Unit Testing Methods

Unit Testing Concepts. Testing Frameworks. NUnit. Writing Your First Test with NUnit

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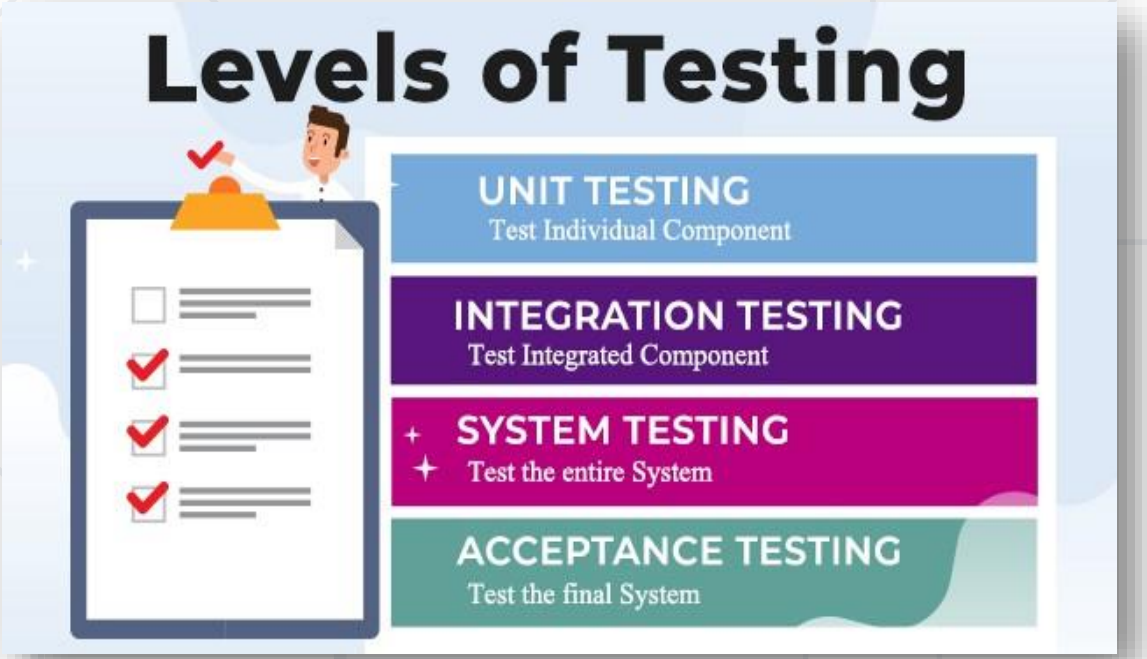
What is Unit Testing?

Automated Testing of Software Components (Units)

Test Levels

- **Unit tests**
  - Test a **single component**
  - NUnit, JUnit, PyUnit, Mocha
- **Integration tests**
  - Test an **interaction** between components, e. g. **API tests**
- **System tests** / **end-to-end tests**
  - Test the **entire system**
  - Selenium, Appium, Cypress, Playwright

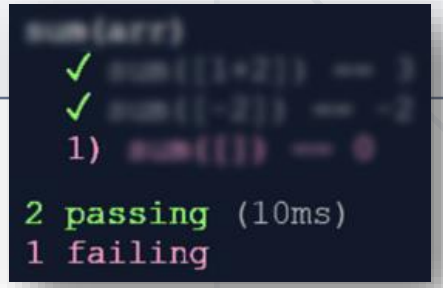


Unit Testing

- **Unit test** == a piece of code that **tests specific functionality** in certain software component (unit)

```
int Sum(int[] arr)
{
  int sum = 0;
  foreach (int num in arr)
    sum += num;
  return sum;
}
```

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



Testing Frameworks

Concepts

Testing Frameworks

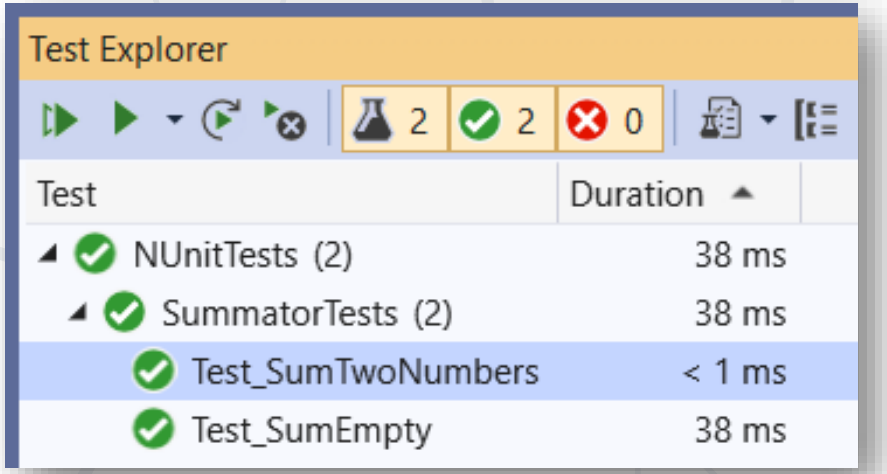
- **Testing frameworks** provide **foundation for test automation**
  - **Structure the tests** into hierarchical or other form
  - **Create** and **run test cases**, then make **reports**
  - **Check** the **results** and **exit** conditions
  - Perform initialization at **startup** and cleanup at **shut down**
- **Examples** of testing frameworks:
  - **NUnit**, xUnit, MSTest (C#), **Junit**, TestNG (Java), **Mocha**, Jest (JS), **PyTest** (Python)

Testing Framework – Example

- **Testing frameworks** simplify automated testing and reporting
  - Example: **NUnit** testing framework for C#

```
using NUnit.Framework;

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



NUnit: First Steps

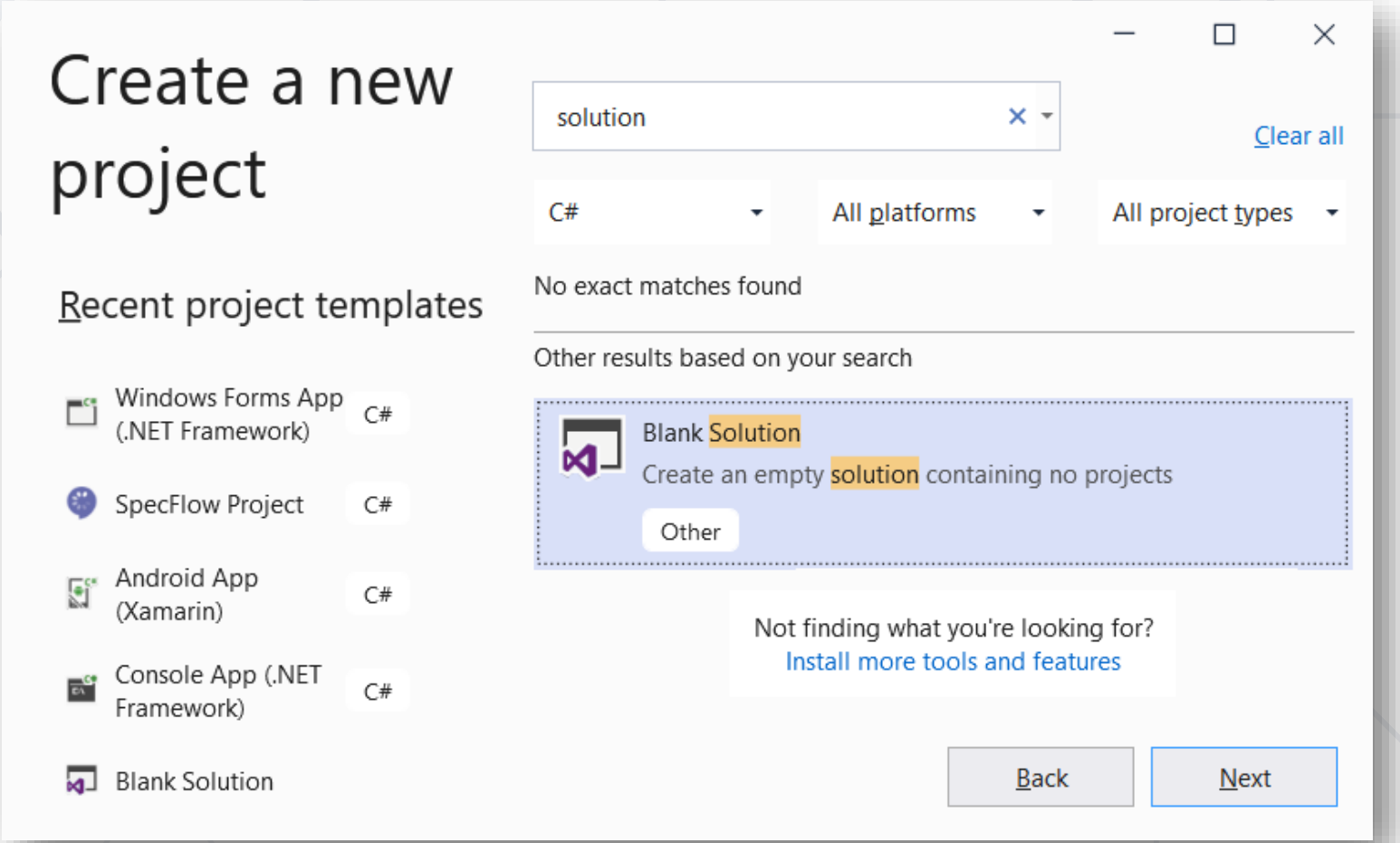
Setup and First Test

Setup and First Test

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

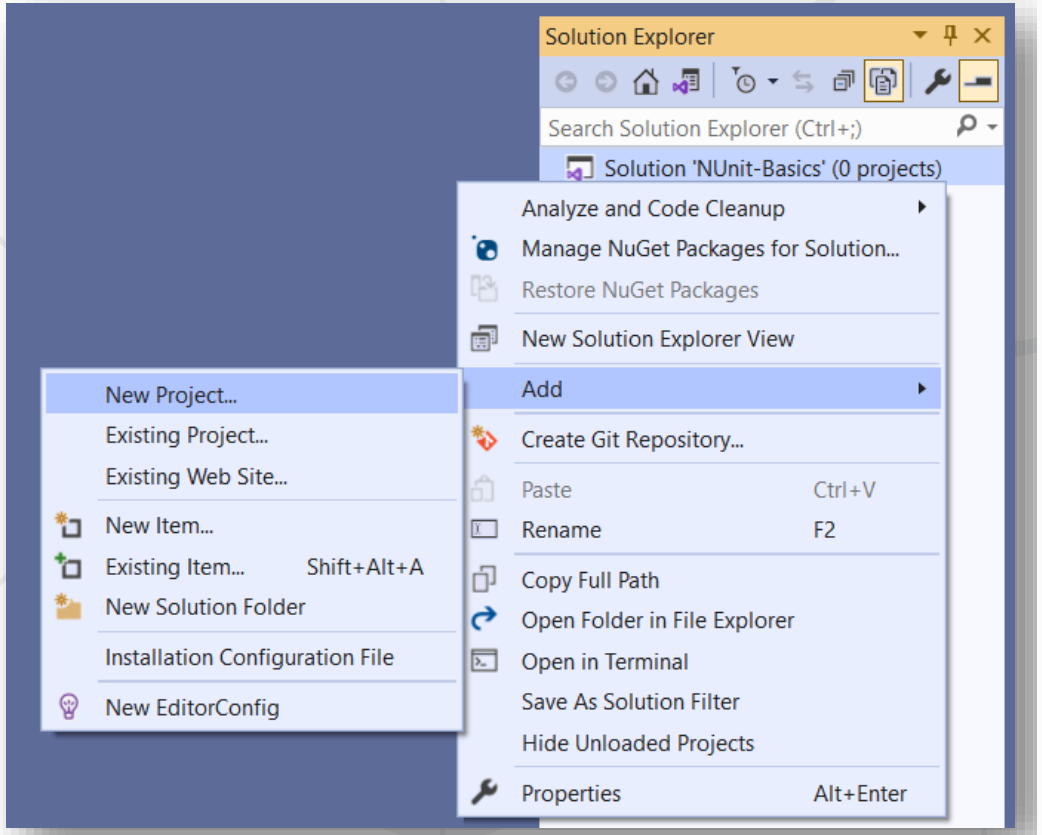
Creating a Blank Solution

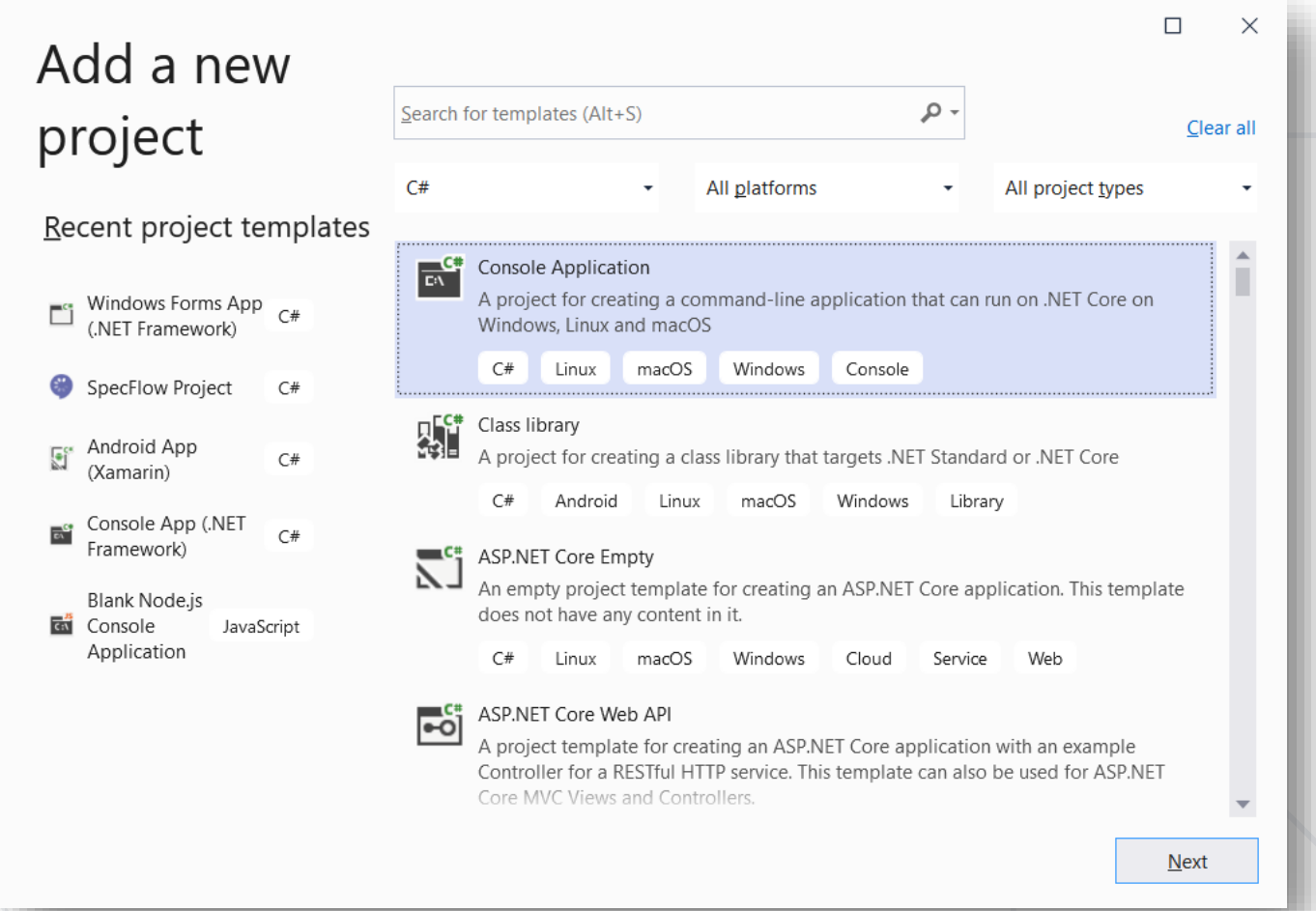
- Create a **blank solution** in Visual Studio
  - It will hold the **project for testing**
  - And the **unit test project** (tests)



Creating a Project for Testing

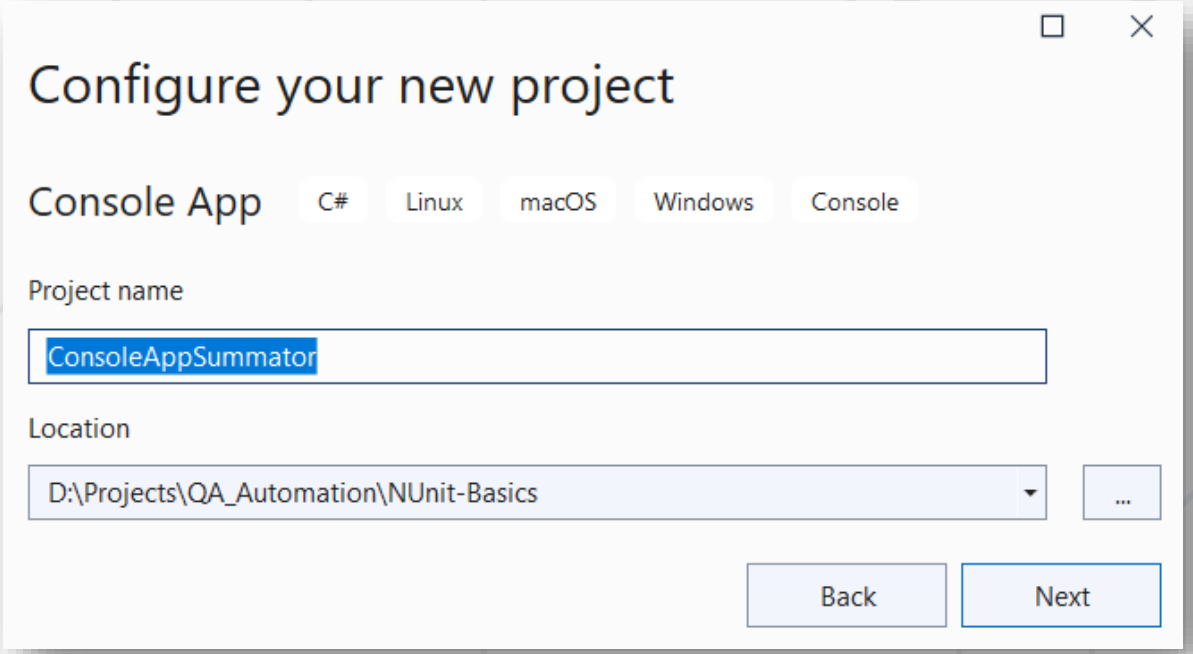
- **Add** a **New Project** in your Solution, to hold the **code for testing**

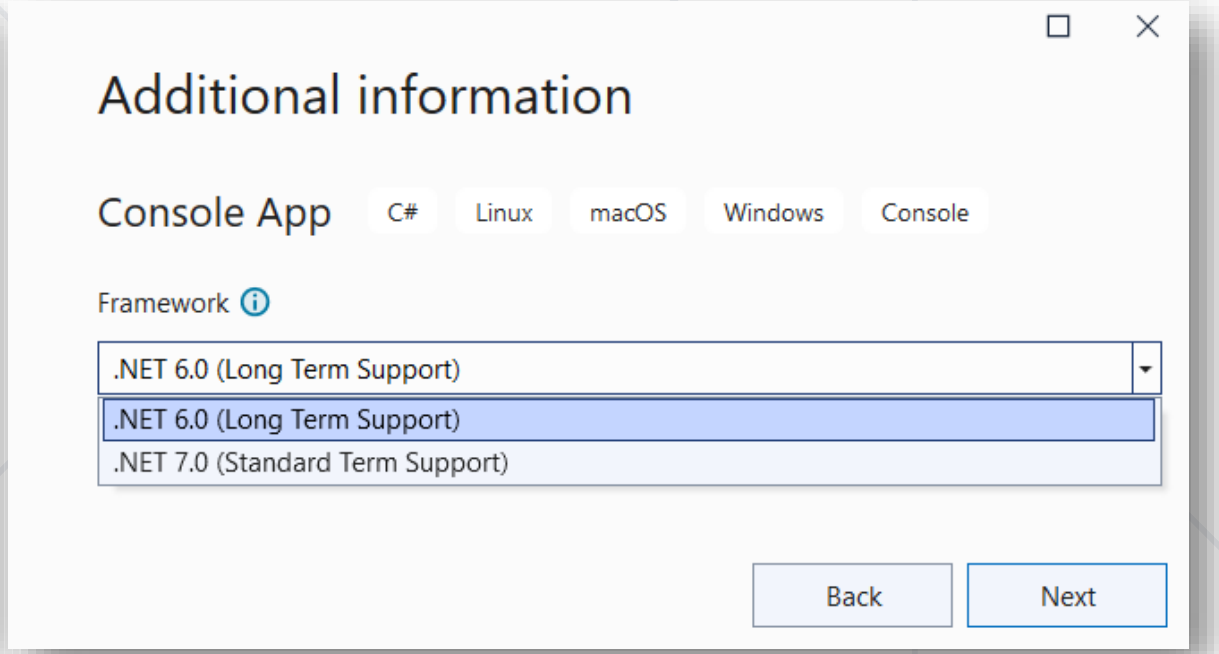




Creating a Project for Testing

- Choose a **meaningful name** for your project
- Choose a **place to store** it
- Use **.NET 6.0** (Long Term Support)





Creating a Project for Testing

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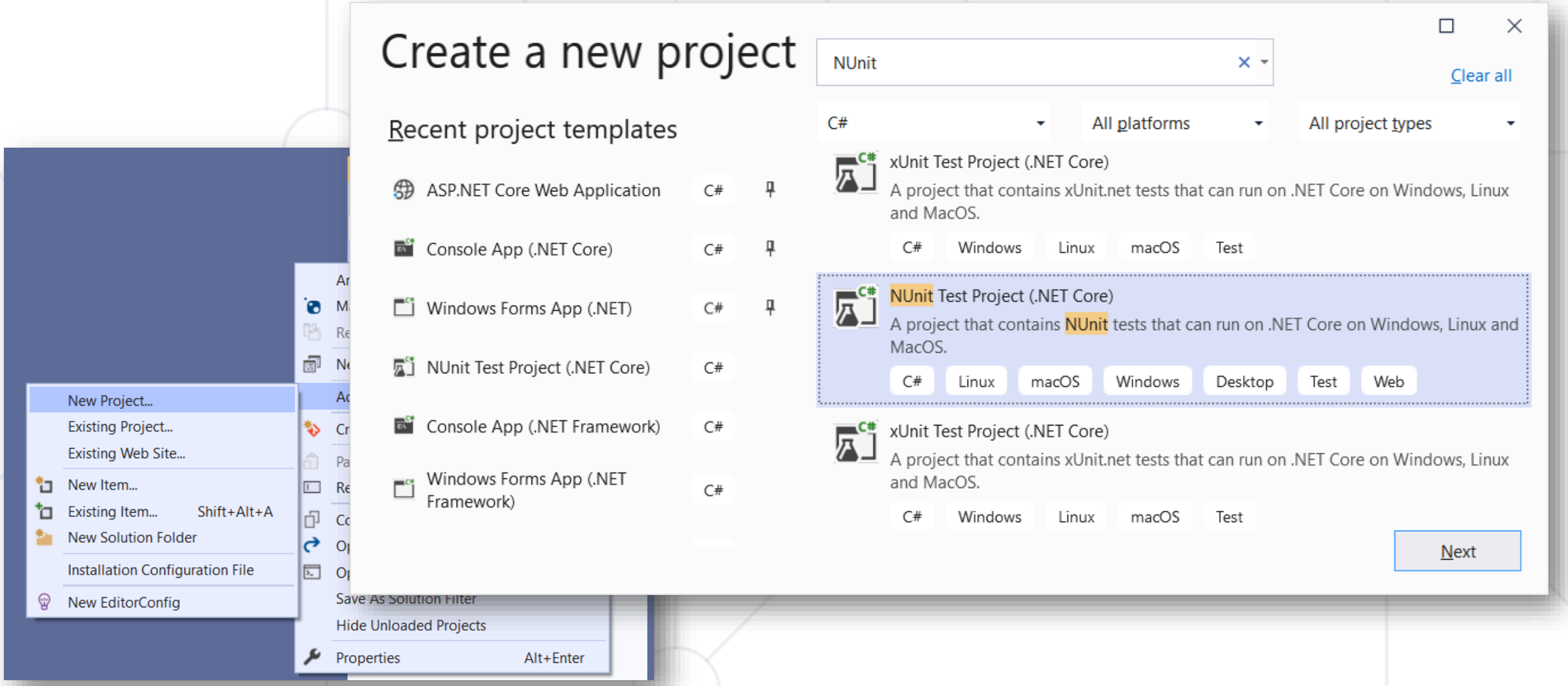
```
using System;

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

    static void Main()
    {
        Console.WriteLine(Sum(new int[] { 10, 20, 30 }));
    }
}
```

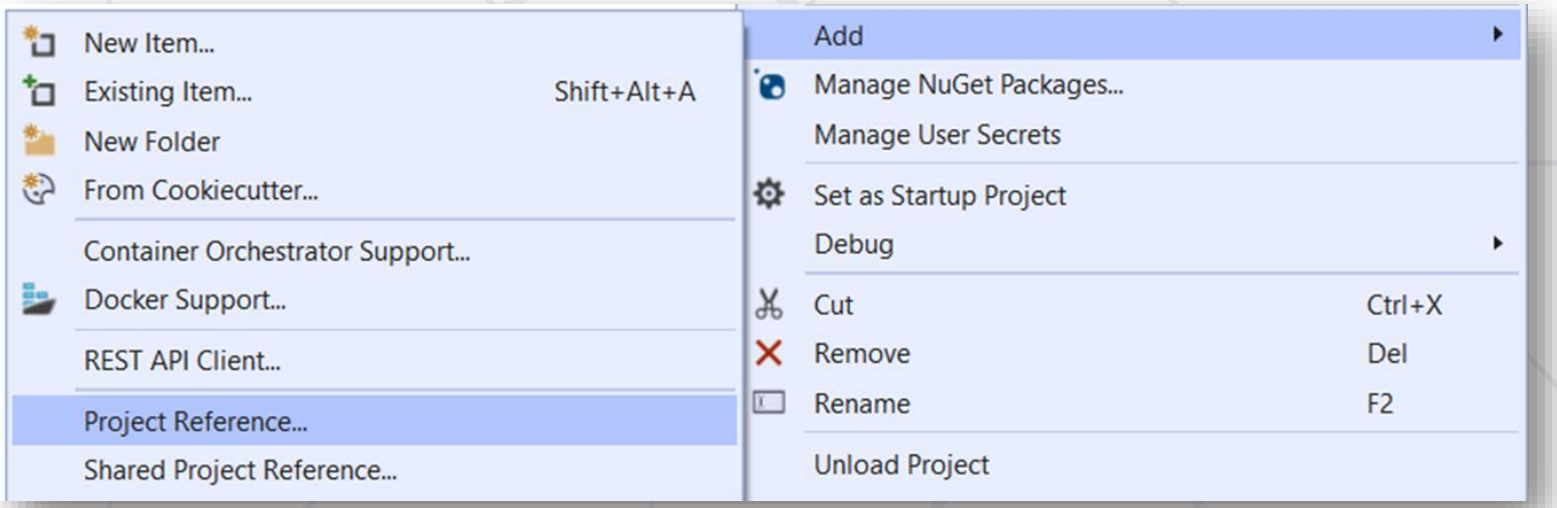
```
60

C:\Projects\NUnit-Basics\ConsoleAppSummator
\bin\Debug\netcoreapp3.1\ConsoleAppSummator
.exe (process 17844) exited with code 0.
Press any key to close this window . . .
```

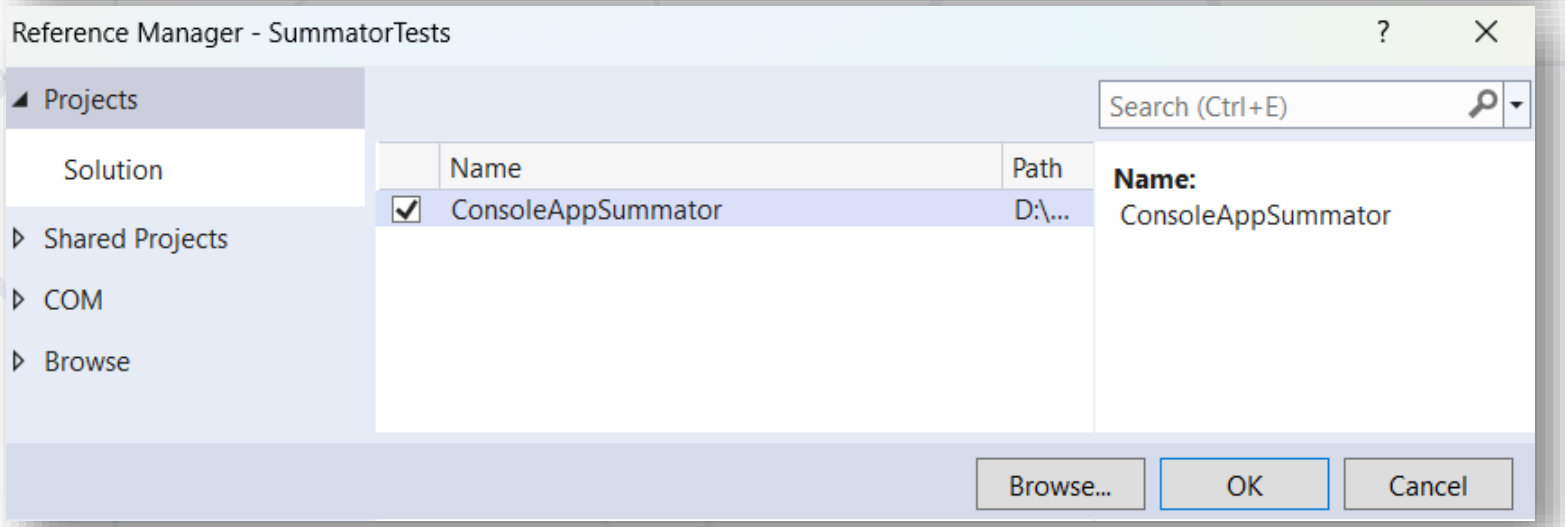
Creating a NUnit Project



Adding Project Reference

- Add **Project Reference** to target the project for testing:





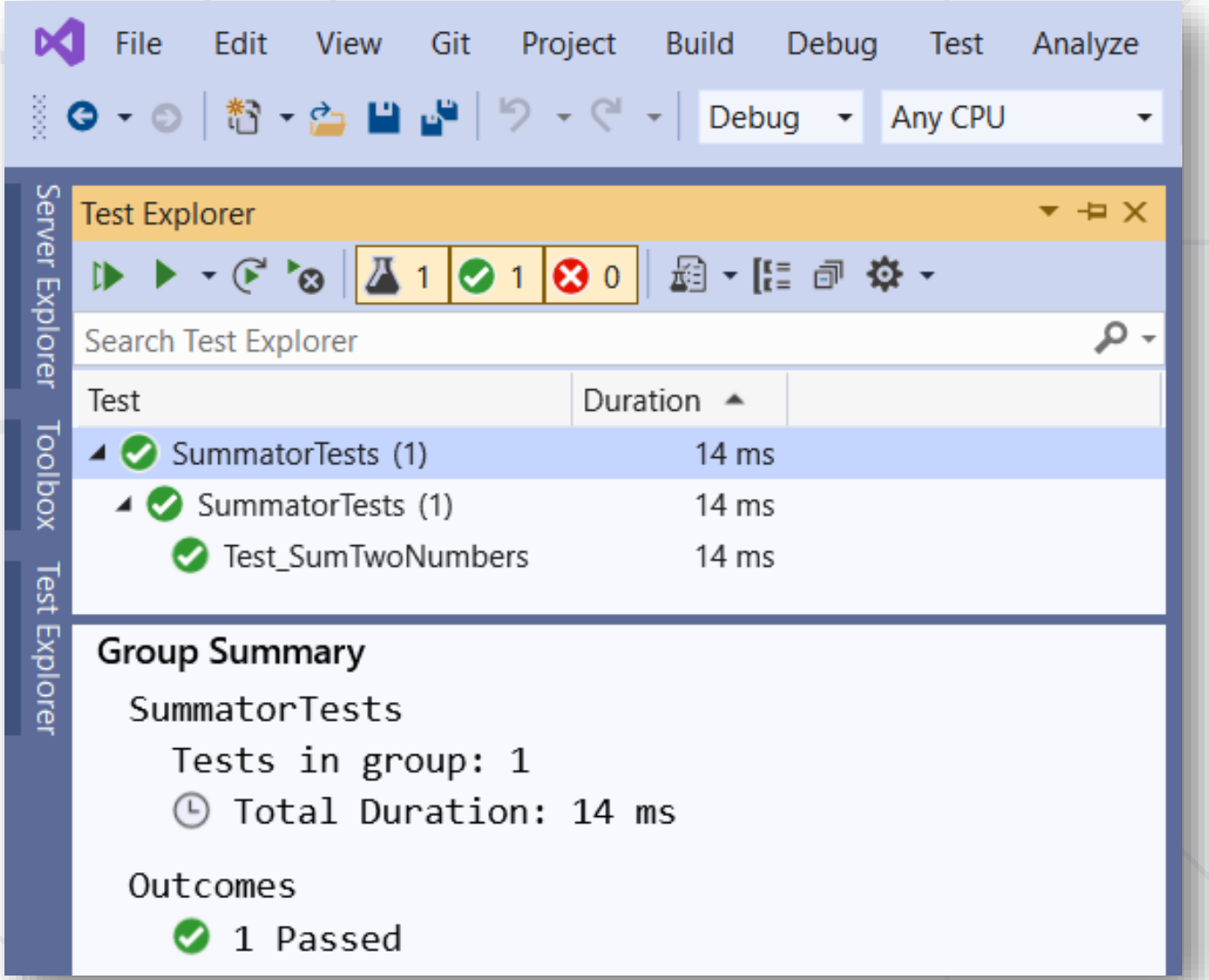
Writing your First Test

- Writing a **NUnit test method**:

```
using NUnit.Framework;

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

Test Explorer

- The **[Test Explorer]** tool in Visual Studio
  - Open with **[Ctrl + E] + T**
  - Visualizes the **hierarchy** of tests
  - **Executes** tests
  - **Reports** results



Failing Tests Produce Errors

Test Explorer

12 10 2

Search

Test run finished: 1 Tests (0 Passed, 1 Failed, 0 Skipped) run in 249 ms

Test	Duration	Error Message
Unit-Tests (12)	133 ms	
<Empty Namespace> (12)	133 ms	
GradesCalculatorTests (8)	6 ms	
SubArrayTests (1)	74 ms	
SummatorTests (1)	53 ms	
Test_Sum	53 ms	Expected: 8 But was: 7
TriangleTests (2)	< 1 ms	

Test Detail Summary

Test_Sum

Source: SummatorTests.cs line 4

Duration: 53 ms

Message:

```
Expected: 8
But was:  7
```

Stack Trace:

```
SummatorTests.Test_Sum() line 8
```

NUnit: Basics

Test Classes and Test Methods

Test Classes and Test Methods

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

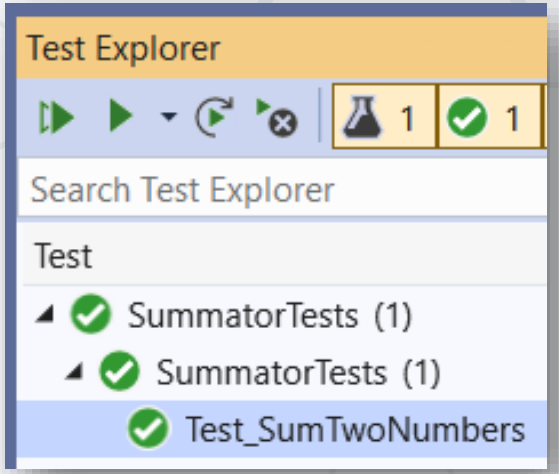
```
using NUnit.Framework;

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

Import NUnit

Test class

Test method

Assertion



Initialization and Cleanup Methods

```
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

The "AAA" Pattern

Arrange → Act → Assert

The "AAA" Testing Pattern

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

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

  // Act
  int sum = Sum(nums);

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

Assertions

Checking the Results and Output Conditions

Two Models of Assertions

- **Constraint** Model (**`Assert.That`**)
  - The **logic** necessary to carry out each assertion is expressed as a **constraint passed as the second parameter**

```
Assert.That(expected, Is.EqualTo(actual));
```

- **Classic** Model (**`Assert.AreEqual`**)
  - **`Assert.AreEqual`**, **`Assert.True`**, **`Assert.False`**, …
  - **Uses** a **separate method** to express each individual assertion:

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

Assertions

- Assert that **condition** is true

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

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

```
Assert.That(actual, Is.EqualTo(expected));
```

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

- Assertions for **expected exception**

```
Assert.That(() => { code },
  Throws.InstanceOf<ArgumentOutOfRangeException>());
```

Assertion Messages

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

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

Test Failed - AxeLosesDurabilyAfterAttack

Message: Axe Durability doesn't change after attack
Expected: 12
But was: 9

Failure messages in the tests help finding the problem

Unit Testing Best Practices

Naming, Repeatable, No Dependencies

Naming the Test Methods

- **Test names** should answer the question "*what's inside?*"
  - Should use **business domain terminology**
  - Should be **descriptive** and **readable**

```
IncrementNumber() {}
Test1() {}
TestTransfer() {}
```

```
Test_DepositAddsMoneyToBalance() {}
Test_DepositNegativeShouldNotAddMoney() {}
Test_TransferSubtractsFromSourceAddsToDestAccount() {}
```

Automation Tests: Good Practices

- Test cases must be **repeatable**
  - Tests should **behave the same** if you run them many times
  - The expected results must be **consistent** and easily verified
- Test cases should **have no dependencies**
  - The order of test execution should never be important
  - Input data and entrance conditions should be set in the test
  - Test cases may depend on the test initialization only: **[SetUp]**
  - Tests should **cleanup** properly any resources used

Automation Tests: Good Practices

- **Single scenario** per test case, not multiple

```
[Test]
0 references
public void Test_Calculator()
{
    // Arrange:

    // Act:
    int resultOne = Calculator.Add(a: 1, b: 2);
    int resultTwo = Calculator.Subtract(a: 3, b: 2);

    // Assert:
    Assert.That(resultOne, Is.EqualTo(3));
    Assert.That(resultTwo, Is.EqualTo(1));
}
```

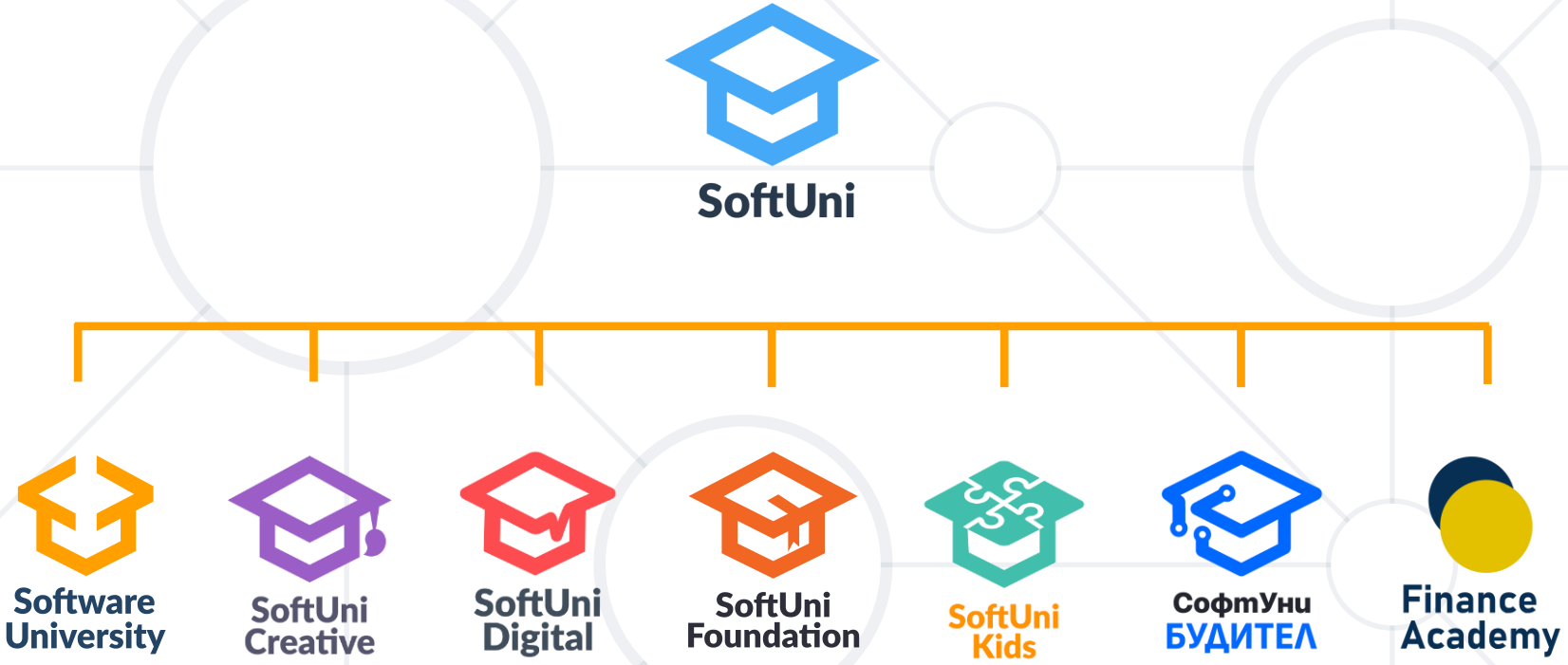
```
[Test]
0 references
public void Test_Calculator_Add()
{
    // Arrange:

    // Act:
    int result = Calculator.Add(a: 1, b: 2);

    // Assert:
    Assert.That(result, Is.EqualTo(3));
}
```

```
[Test]
0 references
public void Test_Calculator_Subtract()
{
    // Arrange:

    // Act:
    int result = Calculator.Subtract(a: 3, b: 2);

    // Assert:
    Assert.That(result, Is.EqualTo(1));
}
```

Summary

- **Unit testing** - automated testing of single component (unit)
- **NUnit** – automated testing framework for C#
  - **[Test]**, **Assert**, **[SetUp]**, **[TearDown]**
- The **AAA pattern**: Arrange, Act, Assert
- **Assertion** – checking results / exit conditions
- **Best practices** – naming and conventions

Questions?



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