JUnit - Unit Testing in Java

CS 4354
Summer II 2015

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Software Testing

- Executing the system with simulated test data and checking the results for errors, anomalies, and unexpected performance.
- **Failure:** Deviation between the specification and the actual behavior of the system.
- **Fault** (aka “bug” or “defect”): A design or coding mistake that may cause abnormal behavior (with respect to specifications)
- **Test case**: set of inputs and expected results that exercises a system (or part) with the purpose of detecting faults
- **Testing**: the systematic attempt to find faults in a planned way in the implemented software.

Testing

Test cases should contain the following:

- **Name**: Explains what is being tested
- **Input**: Set of input data and/or commands and/or actions
- **Expected results:** Output or state or behavior that is correct for the given input.

Testing

- Who performs testing?
  - ✦Developers
  - ✦Testing staff
  - ✦Users/Customers
- What kind of testing do developers do?
  - ✦Unit testing: individual program units (i.e. classes) are tested
  - ✦Component testing: system components (composed of individual units) are tested to make sure the contained units interact correctly.
  - ✦System testing: the system components are integrated and the system is tested as a whole.

Testing in Agile Methods

- Test-first Development
  - ✦Tests are written before the task is implemented.
  - ✦Forces developer to clarify the interface and the behavior of the implementation.
- Test automation is crucial
  - ✦Testing is developer's responsibility (no external test team)
  - ✦No interaction required: results checked automatically and reported.
  - ✦Automatic regression testing ensures no existing functionality gets broken by a new increment or refactoring.

Requirements for Automatic Testing

- The framework must use the programming language to write the test (developer tests)
- It must allow the separation of application code from test code.
- It must enable tests to run independently of each other (one failure cannot cause others to fail).
- It must allow developers to organize test cases into a suite
- The success or failure of a test should be visible at a glance.
- It must support unit testing at the following levels:
  - ✦testing a single method.
  - ✦testing an entire class (interaction of methods).
  - ✦testing the interaction of two or more objects.

JUnit

- Open source framework for the automation of unit testing in Java.
- It meets the requirements in the previous slide.
- It is used widely in the industry.
- It can be downloaded from junit.org
- I will be using version 4.12

JUnit Tutorial (based on vogella.com)

- First we will consider the code to be tested:

```
package mine;

class MyClass {
    public int multiply (int x, int y) {
        return x*y;
    }
}
```

- How can I use JUnit to test it?
  - ✦Create a Test class: a class which is used only for testing.
  - ✦Add a method that will implement the test case.
  - ✦Annotate the method with the @Test annotation.
  - ✦In this method you use a method provided by the JUnit framework to check the expected result of the code execution versus the actual result.

JUnit Tutorial: the test class

- The test class:

```
package mine;

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

public class MyClassTest {

    @Test
    public void multiplicationOfZeroIntegersShouldReturnZero() {

        // MyClass is tested
        MyClass tester = new MyClass();

        // Tests
        assertEquals("10 x 0 must be 0", 0, tester.multiply(10, 0));
        assertEquals("0 x 10 must be 0", 0, tester.multiply(0, 10));
        assertEquals("0 x 0 must be 0", 0, tester.multiply(0, 0));
    }
}
```


JUnit Tutorial: How to compile and run the test? Part I: From the command line

- Download the jar files from junit.org:

```
junit.jar
hamcrest-core.jar
```

- The downloaded filenames may include version numbers.
- Put these in a directory.
- I use src as my root directory. I put these in src/lib.
- I also made a src/bin file to store my *.class files.
- The *.java files from the last slides go in src/mine.

JUnit Tutorial: How to compile and run the test? Part I: From the command line

- Now I need a driver class to execute the test(s):

```
package mine;

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

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

- I passed the name of my Test class to the runClasses method.

JUnit Tutorial: How to compile and run the test? Part I: From the command line

- Here is the compile and execute process ($ is the prompt):

```
$ javac -d bin -cp lib/junit-4.12.jar:lib/hamcrest-core-1.3.jar
mine/*.java
$ java -cp bin:lib/junit-4.12.jar:lib/hamcrest-core-1.3.jar
mine.MyTestRunner
```

- No output means the test(s) passed
- The -d bin option tells the compiler to store the *.class files in the bin directory.
- The -cp option tells the compiler and JVM where to look for the required class files. (“cp” stands for “classpath”).
- Note the **“:”** to separate the directory names and jar files in the -cp option.

JUnit Tutorial: How to compile and run the test? Part I: From the command line

- Now I will change the last test to expect 1 instead of 0, so that it fails:

```
// Tests
assertEquals("10 x 0 must be 0", 0, tester.multiply(10, 0));
assertEquals("0 x 10 must be 0", 0, tester.multiply(0, 10));
assertEquals("0 x 0 must be 1", 1, tester.multiply(0, 0));
```

- Now I recompile and run again, and I get this (see below).
- Note the error message in red (not red on the computer):

```
$ javac -d bin -cp lib/junit-4.12.jar:lib/hamcrest-core-1.3.jar
mine/*.java
$ java -cp bin:lib/junit-4.12.jar:lib/hamcrest-core-1.3.jar
mine.MyTestRunner
multiplicationOfZeroIntegersShouldReturnZero(mine.MyClassTest):
0 x 0 must be 1 expected:<1> but was:<0>
```


JUnit Annotations (@tags)

Annotation	Description
@Test	identifies a public void method as a test method.
@Test (expected = Exception.class)	Fails if the method does not throw the named Exception
@Before	identifies a method that is to be executed before each test.
@BeforeClass	identifies a method that is to be executed once, before the start of all tests. It must be public **static** void.
@After @AfterClass	Analogous to Before/BeforeClass
@Ignore	identifies a method to be skipped (it's broken, or not ready)

JUnit Assert methods

- JUnit provides static methods in its Assert class to test for certain conditions.
- These throw an AssertionException if the comparison test fails.

Statement	Description
fail(string)	Let the method fail.
assertTrue(message, boolean)	Checks that the boolean condition is true.
assertFalse(message, boolean)	Checks that the boolean condition is false.
assertEquals(message, expected, actual)	Tests that two values are the same. Note: for arrays the reference is checked not the content of the arrays.
assertEquals(message, expected, actual, toler)	Test that float or double values match. The tolerance is the number of decimals which must be the same.
assertNull(message, object)	Checks that the object is null.
assertNotNull(message, object)	Checks that the object is NOT null.

JUnit Tutorial: How to compile and run the test? Part II: From within Eclipse

- Eclipse has built-in support for creating and running JUnit tests.
  - ✦you do not need to download and install the junit.jar files, at least not for the more recent versions of eclipse.
- For example, to create a JUnit test or a test class for an existing class,
  - ✦select this class in the Package Explorer view,
  - ✦right-click on it and select New → JUnit Test Case.
- To run a test,
  - ✦select the class which contains the tests,
  - ✦ right-click on it and select Run-as → JUnit Test. This starts JUnit and executes all test methods in this class.

JUnit Tutorial: How to compile and run the test? Part II: From within Eclipse

- I will do the following demo in class.
- Make a project for Assignment2, put the classes in the src folder, inside the assign2 package.
- Make a new src folder called test (right-click on the project, select New → Source Folder)
- Right-click on Movie.java and select New → JUnit Test Case. Call it MovieTest and put it in the test folder.
  - ✦if you get “Warning JUnit 4 is not on the BuildPath…” say yes to add it.

JUnit Tutorial: How to compile and run the test? Part II: From within Eclipse

- I added the method testShippingCreditMovie to test the shipping credit of a Movie:

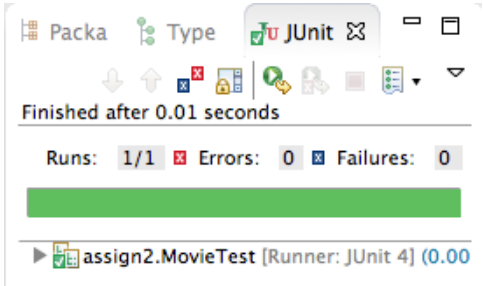
```
package assign2;
import static org.junit.Assert.*;
import org.junit.Test;

public class MovieTest {
   @Test
   public void testShippingCreditMovie() {

      Movie m = new Movie(3333,3,33.50,"Star Wars","1234567899");
      assertEquals("movie shipping credit should be 2.98”,
                   2.98, m.shippingCredit(), .01);
   }
}
```


JUnit Tutorial: How to compile and run the test? Part II: From within Eclipse

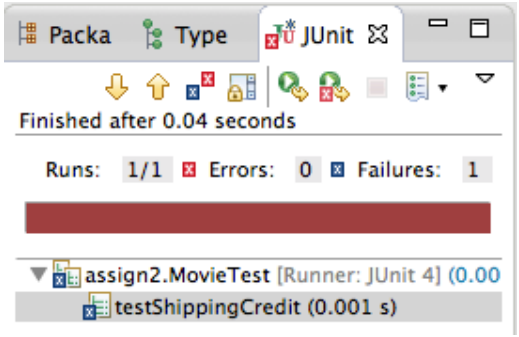
- To run the test,
  - ✦select the MovieTest class (in the package explorer)
  - ✦ right-click on it and select Run-as → JUnit Test. This starts JUnit and executes all test methods in this class.
  - ✦Eclipse uses the JUnit view which shows the results of the tests



Green is good

JUnit Tutorial: How to compile and run the test? Part II: From within Eclipse

- To make the test fail,
  - ✦In the Movie.java class, change the value of the shipping credit to 2.88.
  - ✦Run the test again.



JUnit Tutorial: How to compile and run the test? Part II: From within Eclipse

- Add another class ToyTest.java with a method testShippingCreditToy:

```
@Test
public void testShippingCreditToy() {

    Toy t = new Toy(3344,2,12.55,"Monopoly",34);
    assertEquals("toy shipping credit should be ????",
                 ????, t.shippingCredit(), .01);
}
```


JUnit Tutorial: How to compile and run the test? Part II: From within Eclipse

- Test the Inventory class:

```
public class InventoryTest {

    Inventory inv;   // member variable

    @Before
    public void setUp() throws Exception {   // occurs before each test
        inv = new Inventory();
        Movie m = new Movie(5566,5,9.99,"Fargo","1234567899");
        inv.addProduct(m);
        m = new Movie(1122,17,5.99,"Jaws","1112223334");
        inv.addProduct(m);
        m = new Movie(8899,12,6.50,"Alien","8888888888");
        inv.addProduct(m);
    }

    @Test
    public void testRemove() {
        inv.removeProduct(5566);
        //now what????
    }
}
```


JUnit Tutorial: How to compile and run the test? Part II: From within Eclipse

- Test the ProcessSale method (Inventory collaborates with Product):

```
public class InventoryTest {

    Inventory inv = new Inventory();

    @Before
    public void setUp() throws Exception {
        inv = new Inventory();
        Movie m = new Movie(5566,5,9.99,"Fargo","1234567899");
        inv.addProduct(m);
        m = new Movie(1122,17,5.99,"Jaws","1112223334");
        inv.addProduct(m);
        m = new Movie(8899,12,6.50,"Alien","8888888888");
        inv.addProduct(m);
    }
     //add after testRemove:
    @Test
    public void testProcessSale() {
        inv.processSale(5566, 3, 8.04);
       //now what????
    }
}
```



```
//Final definition of the two tests, and how I changed the Inventory:
    @Test
    public void testRemove() {
        inv.removeProduct(5566);
        //Note: I changed findProduct to return a Product:
        //if found, it returns inventory.get(index), if not it returns NULL
        Product p = inv.findProduct(5566);
        assertNull("product was not removed:",p);
    }
    @Test
    public void testProcessSale() {
        //Note: I changed process Sale to return an ArrayList of Double:
        //public ArrayList<Double> processSale(int sku, int quantitySold,
        //           double shippingCost) {
        //     ArrayList<Double> result = new ArrayList<>();
        //     .. inside of the else after the values are calculated:
        //     result.add(price);
        //     result.add(shippingCredit);
        //     result.add(commission);
        //     result.add(profit);
        //   and at the very end:
        //     return result;

        ArrayList<Double> result = inv.processSale(5566, 3, 8.04);
        assertEquals("Total Price: ",29.97,result.get(0),.01);
        assertEquals("Total Shipping Credit: ",8.94,result.get(1),.01);
        assertEquals("Total Commission: ",3.60,result.get(2),.01);
        assertEquals("Total Profit: ",27.27,result.get(3),.01);
    }
```