **disadvantages**
  - The **Code-first** approach ensures **flexibility** & **fast** development
  - The **Code-first** approach tends to create **tests based on the code**
  - The **Test-first** approach ensures **quality** and **edge case coverage**
  - The **Test-first** approach is **complicated** and is an "**initial delay**"

The "AAA" Testing Pattern

- Automated tests usually follow the "**AAA**" **pattern**
  - **Arrange**: prepare the **input** data and entrance conditions
  - **Act**: invoke the **action** for testing
  - **Assert**: check the **output** and exit conditions

```
[Test]
public void Test_SumNumbers()
{
    // Arrange
    var nums = new int[] {3, 5};

    // Act
    var sum = Sum(nums);

    // Assert
    Assert.AreEqual(8, sum);
}
```

Unit Testing

Unit Testing

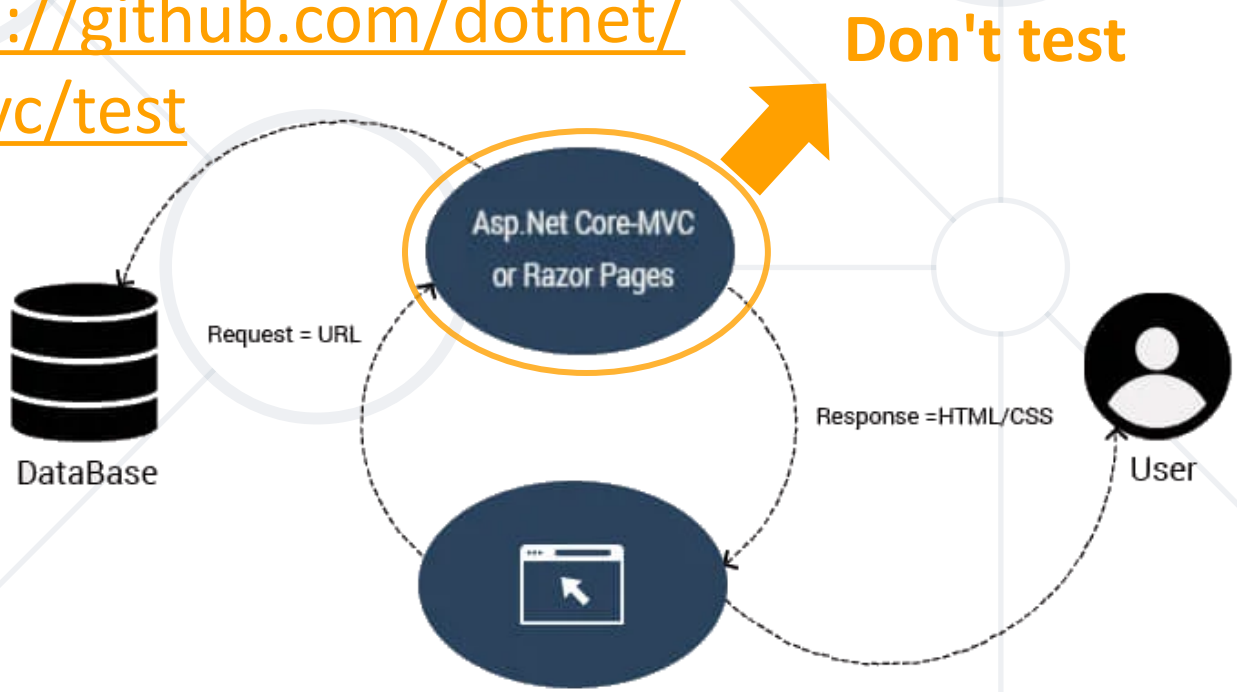
- **Unit Testing** web apps is pretty much like casual unit testing
  - Writing test methods to test classes and methods (functionalities)
    - Testing individual code components (**units**), not the **infrastructure**
  - You still use the same testing frameworks as in casual unit testing

```
public class Summator
{
   public int Sum(int[] arr)
   {
      int sum = arr[0];
      for (int i = 1; i < arr.Length; i++)
         sum += arr[i];
      return sum;
   }
}
```

```
void Test_SumTwoNumbers() {
  var summator = new Summator();
  if (summator.Sum(new int[]{1, 2}) != 3)
    throw new Exception("1+2 != 3");
}
```

Unit Testing in ASP.NET Core

- When using a web frameworks such as **ASP.NET Core**
  - Built-in logic does not need to be tested
    - It is already tested during the development of the framework itself
    - Example of MVC tests: https://github.com/dotnet/aspnetcore/tree/main/src/Mvc/test
  - You still need to test your **custom functionality**

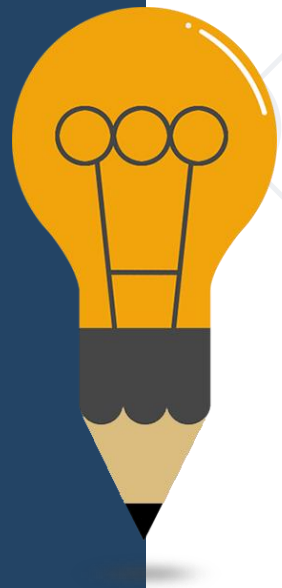


NUnit

Unit-Testing Framework for All .NET Languages

NUnit: Overview

- **NUnit** == popular **C# testing framework**
  - Supports test suites, test cases, before & after code, startup & cleanup code, timeouts, expected errors, …
  - Like **JUnit** (for Java)
  - Free, open-source
  - Powerful and mature
  - Wide community
  - Built-in support in Visual Studio
  - Official site: nunit.org



```
using NUnit.Framework;
0 references
public class SummatorUnitTests
{
    [Test]
    0 references
    public void Test_SumTwoNumbers()
    {
        var summator = new Summator();
        var sum = summator.Sum(new int[] { 1, 2 });
        Assert.AreEqual(3, sum);
    }
}
```

NUnit Assertions (1)

- Assert that **condition** is true

```
Assert.That(bool condition);
```

- **Comparison** (equal, greater than, less than or equal, …)

```
Assert.AreEqual(expected, actual);
```

- **Range** assertions

```
Assert.That(number, Is.InRange(80, 100));
```

NUnit Assertions (2)

- **String** assertions

```
Assert.That(string actual, Does.Contain(string expected));
```

- Assert if a string or collection is empty

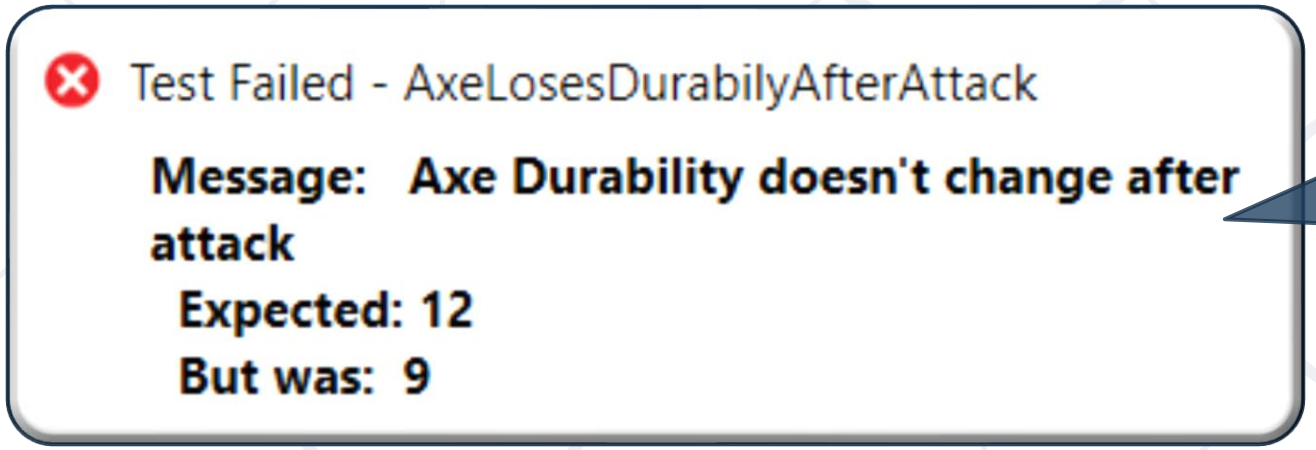
```
Assert.IsEmpty(string message);
Assert.IsEmpty(Ienumerable collection);
```

- And many more
https://docs.nunit.org/articles/nunit/writing-tests/assertions/assertion-models/classic.html

NUnit Assertion Messages

- Assertions can **show messages** to helps with **diagnostics**

```
Assert.That(axe.DurabilityPoints, Is.EqualTo(12),
    "Axe Durability doesn't change after attack");
```



Failure messages in the tests help finding the problem

Test Classes and Test Methods

- Test **classes** hold test **methods**

```
using NUnit.Framework;

[TestFixture]
public class SummatorTests
{
  [Test]
  public void Test_SumTwoNumbers() {
    var summator = new Summator();
    var sum = summator.Sum(new int[] { 1, 2 });
    Assert.AreEqual(3, sum);
  }
}
```

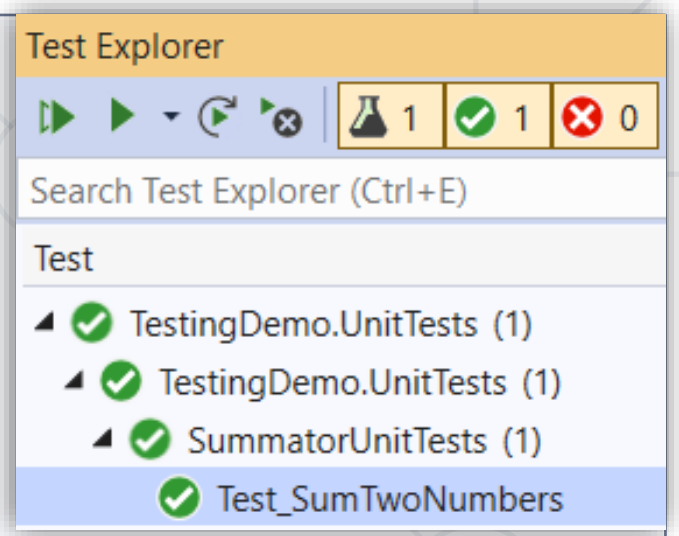
Import NUnit

Optional notation

Test class

Test method

Assertion



Initialization and Cleanup Methods

Software University

```
private Summator summator;

[SetUp] // or [OneTimeSetUp]
public void TestInitialize()
{
  this.summator = new Summator();
}

[TearDown] // or [OneTimeTearDown]
public void TestCleanup()
{
  // …
}
```

Executes before each test

Executes after each test

Mocking

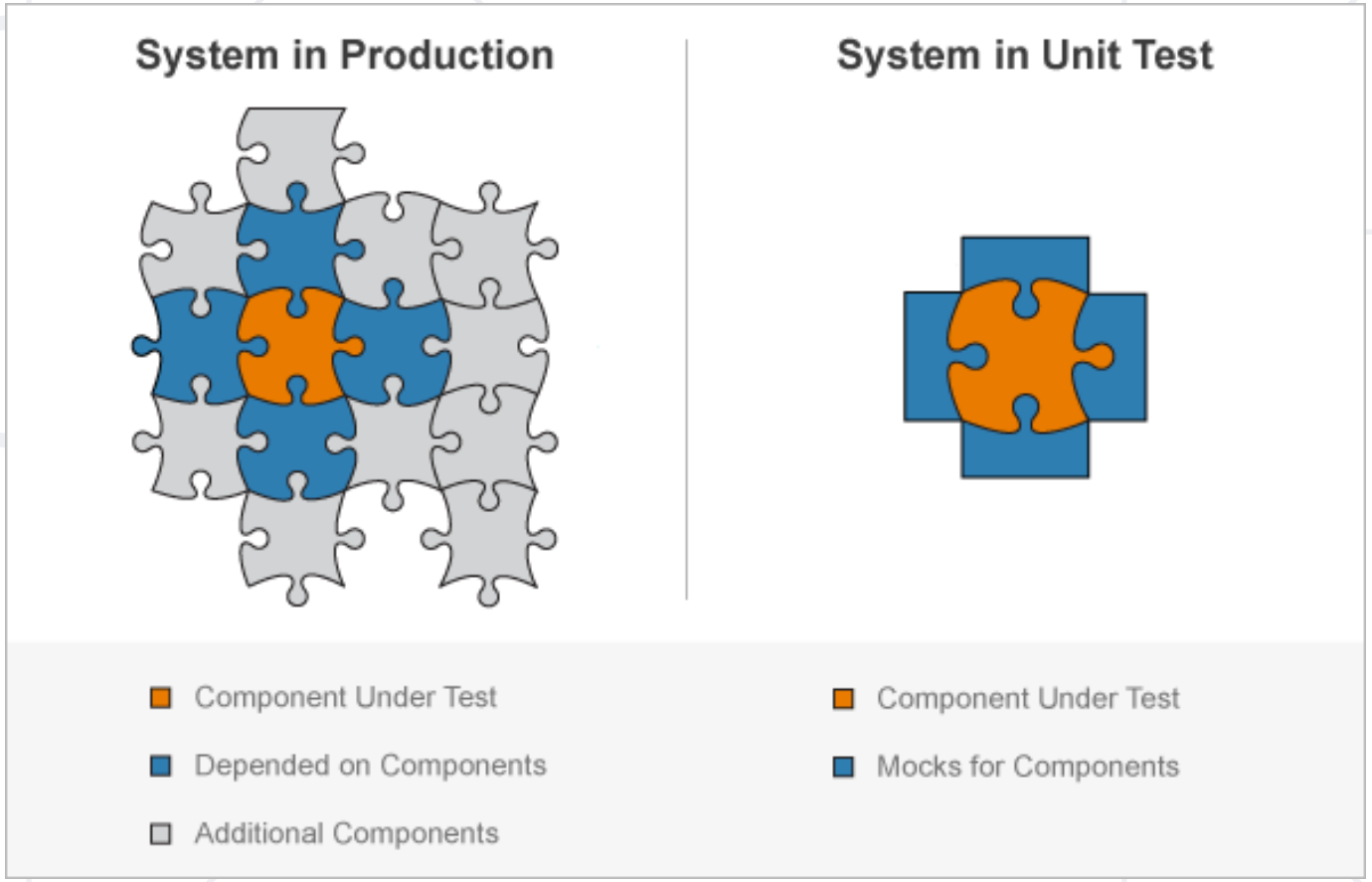
Simulating External Dependencies in Unit Tests

What is Mocking?

- **Mocking** – something made as an imitation
- **Mocking** is a software practice, primarily used in **Unit Testing**
  - An object under test may have **dependencies** on other objects
  - To **isolate** the behavior, the other objects are replaced
    - The replacements are **mocked objects**
    - The mocked objects **simulate** the behavior of the **real objects**
  - Useful if the real objects are **impractical**/**incorporate** to the unit test
- Basically, **Mocking** is creating objects that **simulate behavior**
- In .NET, we can use the **Moq** library to create mock objects

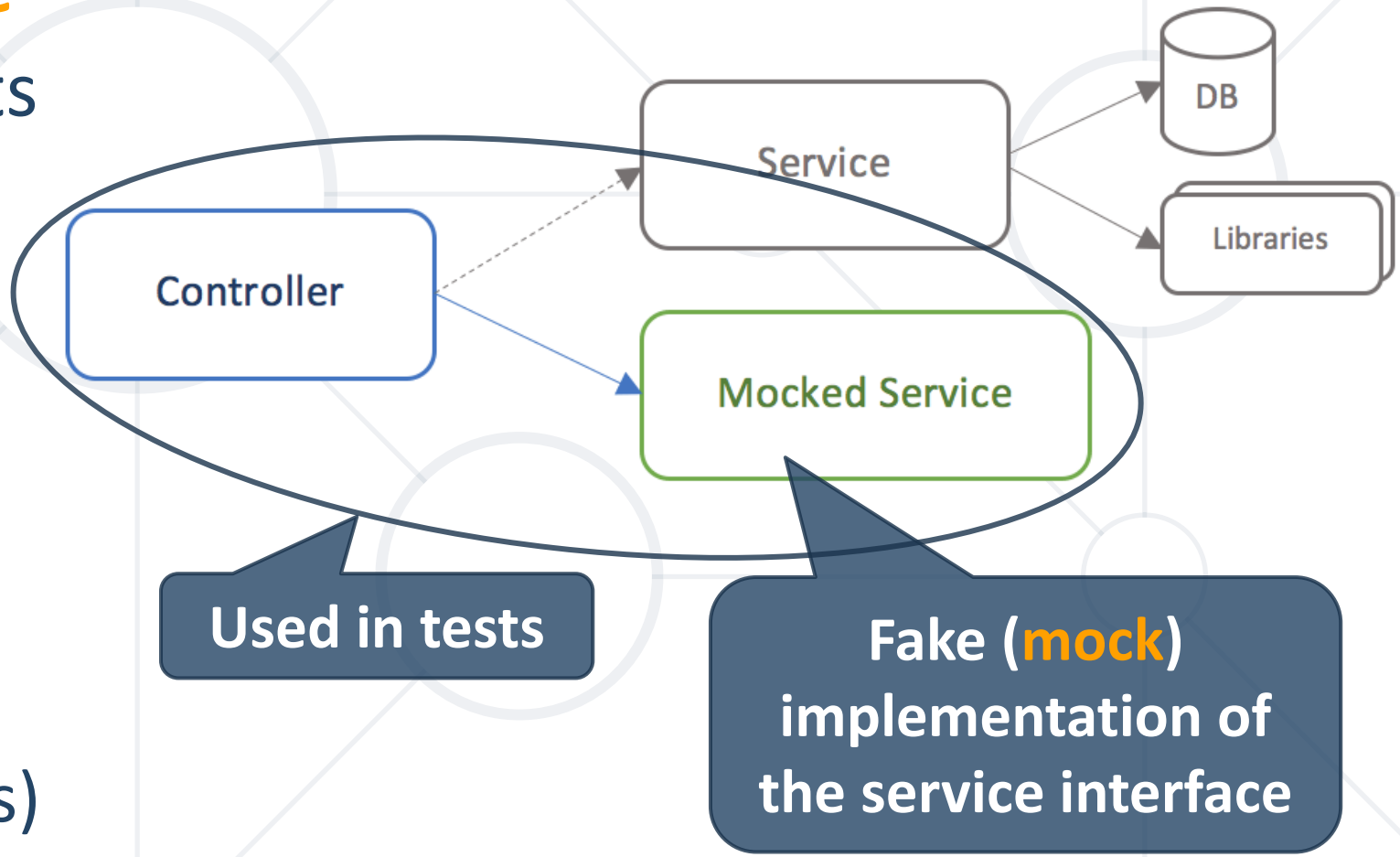
Why Mocking?

- **Unit testing** should **test a single component**
  - Isolated from all the others
- **External dependencies** should be **mocked** (faked, simulated)



Mocking

- **Mocking simulates the behavior** of real objects
  - Usually done through interfaces
  - Real implementation (e.g., with a database)
  - Fake implementation (used for the unit tests)



Testing a Service with Mocking (1)

Software University

```
public interface ICreditDecisionService
{
    string GetDecision(int creditScore);
}
```

```
public class CreditDecision
{
    ICreditDecisionService service;
    public CreditDecision(ICreditDecisionService service)
        => this.service = service;

    public string MakeCreditDecision(int creditScore)
            => service.GetDecision(creditScore);
}
```

```
public class CreditDecisionService
        : ICreditDecisionService
{
    public string GetDecision
        (int creditScore)
    {
        if (creditScore < 550)
            return "Declined";
        else if (creditScore < 675)
            return "Maybe";
        else
            return "Absolutely";
    }
}
```

Testing a Service with Mocking (2)

Software University

```
[TestFixture]
public class CreditDecisionTests
{
    [Test]
    public void MakeCreditDecision_ShouldReturnCorrectResult()
    {
        var mockCreditDecisionService = new Mock<ICreditDecisionService>();
        mockCreditDecisionService
            .Setup(p => p.GetDecision(100))
            .Returns("Declined");

        var controller = new CreditDecision(mockCreditDecisionService.Object);
        var result = controller.MakeCreditDecision(100);

        Assert.That(result, Is.EqualTo("Declined"));

        mockCreditDecisionService.VerifyAll();
    }
}
```

NOTE: You will need the following NuGet package installed: **Moq**

Mock the service

Use the mocked service

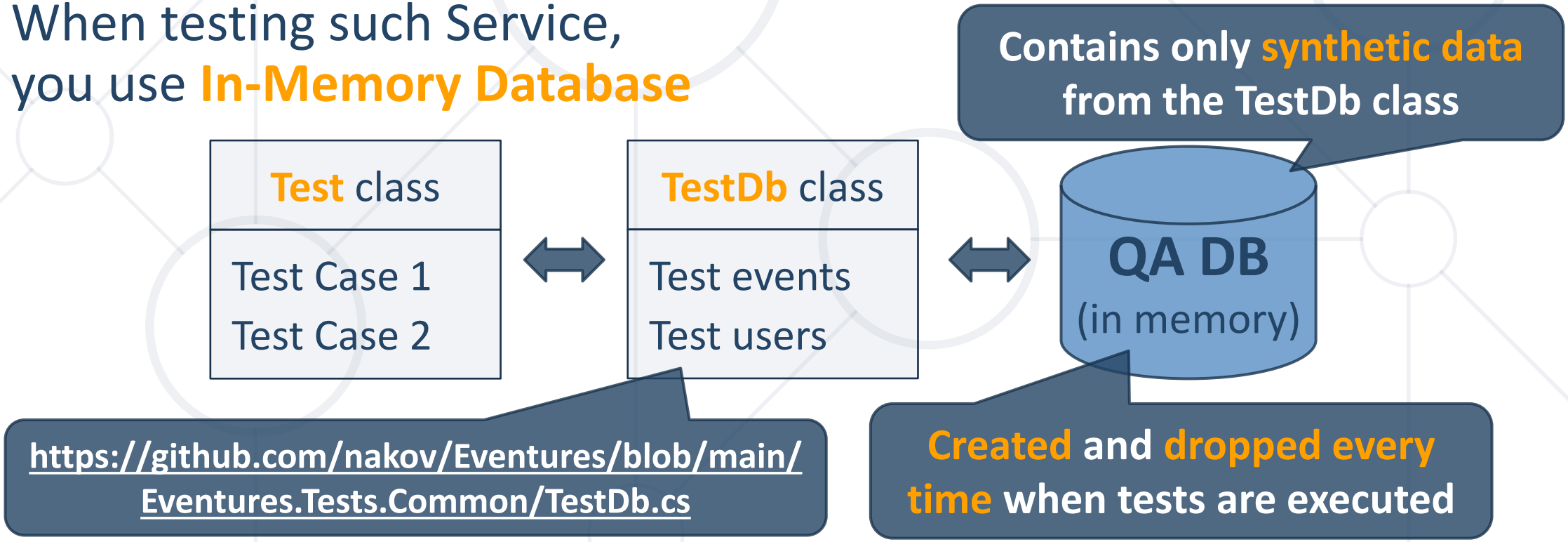
You can look at a more complex example here

In-Memory Database

Data Storage in Memory

In-Memory Database

- **Services**, accessing a **Database**, can (and should) also be tested
  - When testing such Services, you don't create a new Database
    - This would, otherwise, overload the Database Server
  - When testing such Service, you use **In-Memory Database**



EF Core In-Memory Database

- **EF Core** provides an **In-Memory Database**
  - Included with the `Microsoft.EntityFrameworkCore.InMemory` package
  - Its general purpose is to be a **testing database**

```
public class CreditDecision
{
    public int Id { get; set; }
    public int Score { get; set; }
    public string Decision { get; set; }
}
```

Create a **db context** as usual

```
public class AppDbContext : DbContext
{
    public AppDbContext(DbContextOptions<AppDbContext> options)
        : base(options) {}

    public DbSet<CreditDecision> CreditDecisions { get; set; }
}
```

Testing a Service with In-memory Database (1)

```
public interface ICreditDecisionService
{
    CreditDecision GetById(int id);
}
```

```
public class CreditDecisionService: ICreditDecisionService
{
    private readonly AppDbContext data;

    public CreditDecisionService(AppDbContext data)
      => this.data = data;

    public CreditDecision GetById(int id)
      => this.data.CreditDecisions.Find(id);
}
```

Inject the db context to the service

Testing a Service with In-memory Database (2)

Software University

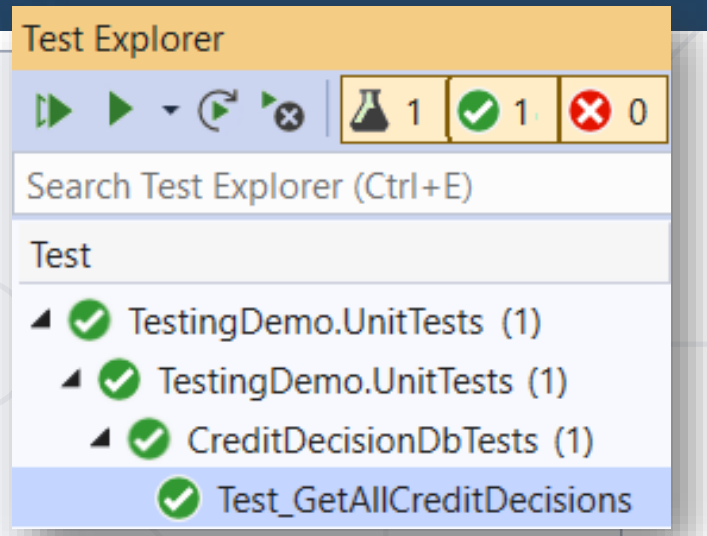
```
[TestFixture]
public class CreditDecisionDbTests
{
    private IEnumerable<CreditDecision> decisions;
    private AppDbContext dbContext;

    [SetUp] // Method is executed before tests
    public void TestInitialize()
    {
        this.decisions = new List<CreditDecision>() {
            new CreditDecision(){ Id = 1, Score = 100, Decision = "Declined" },
            new CreditDecision(){ Id = 2, Score = 600, Decision = "Maybe"  },
            new CreditDecision(){ Id = 3, Score = 800, Decision = "Absolutely" }};

        var options = new DbContextOptionsBuilder<AppDbContext>()
            .UseInMemoryDatabase(databaseName: "CreditsInMemoryDb") // Use an in-memory DB
            .Options;

        this.dbContext = new AppDbContext(options);
        this.dbContext.AddRange(this.decisions); // Add data to the DB
        this.dbContext.SaveChanges();
    }

    ...
}
```

Create data for the in-memory db

Testing a Service with In-memory Database (3)

Software University

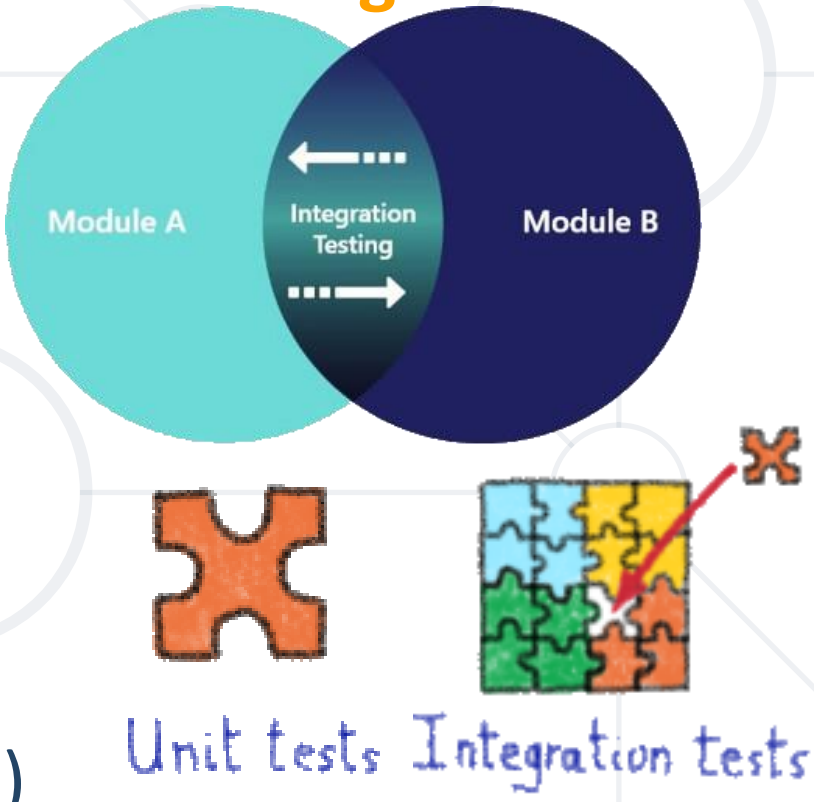
```
[TestFixture]
public class CreditDecisionDbTests
{
    ...

    [Test]
    public void Test_GetAllCreditDescisions()
    {
        var decisionId = 1;

        ICreditDecisionService service =
            new CreditDecisionService(this.dbContext); // Pass the in-memory db to the service
        var decision = service.GetById(decisionId); // Use service methods

        var dbDecision = this.decisions
            .ToList()
            .Find(d => d.Id == decisionId);

        // Compare and assert retuned CreditDecision from DB and from the service method
        Assert.True(decision != null);
        Assert.True(decision.Score == dbDecision.Score);
        Assert.True(decision.Decision == dbDecision.Decision);
    }
}
```



Integration Testing

Integration Testing (1)

- **Integration testing** tests several units (components) together
  - Aims to expose faults in the **interaction between integrated units**
  - Example: test user registration + data access services + database storage (if the new user is stored in the DB)
- **Unit testing** vs. **integration testing**
  - Integration testing tests the interaction between several units
  - Unit testing tests a single unit (component)

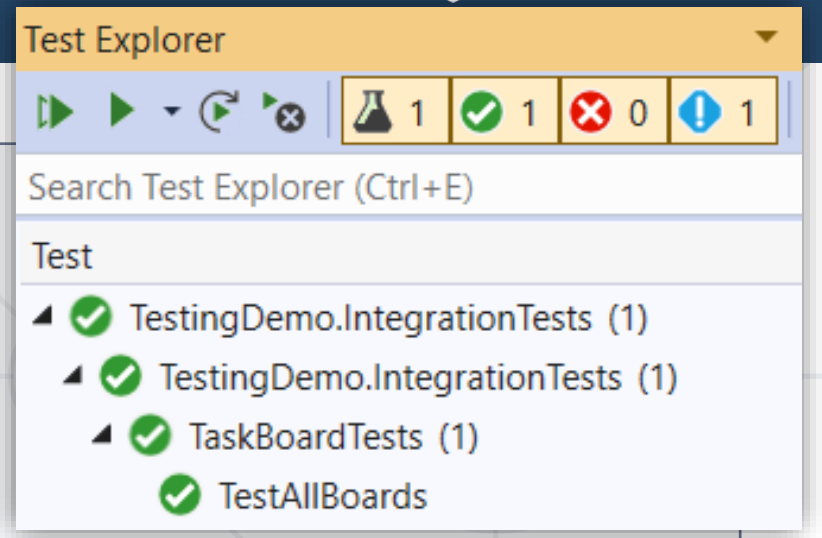


Integration Testing (2)

- **ASP.NET Core** supports **Integration Testing** using a **Unit Test framework**
  - The framework has an integrated web host and in-memory test server
- **Integration Tests** follow a sequence of events
  - The app's web host must be configured
  - A test server client is created to submit requests to the app
  - [**Arrange**] The test app prepares a request
  - [**Act**] The client submits the request and receives a response
  - [**Assert**] The actual response is validated based on expected result
  - After all tests have run, the results are reported

Integration Test for the TaskBoard App

Software University




```
[Test]
public async Task TestAllBoards()
{
    // Arrange
    var httpClient = new HttpClient();

    // Act
    var response = await httpClient
        .GetAsync("https://taskboard.nakov.repl.co/boards");

    // Assert
    Assert.AreEqual(HttpStatusCode.OK, response.StatusCode);
}
```

Send a GET request

Sends HTTP request and receives HTTP responses

Make assertions

Selenium

Selenium

- **Selenium** is a portable **testing** framework for web applications
  - Provides a playback tool for authoring tests (Selenium IDE)
  - Provides a test domain-specific language (Selenese)
  - Provides "browser driving" natively (Selenium WebDriver)
- "**Selenium automates browsers. That's it!**" Selenium docs
  - Automates web applications for test purposes
  - Useful for integration testing SPA apps

Install and Set-up Selenium

- Install latest stable Node.js: https://nodejs.org/en/
  - Install the npm package:
```
npm install -g selenium-standalone
```
- Install latest Java: https://www.java.com/en/download/
- Download Selenium Standalone Server JAR
  - https://www.seleniumhq.org/download/
- Download ChromeDriver (to match your Chrome version)
  - http://chromedriver.chromium.org/downloads
  - Extract the file in the same folder as Selenium Standalone Server
- Start selenium server
```
java -jar .\selenium-server-standalone-3.141.59.jar
```

Selenium and .NET

- Let's get ready Selenium for ASP.NET Core App Testing
  - Install NuGet packages:
    - `Selenium.Support`
    - `Selenium.WebDriver`

MyTested.AspNetCore.Mvc

MyTested.AspNetCore.Mvc

Software University

- **MyTested.AspNetCore.Mvc** is a **powerful** testing library
  - Automatic resolving of test dependencies
  - Fluent API with strongly-typed extensions
  - Unit tests, integration tests, route tests, everything covered
  - Built-in mocks for every ASP.NET Core scenario
    - Authentication, DbContext, HTTP, Session, Caching, and many more…
  - Examine at https://github.com/ivaylokenov/MyTested.AspNetCore.Mvc
  - Latest available version:

```
Install-Package MyTested.AspNetCore.Mvc.Universe -Version 3.1.2
```

MyTested.AspNetCore.Mvc (2)

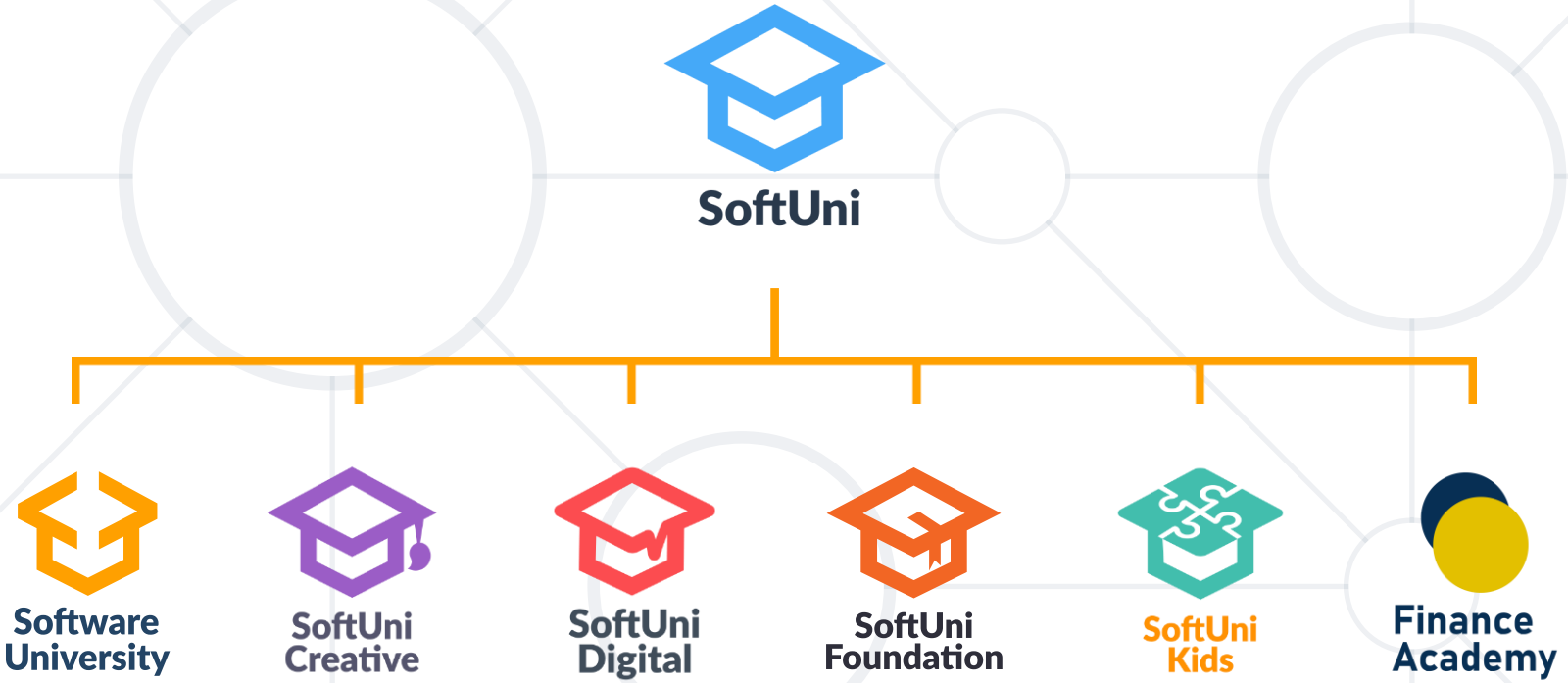
Software University

```
// Instantiates controller with the registered global services,
// and mocks authenticated user,
// and tests for valid model state,
// and tests for added by the action view bag entry,
// and tests for view result and model with specific assertions
MyController<MyMvcController>
    .Instance(instance => instance
        .WithUser(user => user.WithUsername("MyUserName")))
    .Calling(c => c.MyAction(myRequestModel))
    .ShouldHave()
    .ValidModelState()
    .AndAlso().ShouldHave()
    .ViewBag(viewBag => viewBag.ContainingEntry("MyViewBagProperty", "MyViewBagValue"))
    .AndAlso().ShouldReturn()
    .View(result => result
        .WithModelOfType<MyResponseModel>()
        .Passing(model =>
        {
            Assert.AreEqual(1, model.Id);
            Assert.AreEqual("My property value", model.MyProperty);
        }));
```

Summary

- **Testing**
- **Unit Testing** – testing a single unit
  - **NUnit** – a unit-testing framework
  - **Mocking** – simulating external dependencies
  - **In-memory** database
- **Integration Testing** – testing a combination of units
- **Selenium** – automated tests in browser
- **MyTested.AspNetCore.Mvc**

Questions?



SoftUni Diamond Partners

Software University

SUPER HOSTING .BG

Coca-Cola HBC Bulgaria

POKERSTARS
POKER | CASINO | SPORTS
a Flutter International brand

INDEAVR
Serving the high achievers

AMBITIONED

DRAFT KINGS

SOFTWARE GROUP

createX

Postbank
Решения за твоето утре

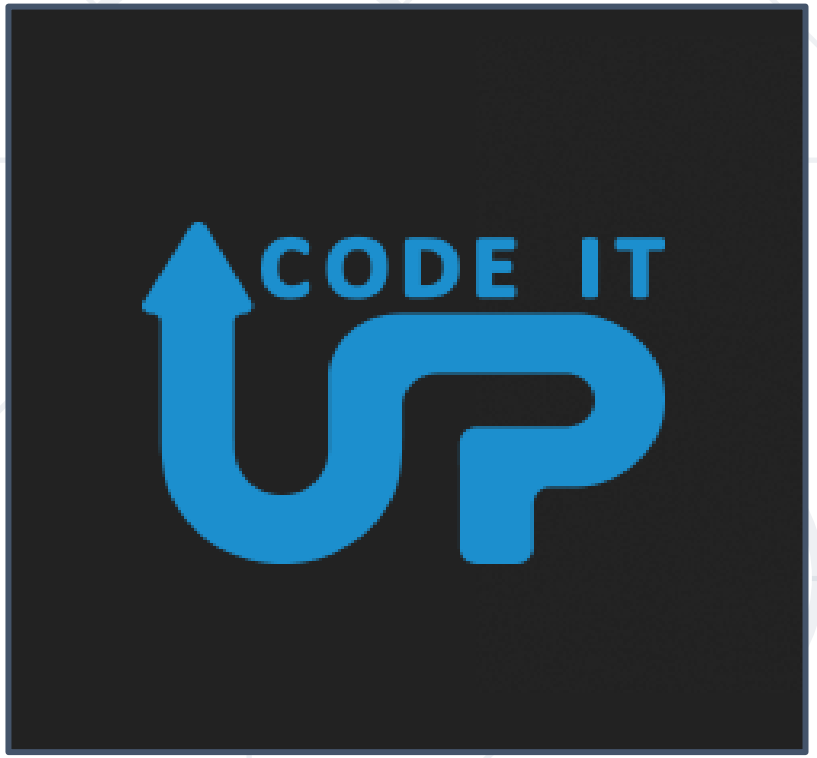
BOSCH

DXC TECHNOLOGY

SmartIT

Educational Partners

Software University



Trainings @ Software University (SoftUni)

- Software University – High-Quality Education, Profession and Job for Software Developers
  - softuni.bg, softuni.org
- Software University Foundation
  - softuni.foundation
- Software University @ Facebook
  - facebook.com/SoftwareUniversity
- Software University Forums
  - forum.softuni.bg

License

- This course (slides, examples, demos, exercises, homework, documents, videos and other assets) is **copyrighted content**
- Unauthorized copy, reproduction or use is illegal
- © SoftUni – https://softuni.org
- © Software University – https://softuni.bg