



JUNIT

testing framework

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About the Tutorial

JUnit is a unit testing framework for Java programming language. JUnit has been important in the development of test-driven development, and is one of a family of unit testing frameworks collectively known as xUnit, that originated with JUnit.

This tutorial explains the use of JUnit in your project unit testing, while working with Java. After completing this tutorial you will gain sufficient knowledge in using JUnit testing framework from where you can take yourself to next levels.

Audience

This tutorial has been prepared for beginners to help them understand the basic functionality of JUnit tool.

Prerequisites

We assume you are going to use JUnit to handle all levels of Java projects development. So it will be good if you have the knowledge of software development using any programming language, especially Java programming and software testing process.

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1. OVERVIEW

Testing is the process of checking the functionality of an application to ensure it runs as per requirements. Unit testing comes into picture at the developers' level; it is the testing of single entity (class or method). Unit testing plays a critical role in helping a software company deliver quality products to its customers.

Unit testing can be done in two ways: manual testing and automated testing.

Manual Testing	Automated Testing
Executing a test cases manually without any tool support is known as manual testing.	Taking tool support and executing the test cases by using an automation tool is known as automation testing.
Time-consuming and tedious: Since test cases are executed by human resources, it is very slow and tedious.	Fast: Automation runs test cases significantly faster than human resources.
Huge investment in human resources: As test cases need to be executed manually, more testers are required in manual testing.	Less investment in human resources: Test cases are executed using automation tools, so less number of testers are required in automation testing.
Less reliable: Manual testing is less reliable, as it has to account for human errors.	More reliable: Automation tests are precise and reliable.
Non-programmable: No programming can be done to write sophisticated tests to fetch hidden information.	Programmable: Testers can program sophisticated tests to bring out hidden information.

What is JUnit?

JUnit is a unit testing framework for Java programming language. It plays a crucial role test-driven development, and is a family of unit testing frameworks collectively known as xUnit.

JUnit promotes the idea of "first testing then coding", which emphasizes on setting up the test data for a piece of code that can be tested first and then implemented. This approach is like "test a little, code a little, test a little, code a little." It increases the productivity of the programmer and the stability of

program code, which in turn reduces the stress on the programmer and the time spent on debugging.

Features of JUnit

- JUnit is an open source framework, which is used for writing and running tests.
- Provides annotations to identify test methods.
- Provides assertions for testing expected results.
- Provides test runners for running tests.
- JUnit tests allow you to write codes faster, which increases quality.
- JUnit is elegantly simple. It is less complex and takes less time.
- JUnit tests can be run automatically and they check their own results and provide immediate feedback. There's no need to manually comb through a report of test results.
- JUnit tests can be organized into test suites containing test cases and even other test suites.
- JUnit shows test progress in a bar that is green if the test is running smoothly, and it turns red when a test fails.

What is a Unit Test Case?

A Unit Test Case is a part of code, which ensures that another part of code (method) works as expected. To achieve the desired results quickly, a test framework is required. JUnit is a perfect unit test framework for Java programming language.

A formal written unit test case is characterized by a known input and an expected output, which is worked out before the test is executed. The known input should test a precondition and the expected output should test a post-condition.

There must be at least two unit test cases for each requirement: one positive test and one negative test. If a requirement has sub-requirements, each sub-requirement must have at least two test cases as positive and negative.

2. ENVIRONMENT SETUP

Try it Online Option

We already have set up Java programming environment online, so that you can compile and execute all the available examples online at the same time while you are doing your theory work. It gives you confidence in what you are reading and verify the programs with different options. Feel free to modify any example and execute it online.

Try the following example using our online compiler option available at <http://www.compileonline.com/>.

```
public class MyFirstJavaProgram {  
    public static void main(String []args) {  
        System.out.println("Hello World");  
    }  
}
```

For most of the examples given in this tutorial, you will find a **Try it** option in our website code sections at the top right corner that will take you to the online compiler. So just make use of it and enjoy your learning.

Local Environment Setup

JUnit is a framework for Java, so the very first requirement is to have JDK installed in your machine.

System Requirement

JDK	1.5 or above.
Memory	No minimum requirement.
Disk Space	No minimum requirement.
Operating System	No minimum requirement.

Step 1: Verify Java Installation in Your Machine

First of all, open the console and execute a java command based on the operating system you are working on.

OS	Task	Command
Windows	Open Command Console	c:\> java -version
Linux	Open Command Terminal	\$ java -version
Mac	Open Terminal	machine:~ joseph\$ java -version

Let's verify the output for all the operating systems:

OS	Output
Windows	java version "1.6.0_21" Java(TM) SE Runtime Environment (build 1.6.0_21-b07) Java HotSpot(TM) Client VM (build 17.0-b17, mixed mode, sharing)
Linux	java version "1.6.0_21" Java(TM) SE Runtime Environment (build 1.6.0_21-b07) Java HotSpot(TM) Client VM (build 17.0-b17, mixed mode, sharing)
Mac	java version "1.6.0_21" Java(TM) SE Runtime Environment (build 1.6.0_21-b07) Java HotSpot(TM)64-Bit Server VM (build 17.0-b17, mixed mode, sharing)

If you do not have Java installed on your system, then download the Java Software Development Kit (SDK) from the following link:

<http://www.oracle.com/technetwork/java/javase/downloads/index.html>

We are assuming Java 1.6.0_21 as the installed version for this tutorial.

Step 2: Set JAVA Environment

Set the **JAVA_HOME** environment variable to point to the base directory location where Java is installed on your machine. For example,

OS	Output
Windows	Set the environment variable JAVA_HOME to C:\Program Files\Java\jdk1.6.0_21
Linux	export JAVA_HOME=/usr/local/java-current
Mac	export JAVA_HOME=/Library/Java/Home

Append Java compiler location to the System Path.

OS	Output
Windows	Append the string C:\Program Files\Java\jdk1.6.0_21\bin at the end of the system variable, Path .
Linux	export PATH=\$PATH:\$JAVA_HOME/bin/
Mac	not required

Verify Java installation using the command **java -version** as explained above.

Step 3: Download Junit Archive

Download the latest version of JUnit jar file from <http://www.junit.org>. At the time of writing this tutorial, we have downloaded Junit-4.10.jar and copied it into C:\>JUnit folder.

OS	Archive name
Windows	junit4.10.jar
Linux	junit4.10.jar

Mac	junit4.10.jar
-----	---------------

Step 4: Set JUnit Environment

Set the **JUNIT_HOME** environment variable to point to the base directory location where JUNIT jar is stored on your machine. Let's assuming we've stored junit4.10.jar in the JUNIT folder.

OS	Description
Windows	Set the environment variable JUNIT_HOME to C:\JUNIT
Linux	export JUNIT_HOME=/usr/local/JUNIT
Mac	export JUNIT_HOME=/Library/JUNIT

Step 5: Set CLASSPATH Variable

Set the **CLASSPATH** environment variable to point to the JUNIT jar location.

OS	Description
Windows	Set the environment variable CLASSPATH to %CLASSPATH%;%JUNIT_HOME%\junit4.10.jar;.;
Linux	export CLASSPATH=\$CLASSPATH:\$JUNIT_HOME/junit4.10.jar:.
Mac	export CLASSPATH=\$CLASSPATH:\$JUNIT_HOME/junit4.10.jar:.

Step 6: Test JUnit Setup

Create a java class file name TestJUnit in **C:\>JUNIT_WORKSPACE**

```
import org.junit.Test;
import static org.junit.Assert.assertEquals;
public class TestJUnit {
    @Test
```

```
public void testAdd() {
    String str= "JUnit is working fine";
    assertEquals("JUnit is working fine",str);
}
}
```

Create a java class file name TestRunner in **C:\>JUNIT_WORKSPACE** to execute test case(s).

```
import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(TestJUnit.class);
        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }
        System.out.println(result.wasSuccessful());
    }
}
```

Step 7: Verify the Result

Compile the classes using **javac** compiler as follows:

```
C:\JUNIT_WORKSPACE>javac TestJUnit.java TestRunner.java
```

Now run the Test Runner to see the result as follows:

```
C:\JUNIT_WORKSPACE>java TestRunner
```

Verify the output.

```
true
```

3. TEST FRAMEWORK

JUnit is a **Regression Testing Framework** used by developers to implement unit testing in Java, and accelerate programming speed and increase the quality of code. JUnit Framework can be easily integrated with either of the following:

- Eclipse
- Ant
- Maven

Features of Junit Test Framework

JUnit test framework provides the following important features:

- Fixtures
- Test suites
- Test runners
- JUnit classes

Fixtures

Fixtures is a fixed state of a set of objects used as a baseline for running tests. The purpose of a test fixture is to ensure that there is a well-known and fixed environment in which tests are run so that results are repeatable. It includes:

- setUp() method, which runs before every test invocation.
- tearDown() method, which runs after every test method.

Let's check one example:

```
import junit.framework.*;

public class JavaTest extends TestCase {
    protected int value1, value2;

    // assigning the values
    protected void setUp(){
        value1=3;
```

```

        value2=3;
    }

    // test method to add two values
    public void testAdd(){
        double result= value1 + value2;
        assertTrue(result == 6);
    }
}

```

Test Suites

A test suite bundles a few unit test cases and runs them together. In JUnit, both `@RunWith` and `@Suite` annotation are used to run the suite test. Given below is an example that uses `TestJUnit1` & `TestJUnit2` test classes.

```

import org.junit.runner.RunWith;
import org.junit.runners.Suite;

//JUnit Suite Test
@RunWith(Suite.class)
@Suite.SuiteClasses({
    TestJUnit1.class ,TestJUnit2.class
})
public class JunitTestSuite {
}

import org.junit.Test;
import org.junit.Ignore;
import static org.junit.Assert.assertEquals;

public class TestJUnit1 {

    String message = "Robert";
    MessageUtil messageUtil = new MessageUtil(message);
}

```

```

@Test
public void testPrintMessage() {
    System.out.println("Inside testPrintMessage()");
    assertEquals(message, messageUtil.printMessage());
}
}
import org.junit.Test;
import org.junit.Ignore;
import static org.junit.Assert.assertEquals;

public class TestJUnit2 {

    String message = "Robert";
    MessageUtil messageUtil = new MessageUtil(message);

    @Test
    public void testSalutationMessage() {
        System.out.println("Inside testSalutationMessage()");
        message = "Hi!" + "Robert";
        assertEquals(message,messageUtil.salutationMessage());
    }
}

```

Test Runners

Test runner is used for executing the test cases. Here is an example that assumes the test class **TestJUnit** already exists.

```

import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(TestJUnit.class);
    }
}

```

```
    for (Failure failure : result.getFailures()) {  
        System.out.println(failure.toString());  
    }  
    System.out.println(result.wasSuccessful());  
}  
}
```

JUnit Classes

JUnit classes are important classes, used in writing and testing JUnits. Some of the important classes are:

- Assert - Contains a set of assert methods.
- TestCase - Contains a test case that defines the fixture to run multiple tests.
- TestResult - Contains methods to collect the results of executing a test case.

4. BASIC USAGE

Let us now have a basic example to demonstrate the step-by-step process of using Junit.

Create a Class

Create a java class to be tested, say, MessageUtil.java in **C:\> JUNIT_WORKSPACE**

```
/*
 * This class prints the given message on console.
 */
public class MessageUtil {

    private String message;

    //Constructor
    //@param message to be printed
    public MessageUtil(String message){
        this.message = message;
    }

    // prints the message
    public String printMessage(){
        System.out.println(message);
        return message;
    }
}
```

Create Test Case Class

1. Create a java test class, say, TestJunit.java.
2. Add a test method testPrintMessage() to your test class.
3. Add an Annotation @Test to method testPrintMessage().

4. Implement the test condition and check the condition using assertEquals API of Junit.

Create a java class file name TestJUnit.java in C:\>JUNIT_WORKSPACE.

```
import org.junit.Test;
import static org.junit.Assert.assertEquals;
public class TestJUnit {

    String message = "Hello World";
    MessageUtil messageUtil = new MessageUtil(message);

    @Test
    public void testPrintMessage() {
        assertEquals(message,messageUtil.printMessage());
    }
}
```

Create Test Runner Class

1. Create a TestRunner java class.
2. Use runClasses method of JUnitCore class of JUnit to run the test case of the above created test class.
3. Get the result of test cases run in Result Object.
4. Get failure(s) using the getFailures() method of Result object.
5. Get Success result using the wasSuccessful() method of Result object.

Create a java class file named TestRunner.java in C:\>JUNIT_WORKSPACE to execute test case(s).

```
import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(TestJUnit.class);
    }
}
```

```

        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }
        System.out.println(result.wasSuccessful());
    }
}

```

Compile the MessageUtil, Test case and Test Runner classes using javac.

```
C:\JUNIT_WORKSPACE>javac MessageUtil.java TestJUnit.java TestRunner.java
```

Now run the Test Runner, which will run the test case defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner
```

Verify the output.

```

Hello World
true

```

Now update TestJUnit in C:\>JUNIT_WORKSPACE so that the test fails. Change the message string.

```

import org.junit.Test;
import static org.junit.Assert.assertEquals;
public class TestJUnit {

    String message = "Hello World";
    MessageUtil messageUtil = new MessageUtil(message);

    @Test
    public void testPrintMessage() {
        message = "New Word";
        assertEquals(message,messageUtil.printMessage());
    }
}

```

Let's keep the rest of the classes as is, and try to run the same Test Runner.

```
import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(TestJUnit.class);
        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }
        System.out.println(result.wasSuccessful());
    }
}
```

Now run the Test Runner, which will run the test case defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner
```

Verify the output.

```
Hello World
testPrintMessage(TestJUnit): expected:<[New Wor]d> but was:<[Hello
Worl]d>
false
```

5. API

The most important package in JUnit is **junit.framework**, which contains all the core classes. Some of the important classes are as follows:

S. No.	Class Name	Functionality
1	Assert	A set of assert methods.
2	TestCase	A test case defines the fixture to run multiple tests.
3	TestResult	A TestResult collects the results of executing a test case.
4	TestSuite	A TestSuite is a composite of tests.

Assert Class

Following is the declaration for **org.junit.Assert** class:

```
public class Assert extends java.lang.Object
```

This class provides a set of assertion methods useful for writing tests. Only failed assertions are recorded. Some of the important methods of Assert class are as follows:

S.No.	Methods & Description
1	void assertEquals(boolean expected, boolean actual) Checks that two primitives/objects are equal.
2	void assertFalse(boolean condition) Checks that a condition is false.
3	void assertNotNull(Object object) Checks that an object isn't null.

4	void assertNull(Object object) Checks that an object is null.
5	void assertTrue(boolean condition) Checks that a condition is true.
6	void fail() Fails a test with no message.

Let's use some of the above-mentioned methods in an example. Create a java class file named **TestJUnit1.java** in C:\>JUNIT_WORKSPACE.

```
import org.junit.Test;
import static org.junit.Assert.*;
public class TestJUnit1 {
    @Test
    public void testAdd() {
        //test data
        int num= 5;
        String temp= null;
        String str= "JUnit is working fine";

        //check for equality
        assertEquals("JUnit is working fine", str);

        //check for false condition
        assertFalse(num > 6);

        //check for not null value
        assertNotNull(str);
    }
}
```

Next, create a java class file named **TestRunner1.java** in C:\> JUNIT_WORKSPACE to execute test case(s).

```
import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner1 {
    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(TestJUnit1.class);
        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }
        System.out.println(result.wasSuccessful());
    }
}
```

Compile the test case and Test Runner classes using javac.

```
C:\JUNIT_WORKSPACE>javac TestJUnit1.java TestRunner1.java
```

Now run the Test Runner, which will run the test case defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner1
```

Verify the output.

```
true
```

TestCase Class

Following is the declaration for **org.junit.TestCaset** class:

```
public abstract class TestCase extends Assert implements Test
```

A test case defines the fixture to run multiple tests. Some of the important methods of **TestCase** class are as follows:

S.No.	Methods & Description
1	int countTestCases() Counts the number of test cases executed by run(TestResult result).
2	TestResult createResult() Creates a default TestResult object.
3	String getName() Gets the name of a TestCase.
4	TestResult run() A convenience method to run this test, collecting the results with a default TestResult object.
5	void run(TestResult result) Runs the test case and collects the results in TestResult.
6	void setName(String name) Sets the name of a TestCase.
7	void setUp() Sets up the fixture, for example, open a network connection.
8	void tearDown() Tears down the fixture, for example, close a network connection.
9	String toString() Returns a string representation of the test case.

Let's use some of the above-mentioned methods in an example. Create a java class file named **TestJunit2.java** in C:\>JUNIT_WORKSPACE.

```
import junit.framework.TestCase;
import org.junit.Before;
```



```

import org.junit.Test;
public class TestJUnit2 extends TestCase {
    protected double fValue1;
    protected double fValue2;

    @Before
    public void setUp() {
        fValue1= 2.0;
        fValue2= 3.0;
    }

    @Test
    public void testAdd() {
        //count the number of test cases
        System.out.println("No of Test Case = "+ this.countTestCases());

        //test getName
        String name= this.getName();
        System.out.println("Test Case Name = "+ name);

        //test setName
        this.setName("testNewAdd");
        String newName= this.getName();
        System.out.println("Updated Test Case Name = "+ newName);
    }
    //tearDown used to close the connection or clean up activities
    public void tearDown( ) {
    }
}

```

Next, create a java class file named **TestRunner2.java** in C:\> JUNIT_WORKSPACE to execute test case(s).

```

import org.junit.runner.JUnitCore;
import org.junit.runner.Result;

```

```

import org.junit.runner.notification.Failure;

public class TestRunner2 {
    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(TestJUnit2.class);
        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }
        System.out.println(result.wasSuccessful());
    }
}

```

Compile the test case and Test Runner classes using javac.

```
C:\JUNIT_WORKSPACE>javac TestJUnit2.java TestRunner2.java
```

Now run the Test Runner, which will run the test case defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner2
```

Verify the output.

```

No of Test Case = 1
Test Case Name = testAdd
Updated Test Case Name = testNewAdd
true

```

TestResult Class

Following is the declaration for **org.junit.TestResult** class:

```
public class TestResult extends Object
```

A TestResult collects the results of executing a test case. It is an instance of the Collecting Parameter pattern. The test framework distinguishes between failures and errors. A failure is anticipated and checked for with assertions. Errors are unanticipated problems like an `ArrayIndexOutOfBoundsException`. Some of the important methods of **TestResult** class are as follows:

S.No.	Methods & Description
1	void addError(Test test, Throwable t) Adds an error to the list of errors.
2	void addFailure(Test test, AssertionError t) Adds a failure to the list of failures.
3	void endTest(Test test) Informs the result that a test was completed.
4	int errorCount() Gets the number of detected errors.
5	Enumeration<TestFailure> errors() Returns an Enumeration for the errors.
6	int failureCount() Gets the number of detected failures.
7	void run(TestCase test) Runs a TestCase.
8	int int runCount() Gets the number of run tests.
9	void startTest(Test test) Informs the result that a test will be started.
10	void stop() Marks that the test run should stop.

Create a java class file named **TestJUnit3.java** in C:\> JUNIT_WORKSPACE.

```
import org.junit.Test;
import junit.framework.AssertionFailedError;
import junit.framework.TestResult;

public class TestJUnit3 extends TestResult {
    // add the error
    public synchronized void addError(Test test, Throwable t) {
        super.addError((junit.framework.Test) test, t);
    }

    // add the failure
    public synchronized void addFailure(Test test, AssertionFailedError t) {
        super.addFailure((junit.framework.Test) test, t);
    }

    @Test
    public void testAdd() {
        // add any test
    }

    // Marks that the test run should stop.
    public synchronized void stop() {
        //stop the test here
    }
}
```

Next, create a java class file named **TestRunner3.java** in C:\> JUNIT_WORKSPACE to execute test case(s).

```
import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner3 {
    public static void main(String[] args) {
```

```

    Result result = JUnitCore.runClasses(TestJUnit3.class);
    for (Failure failure : result.getFailures()) {
        System.out.println(failure.toString());
    }
    System.out.println(result.wasSuccessful());
}
}

```

Compile the test case and Test Runner classes using javac.

```
C:\JUNIT_WORKSPACE>javac TestJUnit3.java TestRunner3.java
```

Now run the Test Runner, which will run the test case defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner3
```

Verify the output.

```
true
```

TestSuite Class

Following is the declaration for **org.junit.TestSuite** class:

```
public class TestSuite extends Object implements Test
```

A TestSuite is a composite of tests. It runs a collection of test cases. Some of the important methods of **TestSuite** class are as follows:

S.No.	Methods & Description
1	void addTest(Test test) Adds a test to the suite.
2	void addTestSuite(Class<? extends TestCase> testClass) Adds the tests from the given class to the suite.
3	int countTestCases() Counts the number of test cases that will be run by this test.

4	String getName() Returns the name of the suite.
5	void run(TestResult result) Runs the tests and collects their result in a TestResult.
6	void setName(String name) Sets the name of the suite.
7	Test testAt(int index) Returns the test at the given index.
8	int testCount() Returns the number of tests in this suite.
9	static Test warning(String message) Returns a test, which will fail and log a warning message.

Create a java class file named **JUnitTestSuite.java** in C:\> JUNIT_WORKSPACE to create Test suite.

```
import junit.framework.*;
public class JUnitTestSuite {
    public static void main(String[] a) {
        // add the test's in the suite
        TestSuite suite = new TestSuite(TestJUnit1.class, TestJUnit2.class,
        TestJUnit3.class);
        TestResult result = new TestResult();
        suite.run(result);
        System.out.println("Number of test cases = " + result.runCount());
    }
}
```

Compile the Test suite classes using javac.

```
C:\JUNIT_WORKSPACE>javac JunitTestSuite.java
```

Now run the Test Suite.

```
C:\JUNIT_WORKSPACE>java JunitTestSuite
```

Verify the output.

```
No of Test Case = 1  
Test Case Name = testAdd  
Updated Test Case Name = testNewAdd  
Number of test cases = 3
```

6. WRITING A TEST

Here we will see one complete example of JUnit testing using POJO class, Business logic class, and a test class, which will be run by the test runner.

Create **EmployeeDetails.java** in C:\>JUNIT_WORKSPACE, which is a POJO class.

```
public class EmployeeDetails {

    private String name;
    private double monthlySalary;
    private int age;

    /**
     * @return the name
     */
    public String getName() {
        return name;
    }

    /**
     * @param name the name to set
     */
    public void setName(String name) {
        this.name = name;
    }

    /**
     * @return the monthlySalary
     */
    public double getMonthlySalary() {
        return monthlySalary;
    }

    /**
     * @param monthlySalary the monthlySalary to set
     */
}
```



```

    */
    public void setMonthlySalary(double monthlySalary) {
        this.monthlySalary = monthlySalary;
    }
    /**
     * @return the age
     */
    public int getAge() {
        return age;
    }
    /**
     * @param age the age to set
     */
    public void setAge(int age) {
        this.age = age;
    }
}

```

EmployeeDetails class is used to:

- get/set the value of employee's name.
- get/set the value of employee's monthly salary.
- get/set the value of employee's age.

Create a file called **EmpBusinessLogic.java** in C:\>JUNIT_WORKSPACE, which contains the business logic.

```

public class EmpBusinessLogic {
    // Calculate the yearly salary of employee
    public double calculateYearlySalary(EmployeeDetails employeeDetails){
        double yearlySalary=0;
        yearlySalary = employeeDetails.getMonthlySalary() * 12;
        return yearlySalary;
    }

    // Calculate the appraisal amount of employee

```

```

public double calculateAppraisal(EmployeeDetails employeeDetails){
    double appraisal=0;

    if(employeeDetails.getMonthlySalary() < 10000){
        appraisal = 500;
    }else{
        appraisal = 1000;
    }
    return appraisal;
}
}

```

EmpBusinessLogic class is used for calculating:

- the yearly salary of an employee.
- the appraisal amount of an employee.

Create a file called **TestEmployeeDetails.java** in C:\>JUNIT_WORKSPACE, which contains the test cases to be tested.

```

import org.junit.Test;
import static org.junit.Assert.assertEquals;

public class TestEmployeeDetails {
    EmpBusinessLogic empBusinessLogic =new EmpBusinessLogic();
    EmployeeDetails employee = new EmployeeDetails();

    //test to check appraisal
    @Test
    public void testCalculateAppriasal() {
        employee.setName("Rajeev");
        employee.setAge(25);
        employee.setMonthlySalary(8000);
        double appraisal= empBusinessLogic.calculateAppraisal(employee);
        assertEquals(500, appraisal, 0.0);
    }
}

```

```

// test to check yearly salary
@Test

public void testCalculateYearlySalary() {
    employee.setName("Rajeev");
    employee.setAge(25);
    employee.setMonthlySalary(8000);
    double salary= empBusinessLogic.calculateYearlySalary(employee);
    assertEquals(96000, salary, 0.0);
}
}

```

TestEmployeeDetails class is used for testing the methods of **EmpBusinessLogic** class. It

- tests the yearly salary of the employee.
- tests the appraisal amount of the employee.

Next, create a java class filed named **TestRunner.java** in C:\>JUNIT_WORKSPACE to execute test case(s).

```

import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(TestEmployeeDetails.class);
        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }
        System.out.println(result.wasSuccessful());
    }
}
}

```

Compile the test case and Test Runner classes using javac.

```

C:\JUNIT_WORKSPACE>javac EmployeeDetails.java
EmpBusinessLogic.java TestEmployeeDetails.java TestRunner.java

```

Now run the Test Runner, which will run the test case defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner
```

Verify the output.

```
true
```

7. USING ASSERTION

Assertion

All the assertions are in the Assert class.

```
public class Assert extends java.lang.Object
```

This class provides a set of assertion methods, useful for writing tests. Only failed assertions are recorded. Some of the important methods of Assert class are as follows:

S.No.	Methods & Description
1	void assertEquals(boolean expected, boolean actual) Checks that two primitives/objects are equal.
2	void assertTrue(boolean expected, boolean actual) Checks that a condition is true.
3	void assertFalse(boolean condition) Checks that a condition is false.
4	void assertNotNull(Object object) Checks that an object isn't null.
5	void assertNull(Object object) Checks that an object is null.
6	void assertSame(boolean condition) The assertEquals() method tests if two object references point to the same object.
7	void assertNotSame(boolean condition) The assertEquals() method tests if two object references do not

	point to the same object.
8	<p>void assertEquals(expectedArray, resultArray);</p> <p>The assertEquals() method will test whether two arrays are equal to each other.</p>

Let's use some of the above-mentioned methods in an example. Create a java class file named **TestAssertions.java** in C:\> JUNIT_WORKSPACE.

```
import org.junit.Test;
import static org.junit.Assert.*;

public class TestAssertions {

    @Test
    public void testAssertions() {
        //test data
        String str1 = new String ("abc");
        String str2 = new String ("abc");
        String str3 = null;
        String str4 = "abc";
        String str5 = "abc";
        int val1 = 5;
        int val2 = 6;
        String[] expectedArray = {"one", "two", "three"};
        String[] resultArray = {"one", "two", "three"};

        //Check that two objects are equal
        assertEquals(str1, str2);

        //Check that a condition is true
        assertTrue (val1 < val2);

        //Check that a condition is false
```

```

    assertFalse(val1 > val2);

    //Check that an object isn't null
    assertNotNull(str1);

    //Check that an object is null
    assertNull(str3);

    //Check if two object references point to the same object
    assertEquals(str4, str5);

    //Check if two object references not point to the same object
    assertNotSame(str1, str3);

    //Check whether two arrays are equal to each other.
    assertEquals(expectedArray, resultArray);
}
}

```

Next, create a java class file named **TestRunner.java** in C:\> JUNIT_WORKSPACE to execute test case(s).

```

import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner2 {
    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(TestAssertions.class);
        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }
        System.out.println(result.wasSuccessful());
    }
}

```

Compile the Test case and Test Runner classes using javac.

```
C:\JUNIT_WORKSPACE>javac TestAssertions.java TestRunner.java
```

Now run the Test Runner, which will run the test case defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner
```

Verify the output.

```
true
```

Annotation

Annotations are like meta-tags that you can add to your code, and apply them to methods or in class. These annotations in JUnit provide the following information about test methods:

- which methods are going to run before and after test methods,
- which methods run before and after all the methods, and
- which methods or classes will be ignored during the execution.

The following table provides a list of annotations and their meaning in JUnit:

S.No.	Annotation & Description
1	<p>@Test</p> <p>The Test annotation tells JUnit that the public void method to which it is attached can be run as a test case.</p>
2	<p>@Before</p> <p>Several tests need similar objects created before they can run. Annotating a public void method with @Before causes that method to be run before each Test method.</p>
3	<p>@After</p> <p>If you allocate external resources in a Before method, you need to release them after the test runs. Annotating a public void method with @After causes that method to be run after the Test method.</p>

4	@BeforeClass Annotating a public static void method with @BeforeClass causes it to be run once before any of the test methods in the class.
5	@AfterClass This will perform the method after all tests have finished. This can be used to perform clean-up activities.
6	@Ignore The Ignore annotation is used to ignore the test and that test will not be executed.

Create a java class file named **JUnitAnnotation.java** in C:\> JUNIT_WORKSPACE to test annotation.

```
import org.junit.After;
import org.junit.AfterClass;
import org.junit.Before;
import org.junit.BeforeClass;
import org.junit.Ignore;
import org.junit.Test;

public class JunitAnnotation {

    //execute before class
    @BeforeClass
    public static void beforeClass() {
        System.out.println("in before class");
    }

    //execute after class
    @AfterClass
    public static void afterClass() {
        System.out.println("in after class");
    }
}
```

```
}

//execute before test
@Before
public void before() {
    System.out.println("in before");
}

//execute after test
@After
public void after() {
    System.out.println("in after");
}

//test case
@Test
public void test() {
    System.out.println("in test");
}

//test case ignore and will not execute
@Ignore
public void ignoreTest() {
    System.out.println("in ignore test");
}
}
```

Next, create a java class file named **TestRunner.java** in C:\> JUNIT_WORKSPACE to execute annotations.

```
import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
```

```
public static void main(String[] args) {
    Result result = JUnitCore.runClasses(JunitAnnotation.class);
    for (Failure failure : result.getFailures()) {
        System.out.println(failure.toString());
    }
    System.out.println(result.wasSuccessful());
}
}
```

Compile the Test case and Test Runner classes using javac.

```
C:\JUNIT_WORKSPACE>javac JunitAnnotation.java TestRunner.java
```

Now run the Test Runner, which will run the test case defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner
```

Verify the output.

```
in before class
in before
in test
in after
in after class
true
```

8. EXECUTION PROCEDURE

This chapter explains the execution procedure of methods in JUnit, which defines the order of the methods called. Discussed below is the execution procedure of the JUnit test API methods with example.

Create a java class file named JunitAnnotation.java in C:\> JUNIT_WORKSPACE to test annotation.

```
import org.junit.After;
import org.junit.AfterClass;
import org.junit.Before;
import org.junit.BeforeClass;
import org.junit.Ignore;
import org.junit.Test;

public class ExecutionProcedureJUnit {

    //execute only once, in the starting
    @BeforeClass
    public static void beforeClass() {
        System.out.println("in before class");
    }

    //execute only once, in the end
    @AfterClass
    public static void afterClass() {
        System.out.println("in after class");
    }

    //execute for each test, before executing test
    @Before
    public void before() {
        System.out.println("in before");
    }
}
```

```

}

//execute for each test, after executing test
@After
public void after() {
    System.out.println("in after");
}

//test case 1
@Test
public void testCase1() {
    System.out.println("in test case 1");
}

//test case 2
@Test
public void testCase2() {
    System.out.println("in test case 2");
}
}

```

Next, create a java class file named **TestRunner.java** in C:\> JUNIT_WORKSPACE to execute annotations.

```

import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
    public static void main(String[] args) {
        Result result =
JUnitCore.runClasses(ExecutionProcedureJUnit.class);
        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }
    }
}

```

```
        System.out.println(result.wasSuccessful());
    }
}
```

Compile the Test case and Test Runner classes using javac.

```
C:\JUNIT_WORKSPACE>javac ExecutionProcedureJUnit.java TestRunner.java
```

Now run the Test Runner, which will run the test case defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner
```

Verify the output.

```
in before class
in before
in test case 1
in after
in before
in test case 2
in after
in after class
```

See the above output. The execution procedure is as follows:

- First of all, the beforeClass() method executes only once.
- The afterClass() method executes only once.
- The before() method executes for each test case, but before executing the test case.
- The after() method executes for each test case, but after the execution of test case.
- In between before() and after(), each test case executes.

9. EXECUTING TESTS

The test cases are executed using **JUnitCore** class. JUnitCore is a facade for running tests. It supports running JUnit 4 tests, JUnit 3.8.x tests, and mixtures. To run tests from the command line, run `java org.junit.runner.JUnitCore <TestClass>`. For one-shot test runs, use the static method `runClasses(Class[])`.

Following is the declaration for **org.junit.runner.JUnitCore** class:

```
public class JUnitCore extends java.lang.Object
```

Here we will see how to execute the tests with the help of JUnitCore.

Create a Class

Create a java class to be tested, say, **MessageUtil.java**, in `C:\>JUNIT_WORKSPACE`.

```
/*
 * This class prints the given message on console.
 */
public class MessageUtil {

    private String message;

    //Constructor
    //@param message to be printed
    public MessageUtil(String message){
        this.message = message;
    }

    // prints the message
    public String printMessage(){
        System.out.println(message);
        return message;
    }
}
```

Create Test Case Class

- Create a java test class, say, TestJUnit.java.
- Add a test method testPrintMessage() to your test class.
- Add an Annotation @Test to the method testPrintMessage().
- Implement the test condition and check the condition using assertEquals API of Junit.

Create a java class file named **TestJUnit.java** in C:\>JUNIT_WORKSPACE.

```
import org.junit.Test;
import static org.junit.Assert.assertEquals;
public class TestJUnit {

    String message = "Hello World";
    MessageUtil messageUtil = new MessageUtil(message);

    @Test
    public void testPrintMessage() {
        assertEquals(message,messageUtil.printMessage());
    }
}
```

Create Test Runner Class

Now create a java class file named **TestRunner.java** in C:\>JUNIT_WORKSPACE to execute test case(s). It imports the JUnitCore class and uses the runClasses() method that takes the test class name as its parameter.

```
import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(TestJUnit.class);
        for (Failure failure : result.getFailures()) {
```



```
        System.out.println(failure.toString());
    }

    System.out.println(result.wasSuccessful());
}
}
```

Compile the Test case and Test Runner classes using javac.

```
C:\JUNIT_WORKSPACE>javac MessageUtil.java TestJUnit.java TestRunner.java
```

Now run the Test Runner, which will run the test case defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner
```

Verify the output.

```
Hello World
true
```

10. SUITE TEST

Test suite is used to bundle a few unit test cases and run them together. In JUnit, both **@RunWith** and **@Suite** annotations are used to run the suite tests. This chapter takes an example having two test classes, **TestJunit1** & **TestJunit2**, that run together using Test Suite.

Create a Class

Create a java class to be tested, say, **MessageUtil.java** in C:\> JUNIT_WORKSPACE.

```
/*
 * This class prints the given message on console.
 */
public class MessageUtil {

    private String message;

    //Constructor
    //@param message to be printed
    public MessageUtil(String message){
        this.message = message;
    }

    // prints the message
    public String printMessage(){
        System.out.println(message);
        return message;
    }

    // add "Hi!" to the message
    public String salutationMessage(){
        message = "Hi!" + message;
        System.out.println(message);
    }
}
```

```

    return message;
}
}

```

Create Test Case Classes

Create a java class file named **TestJUnit1.java** in C:\>JUNIT_WORKSPACE.

```

import org.junit.Test;
import org.junit.Ignore;
import static org.junit.Assert.assertEquals;

public class TestJUnit1 {

    String message = "Robert";
    MessageUtil messageUtil = new MessageUtil(message);

    @Test
    public void testPrintMessage() {
        System.out.println("Inside testPrintMessage()");
        assertEquals(message, messageUtil.printMessage());
    }
}

```

Create a java class file named **TestJUnit2.java** in C:\>JUNIT_WORKSPACE.

```

import org.junit.Test;
import org.junit.Ignore;
import static org.junit.Assert.assertEquals;

public class TestJUnit2 {

    String message = "Robert";
    MessageUtil messageUtil = new MessageUtil(message);

    @Test

```

```

public void testSalutationMessage() {
    System.out.println("Inside testSalutationMessage()");
    message = "Hi!" + "Robert";
    assertEquals(message,messageUtil.salutationMessage());
}
}

```

Create Test Suite Class

- Create a java class.
- Attach @RunWith(Suite.class) Annotation with the class.
- Add reference to JUnit test classes using @Suite.SuiteClasses annotation.

Create a java class file named **TestSuite.java** in C:\>JUNIT_WORKSPACE to execute test case(s).

```

import org.junit.runner.RunWith;
import org.junit.runners.Suite;
@RunWith(Suite.class)
@Suite.SuiteClasses({
    TestJUnit1.class,
    TestJUnit2.class
})
public class JunitTestSuite {
}

```

Create Test Runner Class

Create a java class file named **TestRunner.java** in C:\> JUNIT_WORKSPACE to execute test case(s).

```

import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
    public static void main(String[] args) {

```

```
Result result = JUnitCore.runClasses(JunitTestSuite.class);
for (Failure failure : result.getFailures()) {
    System.out.println(failure.toString());
}
System.out.println(result.wasSuccessful());
}
```

Compile all the java classes using javac.

```
C:\JUNIT_WORKSPACE>javac MessageUtil.java TestJUnit1.java
TestJUnit2.java JunitTestSuite.java TestRunner.java
```

Now run the Test Runner, which will run the test case defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner
```

Verify the output.

```
Inside testPrintMessage()
Robert
Inside testSalutationMessage()
Hi Robert
true
```

11. IGNORE A TEST

Sometimes it so happens that our code is not completely ready while running a test case. As a result, the test case fails. The **@Ignore** annotation helps in this scenario.

- A test method annotated with @Ignore will not be executed.
- If a test class is annotated with @Ignore, then none of its test methods will be executed.

Now let's see @Ignore in action.

Create a Class

Create a java class to be tested, say, **MessageUtil.java** in C:\>JUNIT_WORKSPACE.

```
/*
 * This class prints the given message on console.
 */
public class MessageUtil {

    private String message;

    //Constructor
    //@param message to be printed
    public MessageUtil(String message){
        this.message = message;
    }

    // prints the message
    public String printMessage(){
        System.out.println(message);
        return message;
    }
}
```

```

// add "Hi!" to the message
public String salutationMessage(){
    message = "Hi!" + message;
    System.out.println(message);
    return message;
}
}

```

Create Test Case Class

- Create a java test class, say, TestJUnit.java.
- Add a test method testPrintMessage() or testSalutationMessage() to your test class.
- Add an Annotation @Ignore to method testPrintMessage().

Create a java class file named **TestJUnit.java** in C:\JUNIT_WORKSPACE.

```

import org.junit.Test;
import org.junit.Ignore;
import static org.junit.Assert.assertEquals;

public class TestJUnit {

    String message = "Robert";
    MessageUtil messageUtil = new MessageUtil(message);

    @Ignore
    @Test
    public void testPrintMessage() {
        System.out.println("Inside testPrintMessage()");
        message = "Robert";
        assertEquals(message,messageUtil.printMessage());
    }

    @Test

```

```

public void testSalutationMessage() {
    System.out.println("Inside testSalutationMessage()");

    message = "Hi!" + "Robert";
    assertEquals(message,messageUtil.salutationMessage());
}
}

```

Create Test Runner Class

Create a java class file named **TestRunner.java** in C:\>JUNIT_WORKSPACE to execute test case(s).

```

import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(TestJUnit.class);
        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }
        System.out.println(result.wasSuccessful());
    }
}

```

Compile the MessageUtil, Test case and Test Runner classes using javac.

```
C:\JUNIT_WORKSPACE>javac MessageUtil.java TestJUnit.java TestRunner.java
```

Now run the Test Runner, which will not run the testPrintMessage() test case defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner
```

Verify the output. testPrintMessage() test case is not tested.

```

Inside testSalutationMessage()
Hi!Robert

```



```
true
```

Now, update TestJUnit in C:\>JUNIT_WORKSPACE to ignore all test cases. Add @Ignore at class level.

```
import org.junit.Test;
import org.junit.Ignore;
import static org.junit.Assert.assertEquals;

@Ignore
public class TestJUnit {

    String message = "Robert";
    MessageUtil messageUtil = new MessageUtil(message);

    @Test
    public void testPrintMessage() {
        System.out.println("Inside testPrintMessage()");
        message = "Robert";
        assertEquals(message,messageUtil.printMessage());
    }

    @Test
    public void testSalutationMessage() {
        System.out.println("Inside testSalutationMessage()");
        message = "Hi!" + "Robert";
        assertEquals(message,messageUtil.salutationMessage());
    }
}
```

Compile the test case using javac.

```
C:\JUNIT_WORKSPACE>javac TestJUnit.java
```

Keep your Test Runner unchanged as follows:

```
import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(TestJUnit.class);
        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }
        System.out.println(result.wasSuccessful());
    }
}
```

Now run the Test Runner, which will not run any test case defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner
```

Verify the output. No test case is tested.

```
true
```

12. TIME TEST

JUnit provides a handy option of Timeout. If a test case takes more time than the specified number of milliseconds, then JUnit will automatically mark it as failed. The **timeout** parameter is used along with @Test annotation. Let us see the @Test(timeout) in action.

Create a Class

Create a java class to be tested, say, **MessageUtil.java** in C:\> JUNIT_WORKSPACE.

Add an infinite while loop inside the printMessage() method.

```
/*
 * This class prints the given message on console.
 */
public class MessageUtil {

    private String message;

    //Constructor
    //@param message to be printed
    public MessageUtil(String message){
        this.message = message;
    }

    // prints the message
    public void printMessage(){
        System.out.println(message);
        while(true);
    }

    // add "Hi!" to the message
    public String salutationMessage(){
```

```

        message = "Hi!" + message;
        System.out.println(message);

        return message;
    }
}

```

Create Test Case Class

Create a java test class, say, **TestJUnit.java**. Add a timeout of 1000 to testPrintMessage() test case.

Create a java class file named **TestJUnit.java** in C:\>JUNIT_WORKSPACE.

```

import org.junit.Test;
import org.junit.Ignore;
import static org.junit.Assert.assertEquals;

public class TestJUnit {

    String message = "Robert";
    MessageUtil messageUtil = new MessageUtil(message);

    @Test(timeout=1000)
    public void testPrintMessage() {
        System.out.println("Inside testPrintMessage()");
        messageUtil.printMessage();
    }

    @Test
    public void testSalutationMessage() {
        System.out.println("Inside testSalutationMessage()");
        message = "Hi!" + "Robert";
        assertEquals(message,messageUtil.salutationMessage());
    }
}

```

Create Test Runner Class

Create a java class file named **TestRunner.java** in C:\>JUNIT_WORKSPACE to execute test case(s).

```
import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(TestJunit.class);
        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }
        System.out.println(result.wasSuccessful());
    }
}
```

Compile the MessageUtil, Test case and Test Runner classes using javac.

```
C:\JUNIT_WORKSPACE>javac MessageUtil.java TestJunit.java TestRunner.java
```

Now run the Test Runner, which will run the test cases defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner
```

Verify the output. testPrintMessage() test case will mark the unit testing failed.

```
Inside testPrintMessage()
Robert
Inside testSalutationMessage()
Hi!Robert
testPrintMessage(TestJunit): test timed out after 1000 milliseconds
false
```

13. EXCEPTIONS TEST

JUnit provides an option of tracing the exception handling of code. You can test whether the code throws a desired exception or not. The **expected** parameter is used along with @Test annotation. Let us see @Test(expected) in action.

Create a Class

Create a java class to be tested, say, **MessageUtil.java** in C:\> JUNIT_WORKSPACE.

Add an error condition inside the printMessage() method.

```
/*
 * This class prints the given message on console.
 */
public class MessageUtil {

    private String message;

    //Constructor
    //@param message to be printed
    public MessageUtil(String message){
        this.message = message;
    }

    // prints the message
    public void printMessage(){
        System.out.println(message);
        int a =0;
        int b = 1/a;
    }

    // add "Hi!" to the message
    public String salutationMessage(){
```

```

        message = "Hi!" + message;
        System.out.println(message);
        return message;
    }
}

```

Create Test Case Class

Create a java test class called **TestJUnit.java**. Add an expected exception `ArithmeticException` to the `testPrintMessage()` test case.

Create a java class file named **TestJUnit.java** in `C:\>JUNIT_WORKSPACE`.

```

import org.junit.Test;
import org.junit.Ignore;
import static org.junit.Assert.assertEquals;

public class TestJUnit {

    String message = "Robert";
    MessageUtil messageUtil = new MessageUtil(message);

    @Test(expected = ArithmeticException.class)
    public void testPrintMessage() {
        System.out.println("Inside testPrintMessage()");
        messageUtil.printMessage();
    }

    @Test
    public void testSalutationMessage() {
        System.out.println("Inside testSalutationMessage()");
        message = "Hi!" + "Robert";
        assertEquals(message,messageUtil.salutationMessage());
    }
}

```

Create Test Runner Class

Create a java class file named **TestRunner.java** in C:\>JUNIT_WORKSPACE to execute test case(s).

```
import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(TestJUnit.class);
        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }
        System.out.println(result.wasSuccessful());
    }
}
```

Compile the MessageUtil, Test case and Test Runner classes using javac.

```
C:\JUNIT_WORKSPACE>javac MessageUtil.java TestJUnit.java TestRunner.java
```

Now run the Test Runner, which will run the test cases defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner
```

Verify the output. testPrintMessage() test case will be passed.

```
Inside testPrintMessage()
Robert
Inside testSalutationMessage()
Hi!Robert
true
```


14. PARAMETERIZED TEST

JUnit 4 has introduced a new feature called **parameterized tests**. Parameterized tests allow a developer to run the same test over and over again using different values. There are five steps that you need to follow to create a parameterized test.

- Annotate test class with `@RunWith(Parameterized.class)`.
- Create a public static method annotated with `@Parameters` that returns a Collection of Objects (as Array) as test data set.
- Create a public constructor that takes in what is equivalent to one "row" of test data.
- Create an instance variable for each "column" of test data.
- Create your test case(s) using the instance variables as the source of the test data.

The test case will be invoked once for each row of data. Let us see parameterized tests in action.

Create a Class

Create a java class to be tested, say, **PrimeNumberChecker.java** in `C:\>JUNIT_WORKSPACE`.

```
public class PrimeNumberChecker {
    public Boolean validate(final Integer primeNumber) {
        for (int i = 2; i < (primeNumber / 2); i++) {
            if (primeNumber % i == 0) {
                return false;
            }
        }
        return true;
    }
}
```

Create Parameterized Test Case Class

Create a java test class, say, **PrimeNumberCheckerTest.java**. Create a java class file named **PrimeNumberCheckerTest.java** in C:\>JUNIT_WORKSPACE.

```
import java.util.Arrays;
import java.util.Collection;

import org.junit.Test;
import org.junit.Before;
import org.junit.runners.Parameterized;
import org.junit.runners.Parameterized.Parameters;
import org.junit.runner.RunWith;
import static org.junit.Assert.assertEquals;

@RunWith(Parameterized.class)
public class PrimeNumberCheckerTest {
    private Integer inputNumber;
    private Boolean expectedResult;
    private PrimeNumberChecker primeNumberChecker;

    @Before
    public void initialize() {
        primeNumberChecker = new PrimeNumberChecker();
    }

    // Each parameter should be placed as an argument here
    // Every time runner triggers, it will pass the arguments
    // from parameters we defined in primeNumbers() method
    public PrimeNumberCheckerTest(Integer inputNumber,
        Boolean expectedResult) {
        this.inputNumber = inputNumber;
        this.expectedResult = expectedResult;
    }
}
```

```

@Parameterized.Parameters
public static Collection primeNumbers() {
    return Arrays.asList(new Object[][] {
        { 2, true },
        { 6, false },
        { 19, true },
        { 22, false },
        { 23, true }
    });
}

// This test will run 4 times since we have 5 parameters defined
@Test
public void testPrimeNumberChecker() {
    System.out.println("Parameterized Number is : " + inputNumber);
    assertEquals(expectedResult,
        primeNumberChecker.validate(inputNumber));
}
}

```

Create Test Runner Class

Create a java class file named **TestRunner.java** in C:\> JUNIT_WORKSPACE to execute test case(s).

```

import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
    public static void main(String[] args) {
        Result result =
JUnitCore.runClasses(PrimeNumberCheckerTest.class);
        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }
    }
}

```

```
    }  
    System.out.println(result.wasSuccessful());  
  }  
}
```

Compile the PrimeNumberChecker, PrimeNumberCheckerTest and Test Runner classes using javac.

```
C:\JUNIT_WORKSPACE>javac PrimeNumberChecker.java  
PrimeNumberCheckerTest.java  
TestRunner.java
```

Now run the Test Runner, which will run the test cases defined in the provided Test Case class.

```
C:\JUNIT_WORKSPACE>java TestRunner
```

Verify the output.

```
Parameterized Number is : 2  
Parameterized Number is : 6  
Parameterized Number is : 19  
Parameterized Number is : 22  
Parameterized Number is : 23  
true
```

15. PLUG WITH ANT

We will have an example to demonstrate how to run JUnit using ANT. Follow the steps given below.

Step 1: Download Apache Ant

Download Apache Ant based on the operating system you are working on.

OS	Archive Name
Windows	apache-ant-1.8.4-bin.zip
Linux	apache-ant-1.8.4-bin.tar.gz
Mac	apache-ant-1.8.4-bin.tar.gz

Step 2: Set Ant Environment

Set the **ANT_HOME** environment variable to point to the base directory location, where the ANT libraries are stored on your machine. Let us assume the Ant libraries are stored in the folder apache-ant-1.8.4.

OS	Description
Windows	Set the environment variable ANT_HOME to C:\Program Files\Apache Software Foundation\apache-ant-1.8.4
Linux	export ANT_HOME=/usr/local/apache-ant-1.8.4
Mac	export ANT_HOME=/Library/apache-ant-1.8.4

Append Ant compiler location to the System Path as follows:

OS	Output
Windows	Append the string %ANT_HOME\bin at the end of the system variable, Path .
Linux	export PATH=\$PATH:\$ANT_HOME/bin/
Mac	not required

Step 3: Download JUnit Archive

Download a JUnit archive that suits your operating system.

OS	Archive name
Windows	junit4.10.jar
Linux	junit4.10.jar
Mac	junit4.10.jar

Step 4: Create Project Structure

- Create a folder **TestJUnitWithAnt** in C:\>JUNIT_WORKSPACE.
- Create a folder **src** in C:\>JUNIT_WORKSPACE>TestJUnitWithAnt.
- Create a folder **test** in C:\>JUNIT_WORKSPACE>TestJUnitWithAnt.
- Create a folder **lib** in C:\>JUNIT_WORKSPACE>TestJUnitWithAnt.
- Create **MessageUtil** class in C:\>JUNIT_WORKSPACE>TestJUnitWithAnt>srcfolder.

```

/*
 * This class prints the given message on console.
 */
public class MessageUtil {

```

```

private String message;

//Constructor
//@param message to be printed
public MessageUtil(String message){
    this.message = message;
}

// prints the message
public String printMessage(){
    System.out.println(message);
    return message;
}

// add "Hi!" to the message
public String salutationMessage(){
    message = "Hi!" + message;
    System.out.println(message);
    return message;
}
}

```

- Create **TestMessageUtil** class in the folder C:\>JUNIT_WORKSPACE>TestJUnitWithAnt>src.

```

import org.junit.Test;
import org.junit.Ignore;
import static org.junit.Assert.assertEquals;

public class TestMessageUtil {

    String message = "Robert";
    MessageUtil messageUtil = new MessageUtil(message);

    @Test

```

```

public void testPrintMessage() {
    System.out.println("Inside testPrintMessage()");
    assertEquals(message,messageUtil.printMessage());
}

@Test
public void testSalutationMessage() {
    System.out.println("Inside testSalutationMessage()");
    message = "Hi!" + "Robert";
    assertEquals(message,messageUtil.salutationMessage());
}
}

```

- Copy junit-4.10.jar onto the folder C:\>JUNIT_WORKSPACE>TestJUnitWithAnt>lib.

Create ANT Build.xml

We'll be using **<junit>** task in Ant to execute our JUnit test cases.

```

<project name="JUnitTest" default="test" basedir=".">
  <property name="testdir" location="test" />
  <property name="srcdir" location="src" />
  <property name="full-compile" value="true" />
  <path id="classpath.base"/>
  <path id="classpath.test">
    <pathelement location="/lib/junit-4.10.jar" />
    <pathelement location="${testdir}" />
    <pathelement location="${srcdir}" />
    <path refid="classpath.base" />
  </path>
  <target name="clean" >
    <delete verbose="${full-compile}">
      <fileset dir="${testdir}" includes="**/*.class" />
    </delete>
  </target>

```



```

<target name="compile" depends="clean">
  <javac srcdir="${srcdir}" destdir="${testdir}"
    verbose="${full-compile}">
    <classpath refid="classpath.test"/>
  </javac>
</target>
<target name="test" depends="compile">
  <junit>
    <classpath refid="classpath.test" />
    <formatter type="brief" usefile="false" />
    <test name="TestMessageUtil" />
  </junit>
</target>
</project>

```

Run the following Ant command.

```
C:\JUNIT_WORKSPACE\TestJUnitWithAnt>ant
```

Verify the output.

```

Buildfile: C:\JUNIT_WORKSPACE\TestJUnitWithAnt\build.xml

clean:

compile:
[javac] Compiling 2 source files to
C:\JUNIT_WORKSPACE\TestJUnitWithAnt\test
[javac] [parsing started C:\JUNIT_WORKSPACE\TestJUnitWithAnt\src\
MessageUtil.java]
[javac] [parsing completed 18ms]
[javac] [parsing started C:\JUNIT_WORKSPACE\TestJUnitWithAnt\src\
TestMessageUtil.java]
[javac] [parsing completed 2ms]
[javac] [search path for source files: C:\JUNIT_WORKSPACE\
TestJUnitWithAnt\src]

```

```
[javac] [loading java\lang\Object.class(java\lang:Object.class)]
[javac] [loading java\lang\String.class(java\lang:String.class)]
[javac] [loading org\junit\Test.class(org\junit:Test.class)]
[javac] [loading org\junit\Ignore.class(org\junit:Ignore.class)]
[javac] [loading org\junit\Assert.class(org\junit:Assert.class)]
[javac] [loading java\lang\annotation\Retention.class
(java\lang\annotation:Retention.class)]
[javac] [loading java\lang\annotation\RetentionPolicy.class
(java\lang\annotation:RetentionPolicy.class)]
[javac] [loading java\lang\annotation\Target.class
(java\lang\annotation:Target.class)]
[javac] [loading java\lang\annotation\ElementType.class
(java\lang\annotation:ElementType.class)]
[javac] [loading java\lang\annotation\Annotation.class
(java\lang\annotation:Annotation.class)]
[javac] [checking MessageUtil]
[javac] [loading java\lang\System.class(java\lang:System.class)]
[javac] [loading java\io\PrintStream.class(java\io:PrintStream.class)]
[javac] [loading java\io\FilterOutputStream.class
(java\io:FilterOutputStream.class)]
[javac] [loading java\io\OutputStream.class(java\io:OutputStream.class)]
[javac] [loading java\lang\StringBuilder.class
(java\lang:StringBuilder.class)]
[javac] [loading java\lang\AbstractStringBuilder.class
(java\lang:AbstractStringBuilder.class)]
[javac] [loading java\lang\CharSequence.class(java\lang:CharSequence.class)]
[javac] [loading java\io\Serializable.class(java\io:Serializable.class)]
[javac] [loading java\lang\Comparable.class(java\lang:Comparable.class)]
[javac] [loading java\lang\StringBuffer.class(java\lang:StringBuffer.class)]
[javac] [wrote C:\JUNIT_WORKSPACE\TestJUnitWithAnt\test\MessageUtil.class]
[javac] [checking TestMessageUtil]
[javac] [wrote
C:\JUNIT_WORKSPACE\TestJUnitWithAnt\test\TestMessageUtil.class]
[javac] [total 281ms]
```

```
test:
  [junit] Testsuite: TestMessageUtil
  [junit] Tests run: 2, Failures: 0, Errors: 0, Time elapsed: 0.008
sec
  [junit]
  [junit] ----- Standard Output -----
  [junit] Inside testPrintMessage()
  [junit] Robert
  [junit] Inside testSalutationMessage()
  [junit] Hi!Robert
  [junit] -----

BUILD SUCCESSFUL
Total time: 0 seconds
```

16. PLUG WITH ECLIPSE

To set up JUnit with eclipse, follow the steps given below.

Step 1: Download JUnit Archive

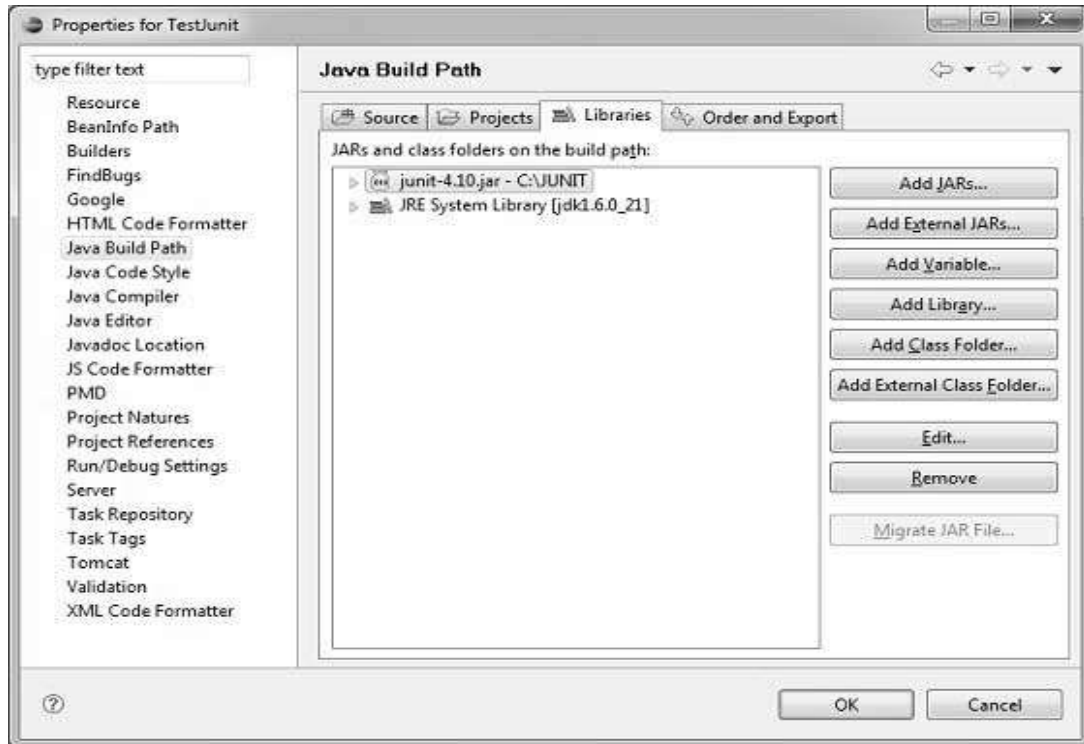
Download a JUnit jar based on the operating system you have on your system.

OS	Archive name
Windows	junit4.10.jar
Linux	junit4.10.jar
Mac	junit4.10.jar

Assume you have copied the above JAR file onto the folder C:\>JUnit.

Step 2: Set Eclipse Environment

Open eclipse -> right click on project and click on property > Build Path > Configure Build Path and add the junit-4.10.jar in the libraries using the button Add External Jar.



We assume that your Eclipse has inbuilt JUnit plugin. If it is not available in C:\>eclipse\plugins directory, then you can download it from **JUnit Plugin**. Unzip the downloaded zip file in the plugin folder of the Eclipse. Finally restart Eclipse.

Now your Eclipse is ready for the development of JUnit test cases.

Step 3: Verify Junit installation in Eclipse

Create a project **TestJUnit** in Eclipse at any location. Then create a class **MessageUtil** to test in the project.

```

/*
 * This class prints the given message on console.
 */
public class MessageUtil {

    private String message;

    //Constructor
    //@param message to be printed

```

```
public MessageUtil(String message){
    this.message = message;
}

// prints the message
public String printMessage(){
    System.out.println(message);
    return message;
}
}
```

Create a test class **TestJUnit** in the project.

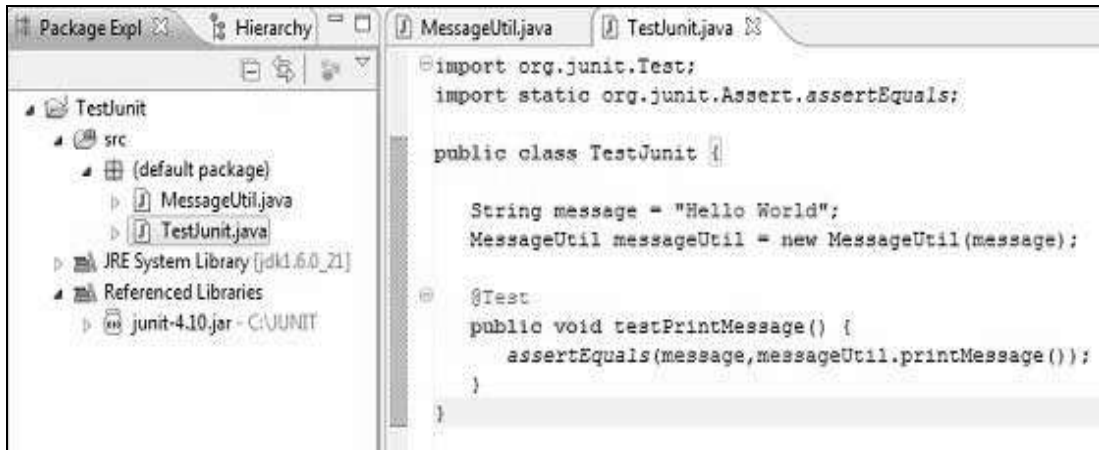
```
import org.junit.Test;
import static org.junit.Assert.assertEquals;

public class TestJUnit {

    String message = "Hello World";
    MessageUtil messageUtil = new MessageUtil(message);

    @Test
    public void testPrintMessage() {
        assertEquals(message,messageUtil.printMessage());
    }
}
```

Following should be the project structure:



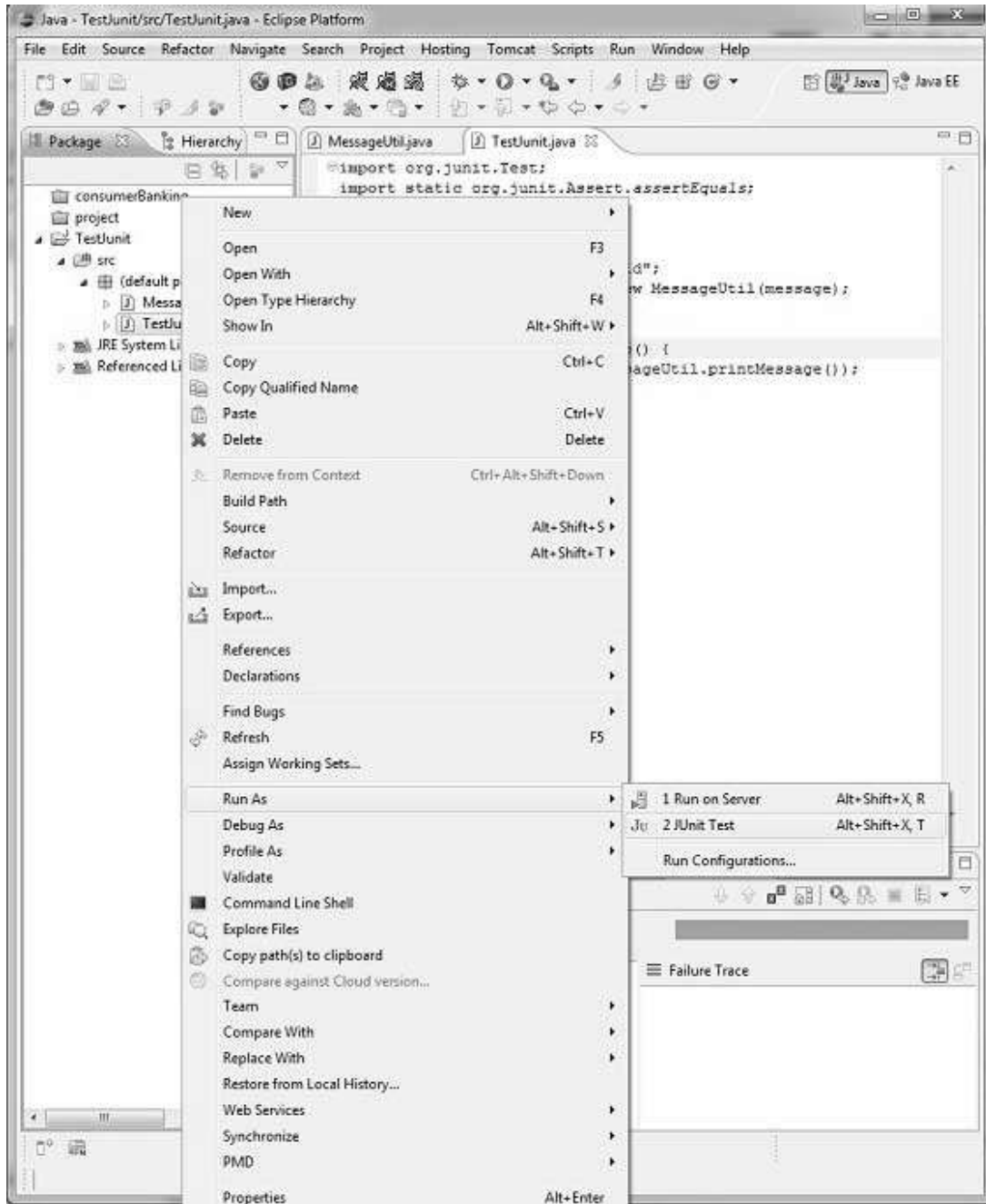
```
import org.junit.Test;
import static org.junit.Assert.assertEquals;

public class TestJUnit {

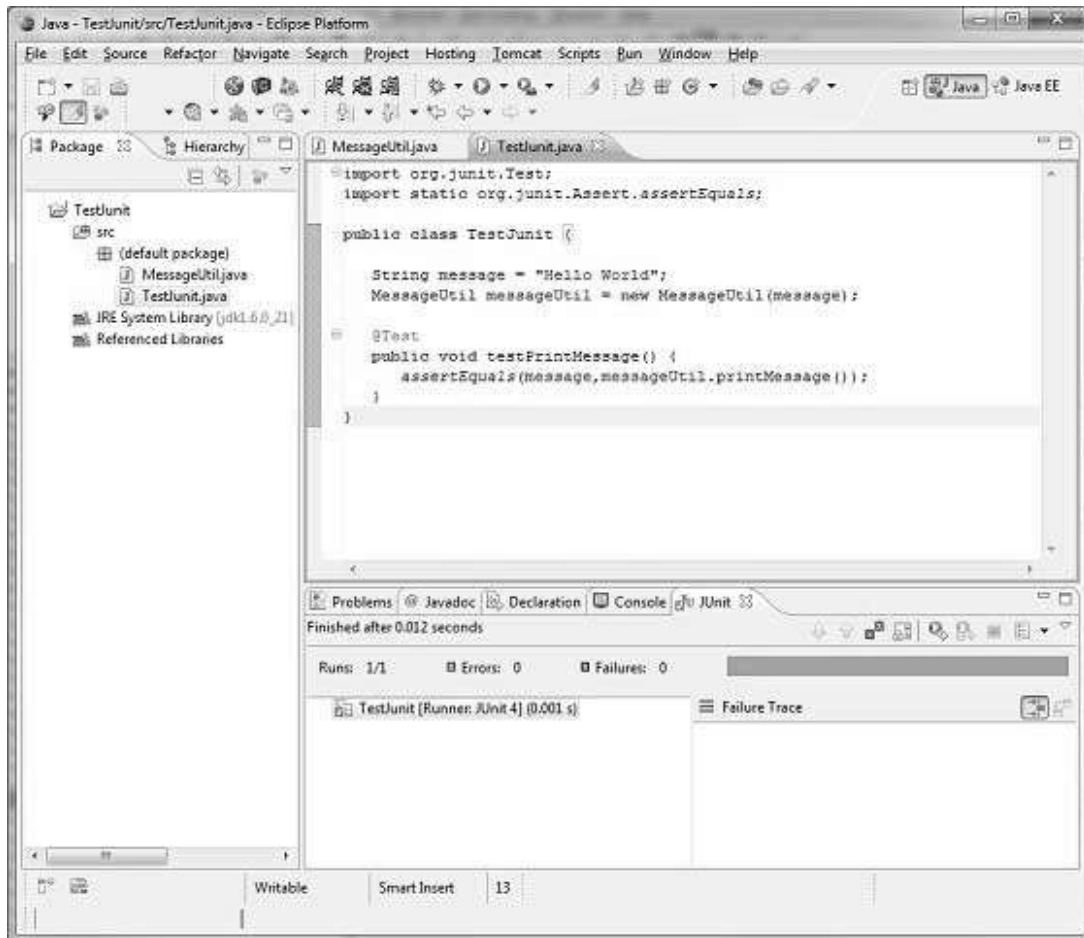
    String message = "Hello World";
    MessageUtil messageUtil = new MessageUtil(message);

    @Test
    public void testPrintMessage() {
        assertEquals(message, messageUtil.printMessage());
    }
}
```

Finally, right click the program and run as JUnit to verify the output of the program.



Verify the result.



17. EXTENSIONS

Following are the JUnit extensions:

- Cactus
- JWebUnit
- XMLUnit
- MockObject

Cactus

Cactus is a simple test framework for unit testing server-side java code (Servlets, EJBs, Tag Libs, Filters). The intent of Cactus is to lower the cost of writing tests for server-side code. It uses JUnit and extends it. Cactus implements an in-container strategy that executes the tests inside a container.

Cactus ecosystem is made of several components:

- **Cactus Framework** is the heart of Cactus. It is the engine that provides the API to write Cactus tests.
- **Cactus Integration Modules** are front-ends and frameworks that provide easy ways of using the Cactus Framework (Ant scripts, Eclipse plugin, and Maven plugin).

The following code demonstrates how Cactus can be used.

```
import org.apache.cactus.*;
import junit.framework.*;

public class TestSampleServlet extends ServletTestCase {
    @Test
    public void testServlet() {
        // Initialize class to test
        SampleServlet servlet = new SampleServlet();

        // Set a variable in session as the doSomething()
        // method that we are testing
        session.setAttribute("name", "value");
    }
}
```

```
// Call the method to test, passing an
// HttpServletRequest object (for example)
String result = servlet.doSomething(request);

// Perform verification that test was successful
assertEquals("something", result);
assertEquals("otherValue", session.getAttribute("otherName"));
}
}
```

JWebUnit

JWebUnit is a Java-based testing framework for web applications. It wraps existing testing frameworks such as HtmlUnit and Selenium with a unified, simple testing interface to test the correctness of your web applications.

JWebUnit provides a high-level Java API for navigating a web application combined with a set of assertions to verify the application's correctness. This includes navigation via links, form entry and submission, validation of table contents, and other typical business web application features.

The simple navigation methods and ready-to-use assertions allow for more rapid test creation than using only JUnit or HtmlUnit. And if you want to switch from HtmlUnit to other plugins such as Selenium (available soon), there is no need to rewrite your tests.

Here is a sample code.

```
import junit.framework.TestCase;
import net.sourceforge.jwebunit.WebTester;

public class ExampleWebTestCase extends TestCase {
    private WebTester tester;

    public ExampleWebTestCase(String name) {
        super(name);
        tester = new WebTester();
    }
}
```

```

//set base url
public void setUp() throws Exception {
    getTestContext().setBaseUrl("http://myserver:8080/myapp");
}
// test base info
@Test
public void testInfoPage() {
    beginAt("/info.html");
}
}

```

XMLUnit

XMLUnit provides a single JUnit extension class, `XMLTestCase`, and a set of supporting classes that allow assertions to be made about:

- The differences between two pieces of XML (via `Diff` and `DetailedDiff` classes).
- The validity of a piece of XML (via `Validator` class).
- The outcome of transforming a piece of XML using XSLT (via `Transform` class).
- The evaluation of an XPath expression on a piece of XML (via classes implementing the `XpathEngine` interface).
- Individual nodes in a piece of XML that are exposed by DOM Traversal (via `NodeTest` class).

Let us assume we have two pieces of XML that we wish to compare and assert that they are equal. We could write a simple test class like this:

```

import org.custommonkey.xmlunit.XMLTestCase;

public class MyXMLTestCase extends XMLTestCase {

    // this test method compare two pieces of the XML
    @Test
    public void testForXMLEquality() throws Exception {
        String myControlXML = "<msg><uuid>0x00435A8C</uuid></msg>";
    }
}

```

```

String myTestXML = "<msg><localId>2376</localId></msg>";
assertXMLEqual("Comparing test xml to control xml",
myControlXML, myTestXML);
}
}

```

MockObject

In a unit test, mock objects can simulate the behavior of complex, real (non-mock) objects and are therefore useful when a real object is impractical or impossible to incorporate into a unit test.

The common coding style for testing with mock objects is to:

- Create instances of mock objects.
- Set state and expectations in the mock objects.
- Invoke domain code with mock objects as parameters.
- Verify consistency in the mock objects.

Given below is an example of MockObject using Jmock.

```

import org.jmock.Mockery;
import org.jmock.Expectations;

class PubTest extends TestCase {
    Mockery context = new Mockery();
    public void testSubReceivesMessage() {
        // set up
        final Sub sub = context.mock(Sub.class);

        Pub pub = new Pub();
        pub.add(sub);

        final String message = "message";

        // expectations
        context.checking(new Expectations() {

```

```
        oneOf (sub).receive(message);
    });

    // execute
    pub.publish(message);

    // verify
    context.assertIsSatisfied();
}
}
```