# Unit Testing in C# with nUnit - Level 1

## To prepare the walkthrough

1. Open Visual Studio 2012.
2. On the **File** menu, point to **New** and then click **Project**.

The **New Project** dialog box appears.

1. Under **Installed Templates**, click **Visual C#**.
2. In the list of application types, click **Class Library**.
3. In the **Name** box, type **Bank** and then click **OK**.

|  |
| --- |
| **Note Note** |
| If the name "Bank" is already used, choose another name for the project. |

1. The new Bank project is created and displayed in Solution Explorer with the Class1.cs file open in the Code Editor.

|  |
| --- |
| **Note Note** |
| If the Class1.cs file is not open in the Code Editor, double-click the file Class1.cs in Solution Explorer to open it. |

1. Rename Class1.cs as BankAccount.cs
2. On the **Build** menu, click **Build Solution**.

You now have a project named Bank.

In this quick start, we focus on the Debit method. The Debit method is called when money is withdrawn an account and contains the following code (Copy and Paste this code into BankAccount.cs):

C#

using System;

namespace Bank

{

public class BankAccount

{

public BankAccount(string name, double startingBalance)

{

Name = name;

Balance = startingBalance;

}

public string Name { get; set; }

public double Balance { get; set; }

// method under test

public void Debit(double amount)

{

double newBalance = Balance - Math.Abs(amount);

if (amount > Balance)

{

throw new ArgumentOutOfRangeException("amount");

}

if (newBalance < 0)

{

throw new ArgumentOutOfRangeException("amount");

}

Balance = newBalance;

}

}

}

[Create a unit test project](javascript:void(0))

To create a unit test project

1. On the **File** menu, choose **Add**, and then choose **New Project ...**.
2. In the New Project dialog box, expand **Installed**, expand **Visual C#**, and then choose **ClassLibrary**.
3. In the **Name** box, enter BankTest, and then choose **OK**.

The **BankTests** project is added to the the **Bank** solution.

1. In the **BankTests** project, add a reference to the **Bank** solution.

In Solution Explorer, select **References** in the **BankTests** project and then choose **Manage Nuget Packages...** from the context menu.

1. In the dialog box, choose “Online” on the left, and search for **nUnit**. It should be the first item in the list, click install, accept dialogs, and close the Nuget Package Management window.
2. Next, we will add a reference to the Bank project by right clicking the BankTest Project, add reference. Choose the Bank project as a reference and hit ok.

[Create the test class](javascript:void(0))

We need a test class for verifying the BankAccount class. We can use the Class1.cs that was generated by the project template, but we should give the file and class more descriptive names. We can do that in one step by renaming the file in Solution Explorer.

**Renaming a class file**

In Solution Explorer, select the UnitTest1.cs file in the BankTests project. From the context menu, choose **Rename**, and then rename the file to BankAccountTests.cs. Choose **Yes** on the dialog that asks if you want to rename all references in the project to the code element 'UnitTest1'. This step changes the name of the class to BankAccountTest.

The BankAccountTests.cs file now contains the following code:

C#

using System;

using System.Collections.Generic;

using System.Linq;

using System.Text;

using System.Threading.Tasks;

namespace BankTest

{

public class BankAccountTests

{

}

}

[Test class requirements](javascript:void(0))

The minimum requirements for a test class are the following:

* Add a using statement to include nUnit’s Framework namespace at the top of BankAccountTests.cs:

using NUnit.Framework;

* The [TestFixture] attribute is required in the nunit testing framework for managed code for any class that contains unit test methods that you want to run in Test Explorer.
* Each test method that you want the Test framework to run must have the [Test] attribute.

You can have other classes in a unit test project that do not have the [TestFixture] attribute, and you can have other methods in test classes that do not have the [Test] attribute. You can use these other classes and methods in your test methods.

[Create the first test method](javascript:void(0))

In this procedure, we will write unit test methods to verify the behavior of the Debit method of the BankAccount class. The method is listed above.

By analyzing the method under test, we determine that there are at least three behaviors that need to be checked:

1. The method throws an [ArgumentOutOfRangeException] if the credit amount is greater than the balance.
2. It also throws ArgumentOutOfRangeException if the credit amount is less than zero.
3. If the checks in 1.) and 2.) are satisfied, the method subtracts the amount from the account balance.

In our first test, we verify that that a valid amount (one that is less than the account balance and that is greater than zero) withdraws the correct amount from the account.

To create a test method

1. Add the following method to that BankAccountTests class:

C#

// unit test code

[Test]

public void Debit\_WithValidAmount\_UpdatesBalance()

{

// arrange

double beginningBalance = 11.99;

double debitAmount = 4.55;

double expected = 7.44;

BankAccount account = new BankAccount("Mr. Bryan Walton", beginningBalance);

// act

account.Debit(debitAmount);

// assert

double actual = account.Balance;

Assert.AreEqual(expected, actual, 0.001, "Account not debited correctly");

}

The method is rather simple. We set up a new BankAccount object with a beginning balance and then withdraw a valid amount. We use the Microsoft unit test framework for managed code [AreEqual](http://msdn.microsoft.com/en-us/library/microsoft.visualstudio.testtools.unittesting.assert.areequal.aspx) method to verify that the ending balance is what we expect.

[Test method requirements](javascript:void(0))

A test method must meet the following requirements:

* The method must be decorated with the [Test] attribute.
* The method must return void.
* The method cannot have parameters.

[Build and run the test](javascript:void(0))

To build and run the test

1. On the **Build** menu, choose **Build Solution**.
2. If you have Resharper installed, you should see a “Resharper” menu item; if so, navigate to Resharper>Unit Test>Run Unit Tests
3. If you do not have Resharper, visit nunit.org, download their installer, and run the nUnit GUI.
4. In this case, the test does fail. The test method will be highlighted in Red. Select the method in Test Explorer to view the details at the bottom of the window.

[Fix your code and rerun your tests](javascript:void(0))

**Analyze the test results**

The test result contains a message that describes the failure. For the AreEquals method, message displays you what was expected (the (**Expected<XXX>**parameter) and what was actually received (the **Actual<YYY>** parameter). We were expecting the balance to decline from the beginning balance, but instead it has increased by the amount of the withdrawal.

A reexamination of the Debit code shows that the unit test has succeeded in finding a bug. The amount of the withdrawal is added to the account balance when it should be subtracted.

**Correct the bug**

To correct the error, simply replace the line

C#

m\_balance += amount;

with

C#

m\_balance -= amount;

**Rerun the test**

In Test Explorer, choose **Run All** to rerun the test. The red/green bar turns green, and the test is moved to the **Passed Tests** group.

[Use unit tests to improve your code](javascript:void(0))

This section describes how an iterative process of analysis, unit test development, and refactoring can help you make your production code more robust and effective.

**Analyze the issues**

After creating a test method to confirm that a valid amount is correctly deducted in the Debit method, we can turn to remaining cases in our original analysis:

1. The method throws an ArgumentOutOfRangeException if the credit amount is greater than the balance.
2. It also throws ArgumentOutOfRangeException if the credit amount is less than zero.

**Create the test methods**

A first attempt at creating a test method to address these issues seems promising:

C#

//unit test method

[Test]

[ExpectedException(typeof(ArgumentOutOfRangeException))]

public void Debit\_WhenAmountIsLessThanZero\_ShouldThrowArgumentOutOfRange()

{

// arrange

double beginningBalance = 11.99;

double debitAmount = -100.00;

BankAccount account = new BankAccount("Mr. Bryan Walton", beginningBalance);

// act

account.Debit(debitAmount);

// assert is handled by ExpectedException

}

We use the [ExpectedExceptionAttribute](http://msdn.microsoft.com/en-us/library/microsoft.visualstudio.testtools.unittesting.expectedexceptionattribute.aspx) attribute to assert that the right exception has been thrown. The attribute causes the test to fail unless anArgumentOutOfRangeException is thrown. Running the test with both positive and negative debitAmount values and then temporarily modifying the method under test to throw a generic [ApplicationException](http://msdn.microsoft.com/en-us/library/system.applicationexception.aspx) when the amount is less than zero demonstrates that test behaves correctly.

To test the case when the amount withdrawn is greater than the balance, all we need to do is:

1. Create a new test method named Debit\_WhenAmountIsMoreThanBalance\_ShouldThrowArgumentOutOfRange.
2. Copy the method body from Debit\_WhenAmountIsLessThanZero\_ShouldThrowArgumentOutOfRange to the new method.
3. Set the debitAmount to a number greater than the balance.

**Run the tests**

Running the two methods with different values for debitAmount demonstrates that the tests adequately handle our remaining cases. Running all three tests confirm that all cases in our original analysis are correctly covered.

**Continue the analysis**

However, the last two test methods are also somewhat troubling. We cannot be certain which condition in the code under test throws when either test runs. Some way of differentiating the two conditions would be helpful. As we think about the problem more, it becomes apparent that knowing which condition was violated would increase our confidence in the tests. This information would also very likely be helpful to the production mechanism that handles the exception when it is thrown by the method under test. Generating more information when the method throws would assist all concerned, but the ExpectedException attribute cannot supply this information..

Looking at the method under test again, we see both conditional statements use an ArgumentOutOfRangeException constructor that takes name of the argument as a parameter:

C#

throw new ArgumentOutOfRangeException("amount");

From a search of the MSDN Library, we discover that a constructor exists that reports far richer information. [ArgumentOutOfRangeException](http://msdn.microsoft.com/en-us/library/system.argumentoutofrangeexception.argumentoutofrangeexception.aspx)(String, Object, String) includes the name of the argument, the argument value, and a user-defined message. We can refactor the method under test to use this constructor. Even better, we can use publicly available type members to specify the errors.

**Refactor the code under test**

We first define two constants for the error messages at class scope (These values could also come from resources for localization purposes):

C#

// class under test

public const string DebitAmountExceedsBalanceMessage = "Debit amount exceeds balance";

public const string DebitAmountLessThanZeroMessage = "Debit amount will result in a negative balance.";

We then modify the two conditional statements in the Debit method:

C#

// method under test

public void Debit(double amount)

{

double newBalance = Balance - Math.Abs(amount);

if (amount > Balance)

{

throw new ArgumentOutOfRangeException("amount", amount, DebitAmountExceedsBalanceMessage);

}

if (newBalance < 0)

{

throw new ArgumentOutOfRangeException("amount", amount, DebitAmountLessThanZeroMessage);

}

Balance = newBalance;

}

// ...

**Refactor the test methods**

In our test method**, we first remove the ExpectedException attribute**. In its place, we catch the thrown exception and verify that it was thrown in the correct condition statement. However, we must now decide between two options to verify our remaining conditions.

For example in theDebit\_WhenAmountIsMoreThanBalance\_ShouldThrowArgumentOutOfRange method, we can take one of the following actions:

* Assert that the ActualValue property of the exception (the second parameter of the ArgumentOutOfRangeException constructor) is greater than the beginning balance. This option requires that we test the ActualValue property of the exception against the beginningBalance variable of the test method, and also requires then verify that the ActualValue is greater than zero.
* Assert that the message (the third parameter of the constructor) includes the DebitAmountExceedsBalanceMessage defined in the BankAccountclass.

The [StringAssert.](http://msdn.microsoft.com/en-us/library/microsoft.visualstudio.testtools.unittesting.stringassert.contains.aspx)StartsWith method in the unit test framework enables us to verify the second option without the calculations that are required of the first option.

A second attempt at revising Debit\_WhenAmountIsMoreThanBalance\_ShouldThrowArgumentOutOfRange might look like:

C#

[Test]

//[ExpectedException(typeof(ArgumentOutOfRangeException))]

public void Debit\_WhenAmountIsGreaterThanBalance\_ShouldThrowArgumentOutOfRange()

{

// arrange

double beginningBalance = 11.99;

double debitAmount = 20.0;

BankAccount account = new BankAccount("Mr. Bryan Walton", beginningBalance);

// act

try

{

account.Debit(debitAmount);

}

catch (ArgumentOutOfRangeException e)

{

// assert

StringAssert.StartsWith(BankAccount.DebitAmountExceedsBalanceMessage, e.Message);

}

}

**Retest, rewrite, and reanalyze**

When we retest the test methods with different values, we encounter the following facts:

1. If we catch the correct error by using an debitAmount that is greater than the balance, the Contains assert passes, the exception is ignored, and so the test method passes. This is the behavior we want.
2. If we use an debitAmount, the assert fails because the wrong error message is returned. The assert also fails if we introduce a temporaryArgumentOutOfRange exception at another point in the method under test code path. This too is good.
3. If the debitAmount value is valid (i.e., less than the balance but greater than zero, no exception is caught, so the assert is never caught. The test method passes. This is not good, because we want the test method to fail if no exception is thrown.

The third fact is a bug in our test method. To attempt to resolve the issue, we add a [Fail](http://msdn.microsoft.com/en-us/library/microsoft.visualstudio.testtools.unittesting.assert.fail.aspx) assert at the end of the test method to handle the case where no exception is thrown.

But retesting shows that the test now fails if the correct exception is caught. The catch statement resets the exception and the method continues to execute, failing at the new assert. To resolve the new problem, we add a return statement after the StringAssert. Retesting confirms that we have fixed our problems. Our final version of the Debit\_WhenAmountIsMoreThanBalance\_ShouldThrowArgumentOutOfRange looks like the following:

C#

[Test]

//[ExpectedException(typeof(ArgumentOutOfRangeException))]

public void Debit\_WhenAmountIsGreaterThanBalance\_ShouldThrowArgumentOutOfRange()

{

// arrange

double beginningBalance = 11.99;

double debitAmount = 20.0;

BankAccount account = new BankAccount("Mr. Bryan Walton", beginningBalance);

// act

try

{

account.Debit(debitAmount);

}

catch (ArgumentOutOfRangeException e)

{

// assert

StringAssert.StartsWith(BankAccount.DebitAmountExceedsBalanceMessage, e.Message);

return;

}

Assert.Fail("No exception was thrown");

}

In this final section, the work that we did improving our test code led to more robust and informative test methods. But more importantly, the extra analysis also led to better code in our project under test.