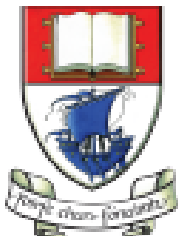


Writing JUnit Tests

Produced
by:

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Anatomy of a Unit Test

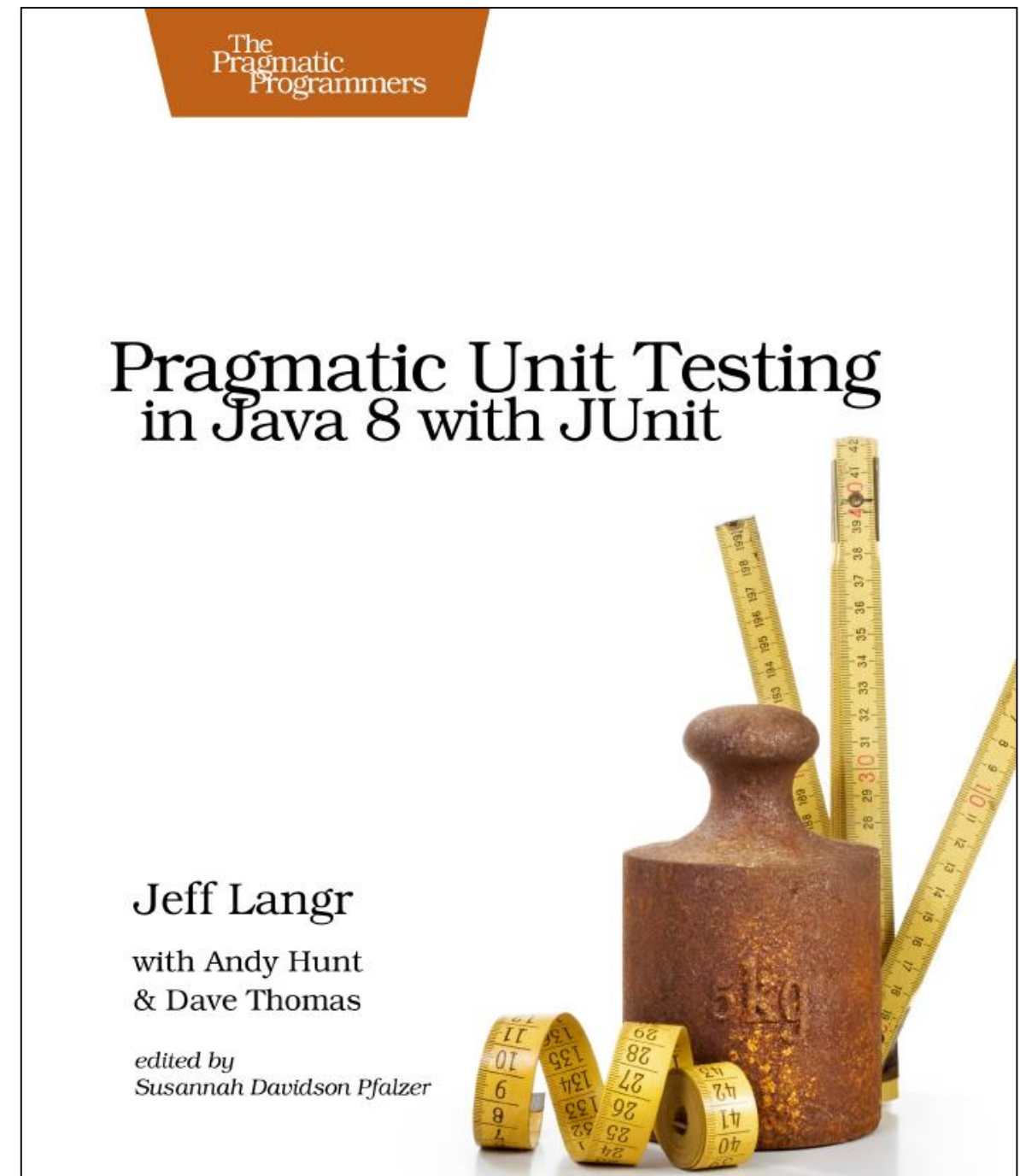
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- In-Line Setup and Teardown.

- Arrange, Act, Assert.

- Structuring Tests.

- JUnit4 Assertions.

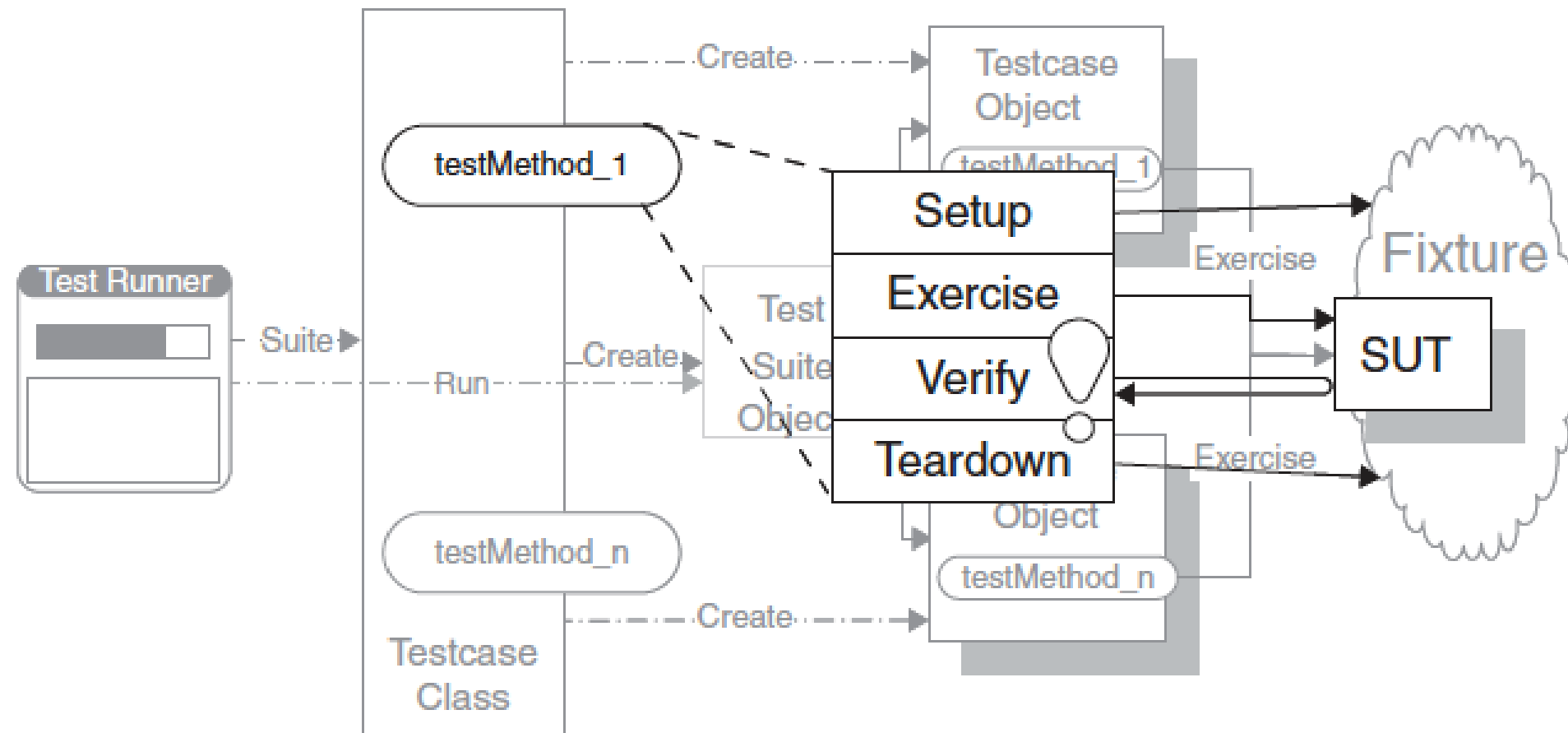


Source Code: https://pragprog.com/titles/utj2/source_code

Four Phase Test

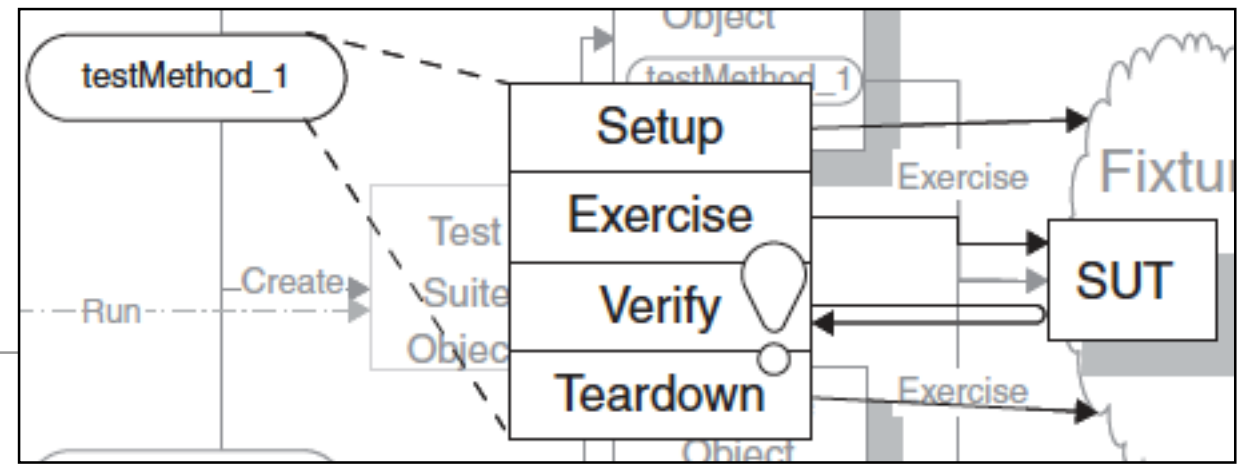
How do we structure our test logic to make what we are testing obvious?

We structure each test with four distinct parts executed in sequence.



SUT = System Under Test

How it works



- **SETUP**: In the first phase, we set up the test fixture (the “before” picture) that is required for the SUT to exhibit the expected behavior as well as anything you need to put in place to be able to observe the actual outcome.
- **EXERCISE**: In the second phase, we interact with the SUT.
- **VERIFY**: In the third phase, we do whatever is necessary to determine whether the expected outcome has been obtained.
- **TEARDOWN**: In the fourth phase, we tear down the test fixture to put the world back into the state in which we found it.

Four Phase Test: Example

```
PacemakerAPITest.java ✖
1 package controllers;
2
3 import static org.junit.Assert.*;
17
18 public class PacemakerAPITest
19 {
20     private PacemakerAPI pacemaker;
21
22     @Before
23     public void setup()
24     {
25         pacemaker = new PacemakerAPI(null);
26         for (User user : users)
27         {
28             pacemaker.createUser(user.firstName, user.lastName, user.email, user.password);
29         }
30     }
31
32     @After
33     public void tearDown()
34     {
35         pacemaker = null;
36     }
37
38     @Test
39     public void testUser()
40     {
41         assertEquals (users.length, pacemaker.getUsers().size());
42         pacemaker.createUser("homer", "simpson", "homer@simpson.com", "secret");
43         assertEquals (users.length+1, pacemaker.getUsers().size());
44         assertEquals (users[0], pacemaker.getUserByEmail(users[0].email));
45     }
46
47 }
```

Phase 1
(setup)

Phase 4
(teardown)

Phase 2 (exercise)
Phase 3 (verify)

Anatomy of a Unit Test

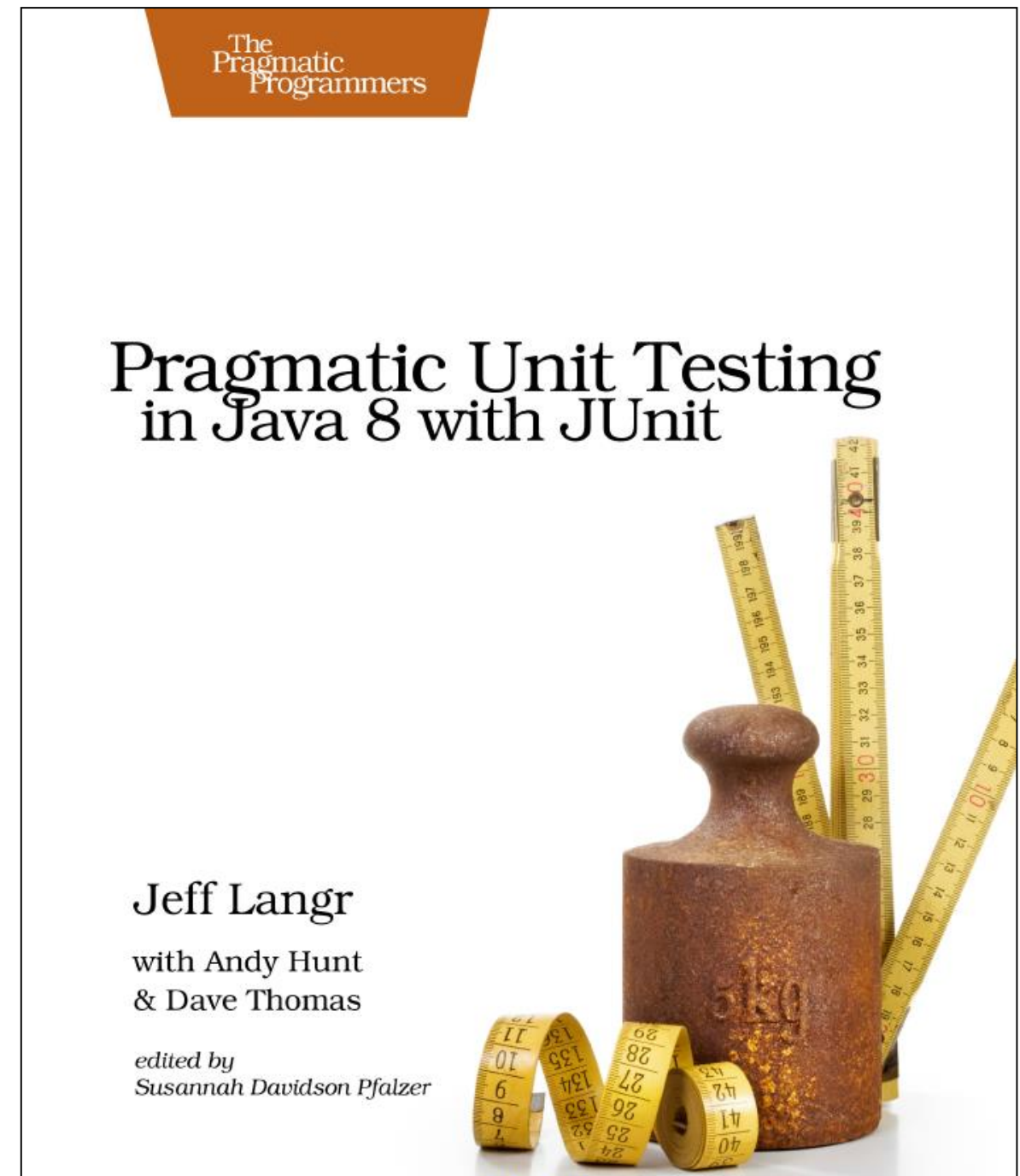
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In-line Setup and Teardown

Phase 1 (setup)

Phase 2(exercise)

Phase 3 (verify)

Phase 4 (teardown)

```
@Test
public void testXMLSerializer() throws Exception
{
    String datastoreFile = "testdatastore.xml";
    deleteFile (datastoreFile);

    Serializer serializer = new XMLSerializer(new File (datastoreFile));

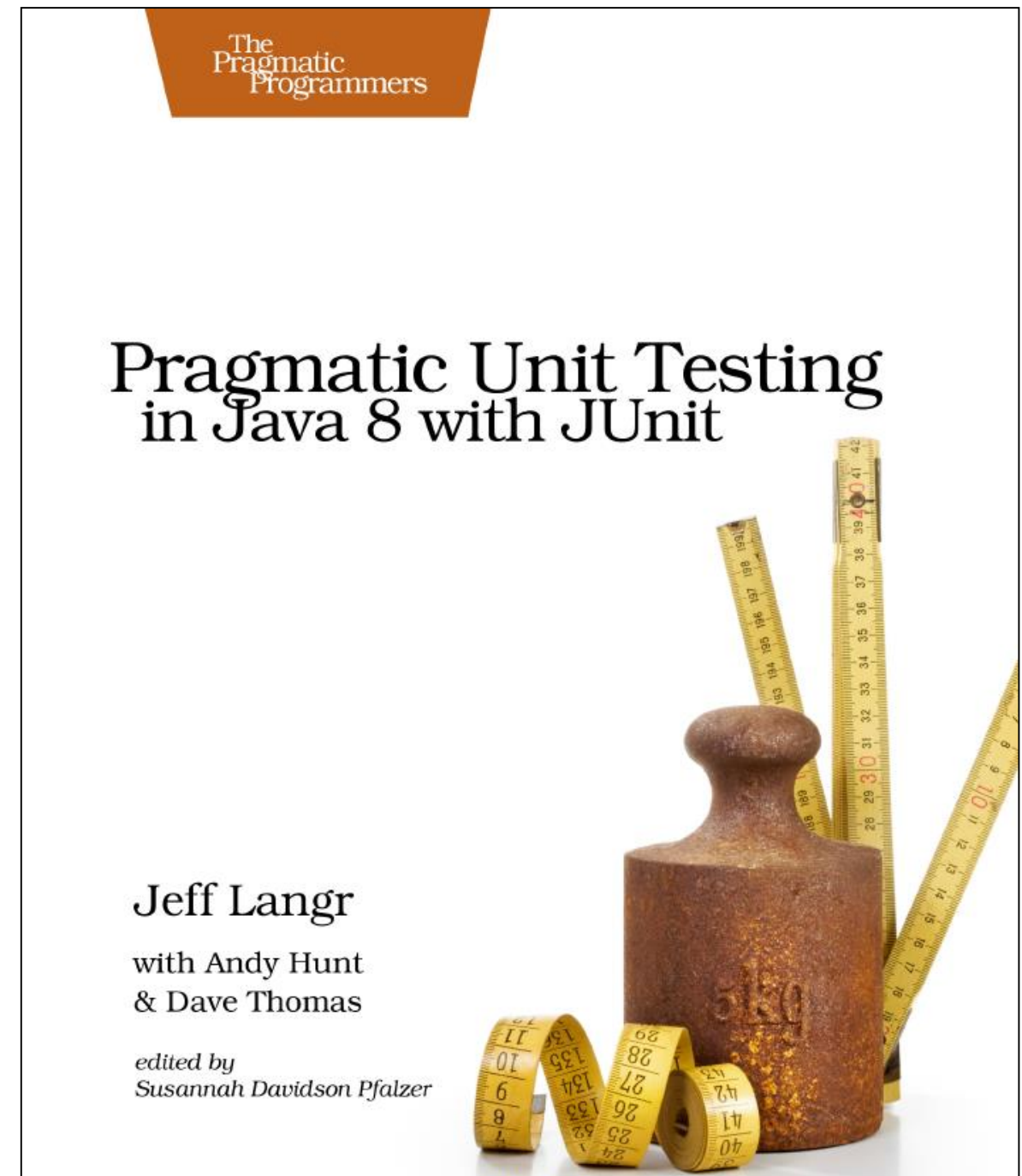
    pacemaker = new PacemakerAPI(serializer);
    populate(pacemaker);
    pacemaker.store();

    PacemakerAPI pacemaker2 = new PacemakerAPI(serializer);
    pacemaker2.load();

    assertEquals (pacemaker.getUsers().size(), pacemaker2.getUsers().size());
    for (User user : pacemaker.getUsers())
    {
        Collection<User> users = pacemaker2.getUsers();
        System.out.println("User to search for:");
        System.out.println(user);
        System.out.println("Collection");
        System.out.println(users);
        assertTrue (users.contains(user));
    }
    deleteFile (datastoreFile);
}
```

Anatomy of a Unit Test

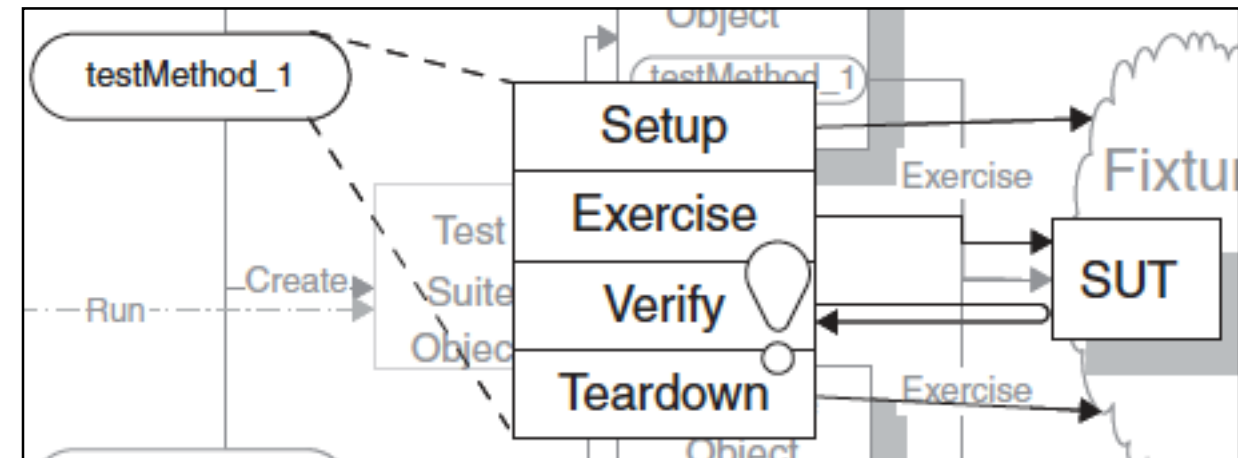
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Arrange, Act, Assert (AAA)

AAA is an alternative,
or a complement to the
Four-phases pattern:



*Arrange, Act, Assert (AAA)
is a pattern of arranging the code
within the method,
something similar to
In-Line Setup and Teardown.*

Arrange, Act, Assert

Arrange	To do anything in a test, we first need to <i>arrange</i> things with code that <u>sets up the state in a test</u> e.g. creating objects, interacting with them, calling other APIs etc. In some rare cases, we won't arrange anything, because the system is already in the state we need.
Act	After we arrange the test, we <u>act on—execute—the code we're trying to verify</u> . Usually this is a call to a single method.
Assert	Finally, we <u>assert that we get the expected result</u> . Verify that the exercised code behaved as expected. This can involve inspecting the return value of the exercised code or the new state of any objects involved. It can also involve verifying that interactions between the tested code and other objects took place.
After	<i>You might need a fourth step...if running the test results in any resources being allocated, ensure that they get <u>cleaned up</u>.</i>

Arrange, Act, Assert: Basic Example

```
ScoreCollection.java  *ScoreCollectionTest.java ✕
2+ * Excerpted from "Pragmatic Unit Testing in Java with JUnit",
9 package iloveyouboss;
10
11- import static org.junit.Assert.*;
12 import static org.hamcrest.CoreMatchers.*;
13 import org.junit.*;
14
15 public class ScoreCollectionTest {
16-     @Test
17     public void answersArithmeticMeanOfTwoNumbers() {
18         // Arrange
19         ScoreCollection collection = new ScoreCollection();
20         collection.add(() -> 5);
21         collection.add(() -> 7);
22
23         // Act
24         int actualResult = collection.arithmeticMean();
25
26         // Assert
27         assertThat(actualResult, equalTo(6));
28     }
29 }
30
31
32
```

—a *test case*—

To test a `ScoreCollection` object, we can add the numbers 5 and 7 to it and expect that the `arithmeticMean()` method will return 6.

i.e. $(5 + 7) / 2 = 6$

Using AAA to complement Four Phase Test

```
public class SomeTestClass
{
    @Before
    public void SetUp()
    {
        //Initialisation of our test
    }

    @Test
    public void Test()
    {
        //Arrange
        // Act
        // Assert
    }

    @After
    public void Teardown()
    {
        //Lets get back to the original state
    }
}
```

Using AAA to complement Four Phase Test

Phase 1 (setup)
/ Arrange

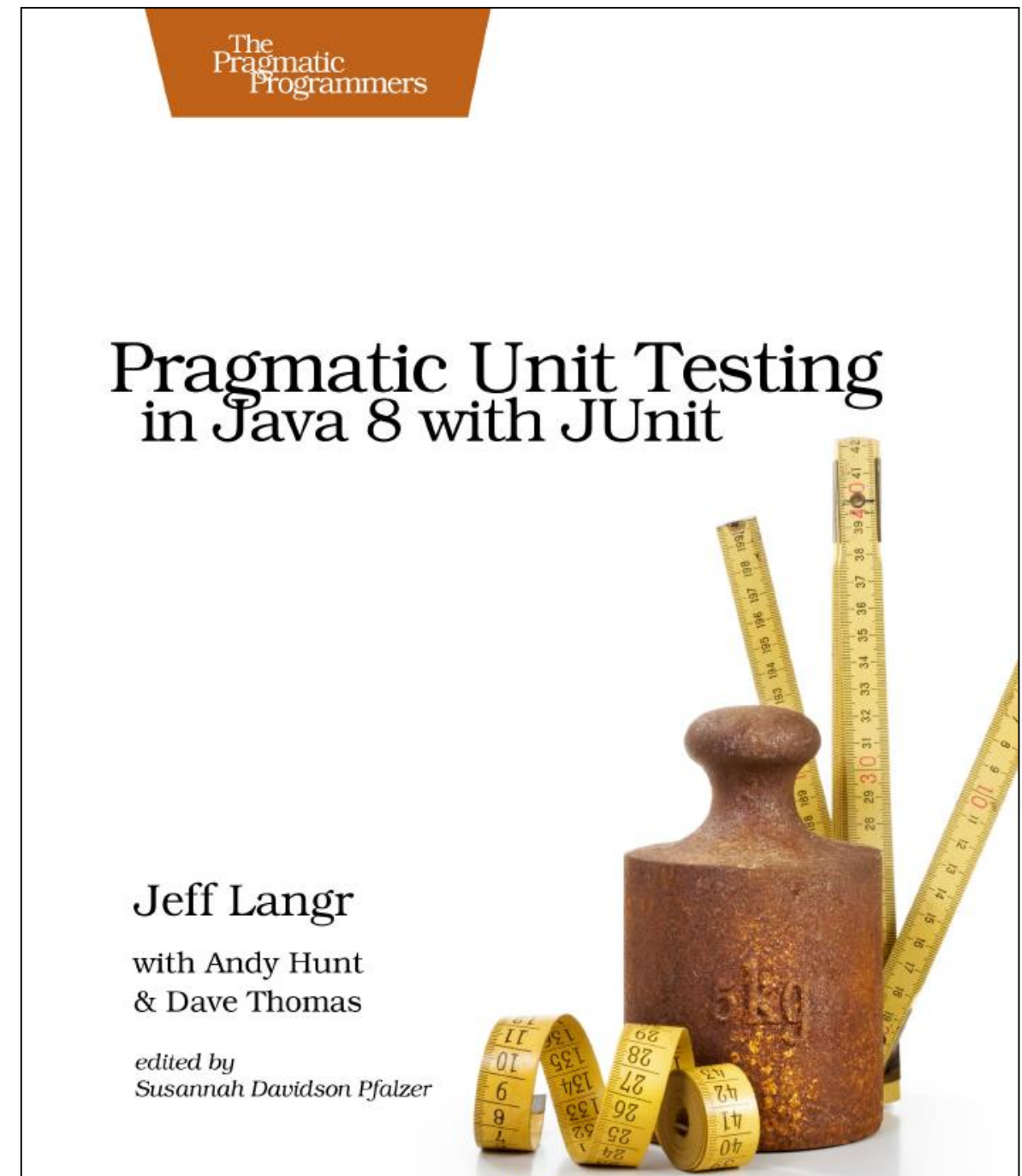
Phase 4 (teardown)
/ After

Act
Assert

```
*PacemakerAPITest.java ✕
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43          assertEquals(users.length+1, pacemaker.getUsers().size());
44          assertEquals(users[0], pacemaker.getUserByEmail(users[0].email));
45      }
46
47      @Test
48      public void testEquals()
49      {
50          User homer = new User ("homer", "simpson", "homer@simpson.com", "secret");
51          User homer2 = new User ("homer", "simpson", "homer@simpson.com", "secret");
52          User bart = new User ("bart", "simpson", "bartr@simpson.com", "secret");
53
54          assertEquals(homer, homer);
55          assertEquals(homer, homer2);
56          assertNotEquals(homer, bart);
57
58          assertSame(homer, homer);
59          assertNotSame(homer, homer2);
60      }
61
```

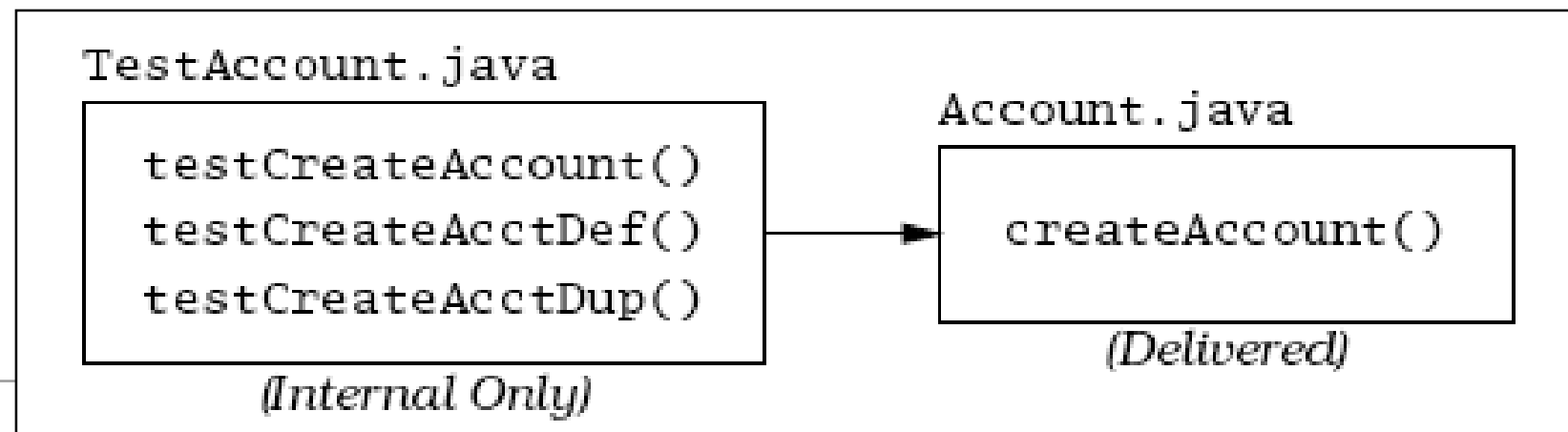
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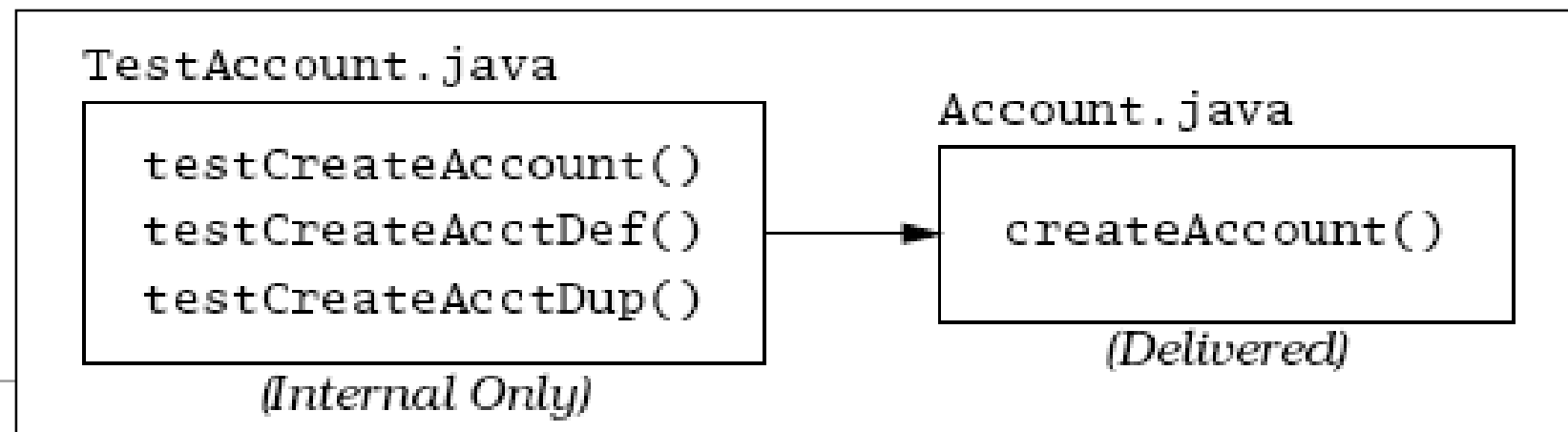
Structuring Tests



- **Adopt Naming conventions**

- A method named *create-Account* to be tested, then test method might be named *testCreateAccount*.
- The method *testCreateAccount* will call *createAccount* with the necessary parameters and verify that *createAccount* works as advertised.
- Can have many test methods that exercise *createAccount*.

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- Can have many test methods that exercise *createAccount*.

- **Distinguish between Testing vs Production Code (separate directories in the same project).**

- The test code is for our internal use only - Customers or end-users will never see it or use it.

Naming Individual Tests (1)

- Aim for more **granular** tests i.e. focused on a distinct behaviour
 - test names can be more meaningful.
- Instead of suggesting what **context** you're going to test
 - suggest what ***happens*** as a result of invoking some behaviour against a certain **context**.

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- Instead of suggesting what **context** you're going to test
 - suggest what **happens** as a result of invoking some behaviour against a certain **context**.
- Reasonable test names can consist of up to seven or so words.

not-so-hot name

makeSingleWithdrawal

attemptToWithdrawTooMuch

multipleDeposits

cooler, more descriptive name

withdrawalReducesBalanceByWithdrawnAmount

withdrawalOfMoreThanAvailableFundsGeneratesError

multipleDepositsIncreaseBalanceBySumOfDeposits

Naming Individual Tests (2)

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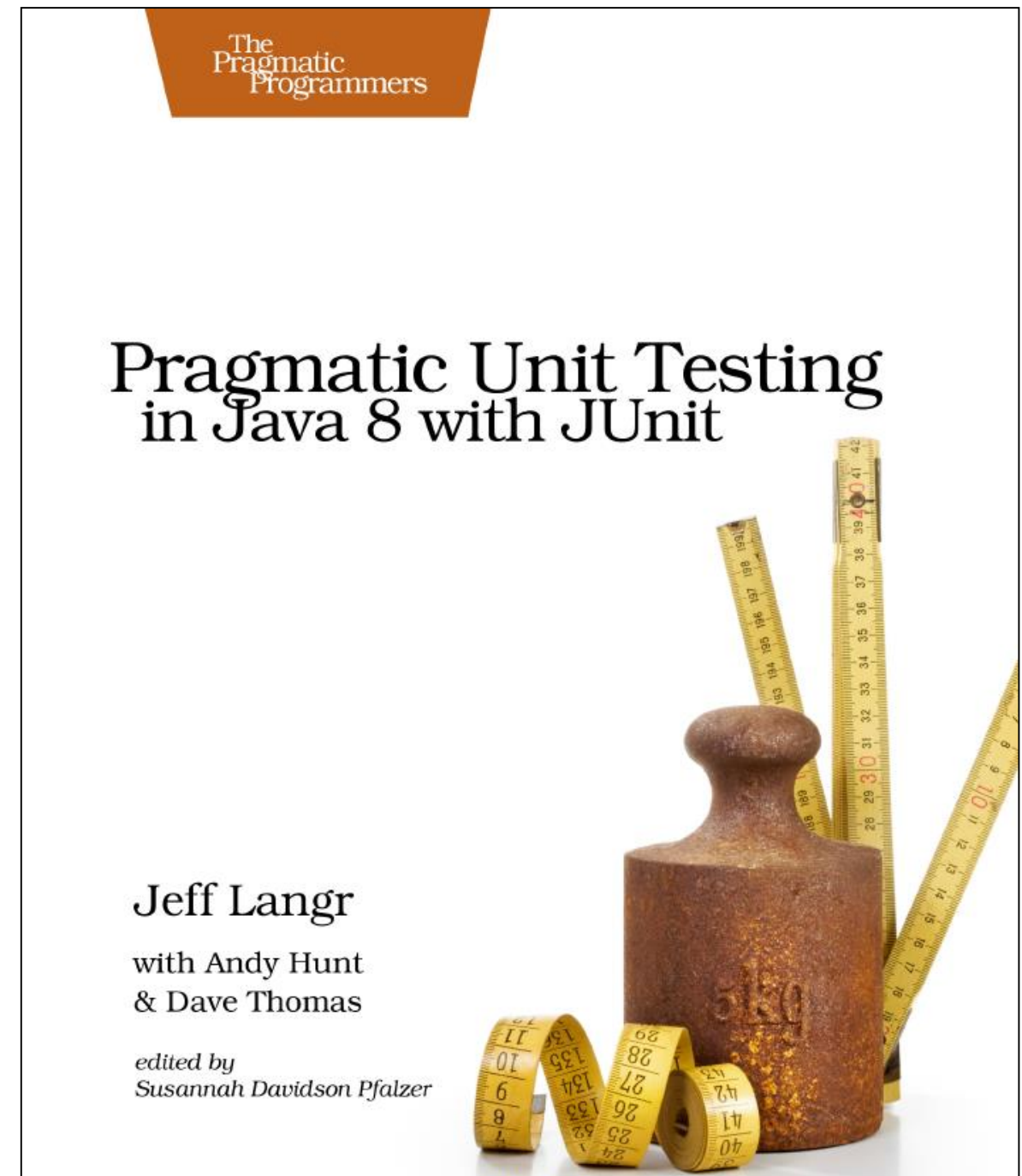
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- You can usually drop the *givenSomeContext* portion without creating too much additional work for your test reader:
whenDoingSomeBehaviorThenSomeResultOccurs
- ...which is about the same as *doingSomeOperationGeneratesSomeResult*.

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JUnit Asserts

...methods that assist in determining whether a method under test is performing correctly or not.

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...methods that assist in determining whether a method under test is performing correctly or not.

The developer **asserts** that some condition is true; that two bits of data are equal, or not equal, or the same, etc.

JUnit Asserts

- Records failures (when the assertion is false) or errors (when an unexpected exception occurs), and reports these through the JUnit classes.

GUI version → red bar indicates failure.

- Asserts are the fundamental building block for unit tests; the JUnit library provides a number of different forms of assert.

assertTrue

assertTrue([String message], boolean condition)

- Asserts that the given boolean condition is true, otherwise the test fails.
- If test code is littered with the following:

```
assertTrue(true);
```

- it suggests that the construct is used to verify some sort of branching or exception logic, it's probably a bad idea and may indicate unnecessarily complex test logic.

assertTrue / assertFalse

assertTrue([String message], boolean condition)

- Asserts that the given boolean condition is true, otherwise the test fails.
- If test code is littered with the following:

```
assertTrue(true);
```

- it suggests that the construct is used to verify some sort of branching or exception logic, it's probably a bad idea and may indicate unnecessarily complex test logic.

assertFalse([String message], boolean condition)

- Asserts that the given boolean condition is false, otherwise the test fails.

assertThat (using Hamcrest assertion, equalTo)

assertThat(*actual*, *matcher*);

- *actual*: value to verify; often a call to the SUT.
- *matcher*: a static method call that allows comparing the results of an expression against an actual value. Matchers can impart greater readability to your tests as they read fairly well left-to-right as a sentence.

assertThat(account.getBalance(), equalTo(100));

Note: you need to **import** static org.hamcrest.CoreMatchers.*;

assertThat (using Hamcrest assertion, **equalTo**)

```
assertThat(account.getBalance(), equalTo(100));
```

- ***equalTo*** uses the `equals()` method as the basis for comparison.
- Primitive types are autoboxed into instances, so we can compare any type.

assertThat (using Hamcrest assertion, equalTo)

```
assertThat(account.getBalance(), equalTo(100));
```

- **equalTo** uses the equals() method as the basis for comparison.
- Primitive types are autoboxed into instances, so we can compare any type.

- Hamcrest assertions provide a more helpful message when they fail. The prior test expected account.getBalance() to return 100. If it returns 101 instead, you see this:

```
java.lang.AssertionError:  
Expected: <100>  
but: was <101>  
at org.hamcrest.MatcherAssert.assertThat(MatcherAssert.java:20)
```

- **assertTrue():** when it fails, we get the following stack trace:

```
java.lang.AssertionError  
at org.junit.Assert.fail(Assert.java:86)
```


assertThat (other Hamcrest assertions)

```
assertThat(account.getName(), startsWith("xyz"));
```

- When the assertThat() call fails, we get the following stack trace:

```
java.lang.AssertionError:
```

```
Expected: a string starting with "xyz"
```

```
but: was "an account name"
```

```
at org.hamcrest.MatcherAssert.assertThat(MatcherAssert.java:20)
```

assertThat (other Hamcrest assertions)

```
assertThat(account.getName(), startsWith("xyz"));
```

- When the assertThat() call fails, we get the following stack trace:

```
java.lang.AssertionError:
```

```
Expected: a string starting with "xyz"
```

```
but: was "an account name"
```

```
at org.hamcrest.MatcherAssert.assertThat(MatcherAssert.java:20)
```

```
assertThat(account.getName(), not(equalTo("plunderings")));  
assertThat(account.getName(), is(not(nullValue())));  
assertThat(account.getName(), is(notNullValue()));
```

And many more hamcrest matchers: <http://hamcrest.org/JavaHamcrest/javadoc/1.3/org/hamcrest/CoreMatchers.html>

Good comparison of assertThat vs asserts: <https://objectpartners.com/2013/09/18/the-benefits-of-using-assertthat-over-other-assert-methods-in-unit-tests/>

assertEquals

assertEquals([String message], expected, actual)

- **expected** → a value predicted to be correct (typically hard-coded).
- **actual** → a value actually produced by the code under test.
- **message** → an optional and will be reported in the event of a failure.
- Any kind of object may be tested for equality; the appropriate equals method will be used for the comparison (e.g. String.equals()).
- A note of caution: the equals method for native arrays, however, does not compare the contents of the arrays, just the array reference itself.

assertEquals (with Tolerance)

- Computers cannot represent all floating-point numbers exactly, and will usually be off a little bit → a loss of precision.
- Thus using assert to compare floating point numbers (floats or doubles in Java), you should specify one additional piece of information, the **tolerance**.

assertEquals([String message], expected, actual, tolerance)

e.g.

assertEquals("Should be 3 1/3", 3.33, 10.0/3.0, 0.01);

assertNull / assertNotNull

- **assertNull([String message], java.lang.Object object)**
- **assertNotNull([String message], java.lang.Object object)**
 - Asserts that the given object is null (or not null), failing otherwise.

assertSame / assertNotSame

- **assertSame([String message], expected, actual)**
 - Asserts that **expected** and **actual** refer to the same object, and fails the test if they do not.
- **assertNotSame([String message], expected, actual)**
 - Asserts that **expected** and **actual** do not refer to the same object, and fails the test if they are the same object.

fail

- **fail([String message])**
 - Fails the test immediately, with the optional message.
 - Often used to mark sections of code that should not be reached (for instance, after an exception is expected).

Using asserts

- Usually have multiple asserts in a given test method, as you prove various aspects and relationships of the method(s) under test.
- When an assert fails, that test method will be aborted and the remaining assertions in that method will not be executed this time.
- Normally expect that all tests pass all of the time.
- In practice, that means that when a bug introduced, only one or two tests fail.
- Developer should NOT continue to add features when there are failing tests.

JUnit4 Framework

- The import statement brings in the necessary JUnit methods/annotations.
- Individual tests are marked with the **@Test** annotation against public methods.

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

```
public class TestClassOne  
{  
  
    @Test  
    public void testAddition ()  
    {  
        assertEquals(4, 2 + 2);  
    }  
  
    @Test  
    public void testSubtraction ()  
    {  
        assertEquals(0, 2 - 2);  
    }  
}
```

@Before / @After

- Each test should run independently of every other test; this allows any individual test to be run at any time, in any order.
- This requires ability to reset some parts of the testing environment in between tests, and/or clean up after a test has run.
- **@Before** / **@After** annotations ensure that these methods are called before and after each test is executed.
- You can have multiple methods annotated with **@Before** / **@After** however the order of execution is out of your control; if you require your @Before methods to run in a specific order, resort to just having one method.

```
public class TestLargest
{
    private int[] arr;

    @Before
    public void setUp()
    {
        arr = new int[] {8,9,7};
    }

    @After
    public void tearDown()
    {
        arr = null;
    }
}
```

@Before / @After Example

```
public class TestDB extends TestCase {  
    private Connection dbConn;  
  
    @Before  
    public void setUp() {  
        dbConn = new Connection("oracle", 1521, "fred", "foobar");  
        dbConn.connect();  
    }  
  
    @After  
    public void tearDown() {  
        dbConn.disconnect();  
        dbConn = null;  
    }  
  
    @Test  
    public void testAccountAccess() // Uses dbConn  
    {  
    }  
  
    @Test  
    public void testEmployeeAccess() // Uses dbConn  
    {  
    }  
}
```

@BeforeClass / @AfterClass

- One Time set up for full TestCase.
- Called once before all tests are executed.
- Called once after all tests have executed.
- Does not effect @Before / @After.
- Usually used for expensive operations/initialisation e.g. populate a database.

```
public class TestDB extends TestCase {  
    private Connection dbConn;  
  
    @Before  
    public void setUp() {  
        dbConn = new Connection("oracle", 1521, "fred", "foobar");  
        dbConn.connect();  
    }  
  
    @After  
    public void tearDown() {  
        dbConn.disconnect();  
        dbConn = null;  
    }  
  
    @BeforeClass  
    public static void populateDB()  
    {  
    }  
  
    @AfterClass  
    public static void depopulateDB()  
    {  
    }  
}
```

@Ignore

- JUnit runs all of the **@Test** annotated methods automatically.
- Individual tests can be removed temporarily via the **@Ignore** annotation. You can include an explanatory message e.g.:

 @Ignore("takes too long")
- **testLongRunner** uses a brute-force algorithm to find the shortest route for the Travelling Salesman Problem (TSP). @Ignore removed it from default tests

```
public class TestClassTwo
{
    // This one takes a few hours...
    @Ignore
    @Test
    public void testLongRunner (){
        TSP tsp = new TSP(); // Load with default cities
        assertEquals(2300, tsp.shortestPath(50)); // top 50
    }

    @Test
    public void testShortTest (){
        TSP tsp = new TSP(); // Load with default cities
        assertEquals(140, tsp.shortestPath(5)); // top 5
    }

    @Test
    public void testAnotherShortTest (){
        TSP tsp = new TSP(); // Load with default cities
        assertEquals(586, tsp.shortestPath(10)); // top 10
    }
}
```

Composed Tests

- Higher-level test that is composed of both of two (or more) other test classes.
- The following individual test methods will be run:
 - testAddition()
from TestClassOne
 - testSubtraction()
from TestClassOne
 - testShortTest()
from TestClassTwo
 - testAnotherShortTest()
from TestClassTwo


```
import org.junit.AfterClass;  
import org.junit.BeforeClass;  
import org.junit.runner.RunWith;  
import org.junit.runners.Suite;
```


```
@RunWith(Suite.class)  
@Suite.SuiteClasses({TestClassOne.class,  
                    TestClassTwo.class})
```


```
public class MetaTest  
{  
}
```


Finished after 0.031 seconds


Runs: 5/5 (1 ignored) ✖ Errors: 0





▼  firsttests.MetaTest [Runner: JUnit 4] (0.000 s)


▼  firsttests.TestClassOne (0.000 s)


 testAddition (0.000 s)

 testSubtraction (0.000 s)

▼  firsttests.TestClassTwo (0.000 s)

 testLongRunner (0.000 s)

 testShortTest (0.000 s)

 testAnotherShortTest (0.000 s)

Composed Tests

Class Level Annotations:

- **@RunWith**

JUnit will invoke the annotated class to run the tests, instead of using the runner built into JUnit.

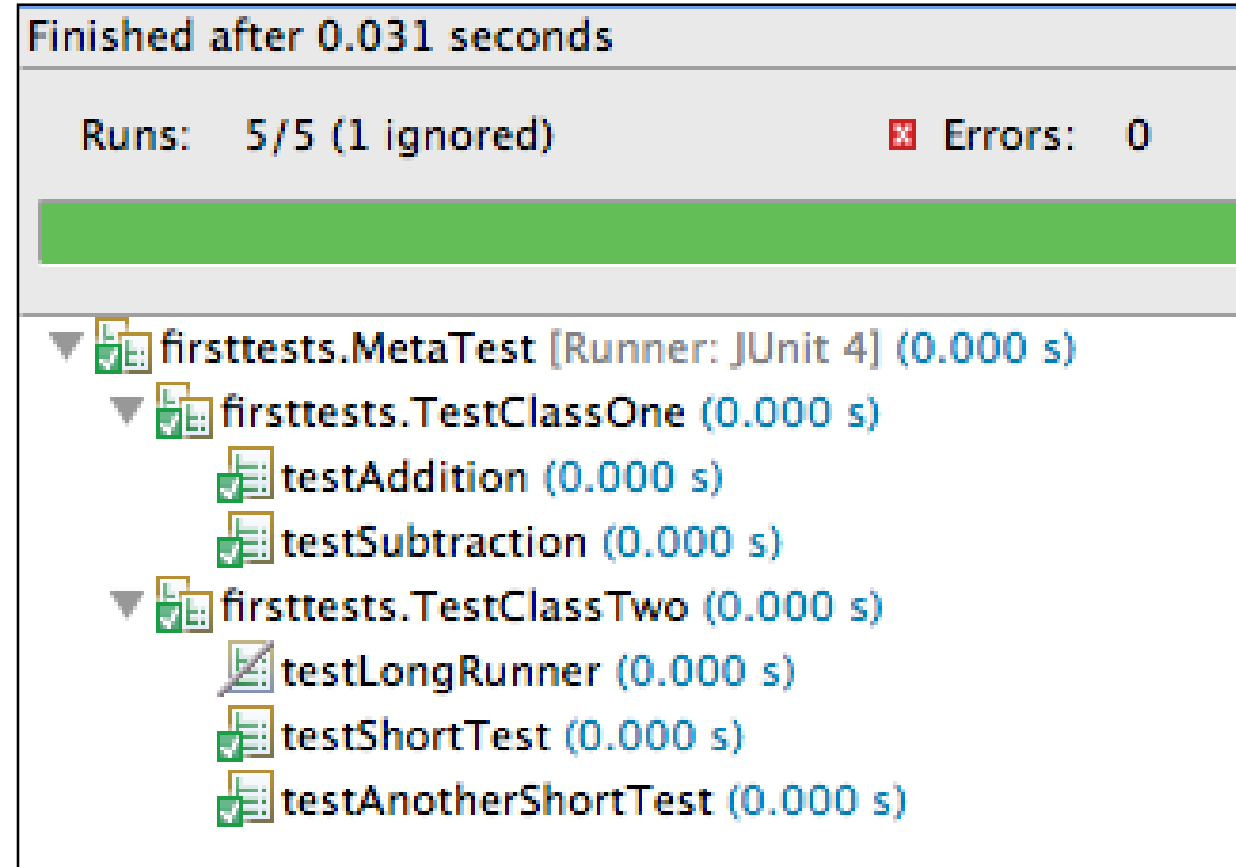
- **@Suite.SuiteClasses**

The SuiteClasses annotation specifies the classes to be executed when a class annotated with @RunWith(Suite.class) is run.

```
import org.junit.AfterClass;
import org.junit.BeforeClass;
import org.junit.runner.RunWith;
import org.junit.runners.Suite;
```

```
@RunWith(Suite.class)
@Suite.SuiteClasses({TestClassOne.class,
                    TestClassTwo.class})
```

```
public class MetaTest
{
}
```



Composed Tests: @BeforeClass / @AfterClass

1

One time
initialization in
class
MetaTest.

```
@RunWith(Suite.class)
@Suite.SuiteClasses({TestClassOne.class,
                    TestClassTwo.class})
```

```
public class MetaTest
{
```

```
    @BeforeClass
    public static void initialize(){
        System.out.println("setting up");
        // ...
    }
```

```
    @AfterClass
    public static void terminate(){
        System.out.println("tearing down");
        //...
    }
}
```

```
public class TestClassOne
{
    @Test
    public void test1()
    {
        System.out.println("test1");
        //...
    }
}
```

```
public class TestClassTwo
{
    @Test
    public void test2()
    {
        System.out.println("test2");
        //...
    }
}
```

Output:

```
setting up
test1
test2
tearing down
```


Composed Tests: @BeforeClass / @AfterClass

2

Then all
(non-ignored)
tests in
TestClassOne
and
TestClassTwo

```
@RunWith(Suite.class)
@Suite.SuiteClasses({TestClassOne.class,
                    TestClassTwo.class})
```

```
public class MetaTest
{
```

```
    @BeforeClass
    public static void initialize(){
        System.out.println("setting up");
        // ...
    }
```

```
    @AfterClass
    public static void terminate(){
        System.out.println("tearing down");
        //...
    }
}
```

```
public class TestClassOne
{
    @Test
    public void test1()
    {
        System.out.println("test1");
        //...
    }
}
```

```
public class TestClassTwo
{
    @Test
    public void test2()
    {
        System.out.println("test2");
        //...
    }
}
```

Output:

```
setting up
test1
test2
tearing down
```

Composed Tests: @BeforeClass / @AfterClass

Note

If any exist, all
@Before
@After
@BeforeClass
@AfterClass
methods in
TestClassOne
and
TestClassTwo
are executed.

```
@RunWith(Suite.class)
@Suite.SuiteClasses({TestClassOne.class,
                    TestClassTwo.class})
```

```
public class MetaTest
{
```

```
    @BeforeClass
    public static void initialize(){
        System.out.println("setting up");
        // ...
    }
```

```
    @AfterClass
    public static void terminate(){
        System.out.println("tearing down");
        //...
    }
}
```

```
public class TestClassOne
{
    @Test
    public void test1()
    {
        System.out.println("test1");
        //...
    }
}
```

```
public class TestClassTwo
{
    @Test
    public void test2()
    {
        System.out.println("test2");
        //...
    }
}
```

Output:

```
setting up
test1
test2
tearing down
```

Composed Tests: @BeforeClass / @AfterClass

3

One time
teardown in
class
MetaTest.

```
@RunWith(Suite.class)
@Suite.SuiteClasses({TestClassOne.class,
                    TestClassTwo.class})
```

```
public class MetaTest
{
```

```
    @BeforeClass
    public static void initialize(){
        System.out.println("setting up");
        // ...
    }
```

```
    @AfterClass
    public static void terminate(){
        System.out.println("tearing down");
        //...
    }
}
```

```
public class TestClassOne
{
    @Test
    public void test1()
    {
        System.out.println("test1");
        //...
    }
}
```

```
public class TestClassTwo
{
    @Test
    public void test2()
    {
        System.out.println("test2");
        //...
    }
}
```

Output:

```
setting up
test1
test2
tearing down
```

JUnit & Exceptions

- There are two kinds of exceptions worth noting:

Case 1. Expected exceptions resulting from a test

Case 2. Unexpected exceptions from something that's gone horribly wrong

For case 2 - JUnit will catch these and provide a complete stack trace.

Expected Exceptions

Case 1 - sometimes in a test, need to verify that the method under test has actually thrown an exception.

Simple School Approach:

“expected” annotation parameter declares that the specified exception should have been thrown.

Old School Approach

```
@Test
public void testEmpty ()
{
    try
    {
        Largest.largest(new int[] {});
        fail("Should have thrown an exception");
    }
    catch (RuntimeException e)
    {
        assertTrue(true);
    }
}
```

Simple School Approach

```
@Test (expected = RuntimeException.class)
public void testEmpty ()
{
    Largest.largest(new int[] {});
}
```

Expected Exceptions – New School Approach

JUnit allows you to define **rules**, which can provide greater control over what happens during the flow of test execution.

New School Approach (JUnit 4)

```
import org.junit.rules.*;
// ...

@Rule
public ExpectedException thrown = ExpectedException.none();

@Test
public void exceptionRule() {
    thrown.expect(InsufficientFundsException.class);
    thrown.expectMessage("balance only 0");
    account.withdraw(100);
}
```

Expected Exceptions – New School Approach

New School Approach (JUnit 4)

```
import org.junit.rules.*;  
// ...
```

@Rule

```
public ExpectedException thrown = ExpectedException.none();
```

@Test

```
public void exceptionRule() {  
    thrown.expect(InsufficientFundsException.class);  
    thrown.expectMessage("balance only 0");  
    account.withdraw(100);  
}
```

Suppose we're designing a test in which we withdraw funds from a new account—that is, one with no money. Withdrawing any money from the account should generate an exception.

To use the *ExpectedException* rule, declare a public instance of `ExpectedException` in the test class and mark it with **@Rule**.

Expected Exceptions – New School Approach

New School Approach (JUnit 4)

```
import org.junit.rules.*;
// ...

@Rule
public ExpectedException thrown
    = ExpectedException.none();

@Test
public void exceptionRule() {
    thrown.expect(InsufficientFundsException.class);
    thrown.expectMessage("balance only 0");
    account.withdraw(100);
}
```

We tell the **thrown** rule instance to **expect** that an ***InsufficientFundsException*** gets thrown.

We set another **expectation** on the **thrown** rule...the thrown exception should contain the passed substring.

Finally, our *act* portion of the test withdraws money which hopefully triggers the exception we expect. JUnit's rule mechanism handles the rest, passing the test if all expectations on the rule were met and failing the test otherwise.

Testing Exceptions - New School Approach (JUnit 5)

- The **@Rule** annotation no longer exists in JUnit5; use **assertThrows** instead!

org.junit.jupiter.api

Class Assertions

java.lang.Object

org.junit.jupiter.api.Assertions

@API(value=Maintained)

public final class **Assertions**

extends java.lang.Object

Assertions is a collection of utility methods that support asserting conditions in tests.

Unless otherwise noted, a *failed* assertion will throw an `AssertionFailedError` or a subclass thereof.

Since:

5.0

See Also:

`AssertionFailedError`, `Assumptions`

```
static <T extends java.lang.Throwable> assertThrows(java.lang.Class<? extends java.lang.Throwable> expectedType, Executable executable)
T
    Asserts that execution of the supplied executable throws an exception of the expectedType and returns the exception.
```

Testing Exceptions - New School Approach (JUnit 5)

```
static <T extends java.lang.Throwable> assertThrows(java.lang.Class<? extends java.lang.Throwable> expectedType, Executable executable)  
T  
    Asserts that execution of the supplied executable throws an exception of the expectedType and returns the exception.
```

assertThrows

```
public static <T extends java.lang.Throwable> T assertThrows(java.lang.Class<? extends java.lang.Throwable> expectedType,  
    Executable executable)
```

Asserts that execution of the supplied `executable` throws an exception of the `expectedType` and returns the exception.

If no exception is thrown, or if an exception of a different type is thrown, this method will fail.

If you do not want to perform additional checks on the exception instance, simply ignore the return value.

```
@Test  
@DisplayName("throws EmptyStackException when popped")  
void throwsExceptionWhenPopped()  
{  
    assertThrows(EmptyStackException.class, () -> stack.pop());  
}  
  
@Test  
@DisplayName("throws EmptyStackException when peeked")  
void throwsExceptionWhenPeeked()  
{  
    assertThrows(EmptyStackException.class, () -> stack.peek());  
}
```

JUnit Testing Advice (so far)

- You should make your tests visually consistent using AAA(A).
- You should keep your tests maintainable by testing behaviour, not methods (i.e. focus on the behaviours of your class and not individual methods).
- Adhere to test naming conventions (and separate folder structures).
- Use @Before and @After for common initialisation and cleanup needs. You can have multiples of these methods (can't guarantee order of execution, though).
- Safely ignore tests getting in your way.



Any questions?