CS 635 Advanced Object-Oriented Design & Programming
Spring Semester, 2009
Doc 3 Refactoring Intro
Jan 29, 2009

References

JUnit Javadoc: http://www.junit.org/junit/javadoc/3.8/index.htm, http://junit.org/junit/javadoc/4.5/

Refactoring: Improving the Design of Existing Code, Fowler, Addison-Wesley, 1999

Unit Testing

Testing

Johnson's Law

If it is not tested it does not work

The more time between coding and testing

More effort is needed to write tests
More effort is needed to find bugs
Fewer bugs are found
Time is wasted working with buggy code
Development time increases
Quality decreases

Unit Testing

Tests individual code segments

Automated tests

What wrong with:

Using print statements

Writing driver program in main

Writing small sample programs to run code

Running program and testing it be using it

We have a QA Team, so why should I write tests?

When to Write Tests

First write the tests

Then write the code to be tested

Writing tests first saves time

- Makes you clear of the interface & functionality of the code

- Removes temptation to skip tests

What to Test

Everything that could possibly break

Test values

- Inside valid range
- Outside valid range
- On the boundary between valid/invalid

GUIs are very hard to test

- Keep GUI layer very thin
- Unit test program behind the GUI, not the GUI

Common Things Programs Handle Incorrectly

Adapted with permission from “A Short Catalog of Test Ideas” by Brian Marick,

http://www.testing.com/writings.html

Strings

Empty String

Collections

Empty Collection

Collection with one element

Collection with duplicate elements

Collections with maximum possible size

Numbers

Zero

The smallest number

Just below the smallest number

The largest number

Just above the largest number

XUnit

Free frameworks for Unit testing

SUnit originally written by Kent Beck 1994

JUnit written by Kent Beck & Erich Gamma

Available at: http://www.junit.org/

Ports to many languages at:

http://www.xprogramming.com/software.htm

Sample JUnit 4.x Example

```
import static org.junit.Assert.*;
import java.util.ArrayList;
import org.junit.Before;
import org.junit.Test;

public class HelloWorldTest {
	int testValue;
	@Test
	public void testMe() {
		assertEquals(1, testValue);
	}

	@Test
	public void foo() {
		assertTrue(2 == testValue);
	}
```

```
@Test(expected=IndexOutOfBoundsException.class)
   public void testIndexOutOfBoundsException() {
      ArrayList emptyList = new ArrayList();
      Object notValid = emptyList.get(0);
   }

      @Before
      public void initialize(){
            testValue = 1;
      }
}
```

JUnit Example - JUnit 3.x

Goal: Implement a Stack containing integers.

Tests:

Subclass junit.framework.TestCase

Methods starting with 'test" are run by TestRunner

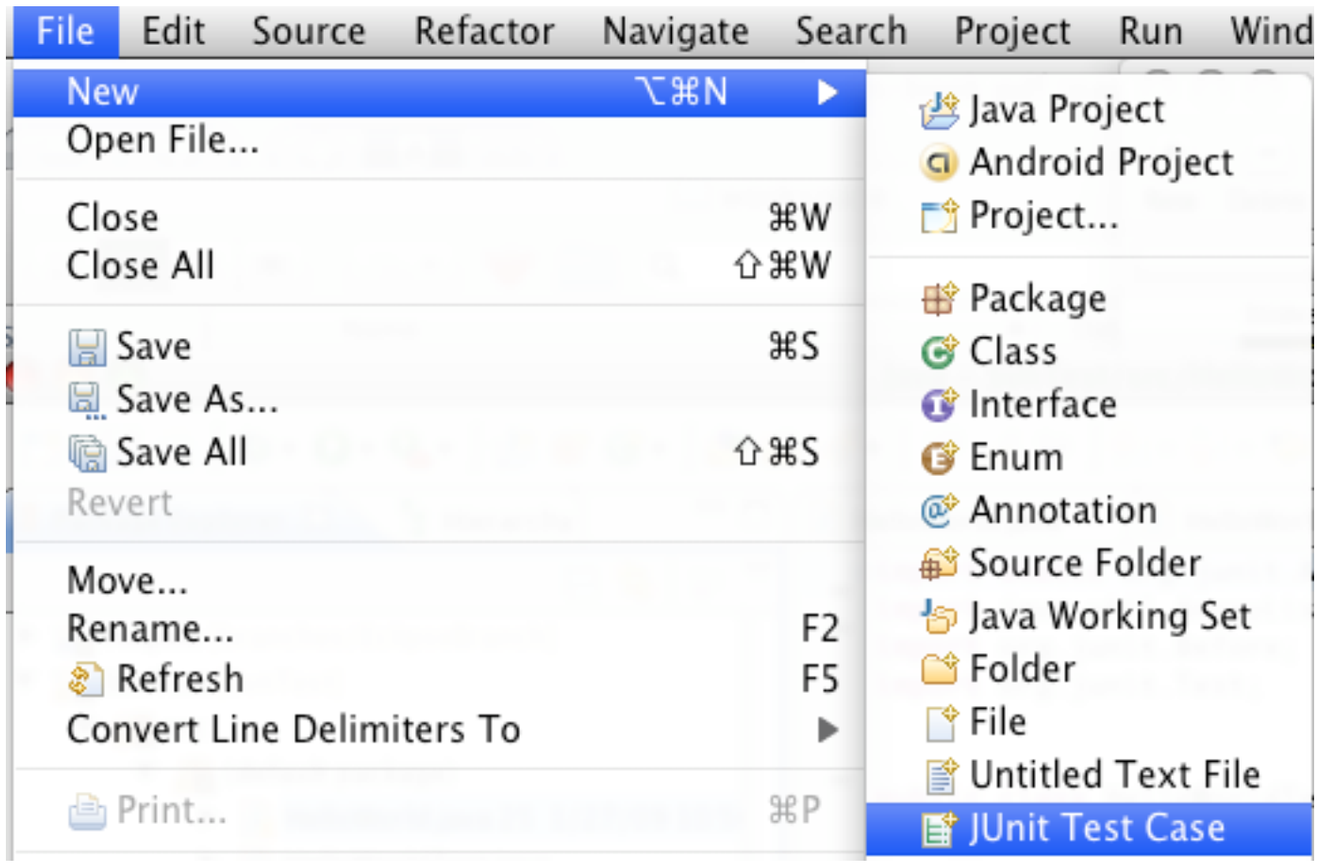
```
import junit.framework.*;
public class  TestStack extends TestCase {

        public void testDefaultConstructor() {
                Stack test = new Stack();
                assertTrue("Default constructor", test.isEmpty() );
        }

        public void testSizeConstructor() {
                Stack test = new Stack(5);
                assertTrue( test.isEmpty() );
        }
}
```

Start of Stack Class

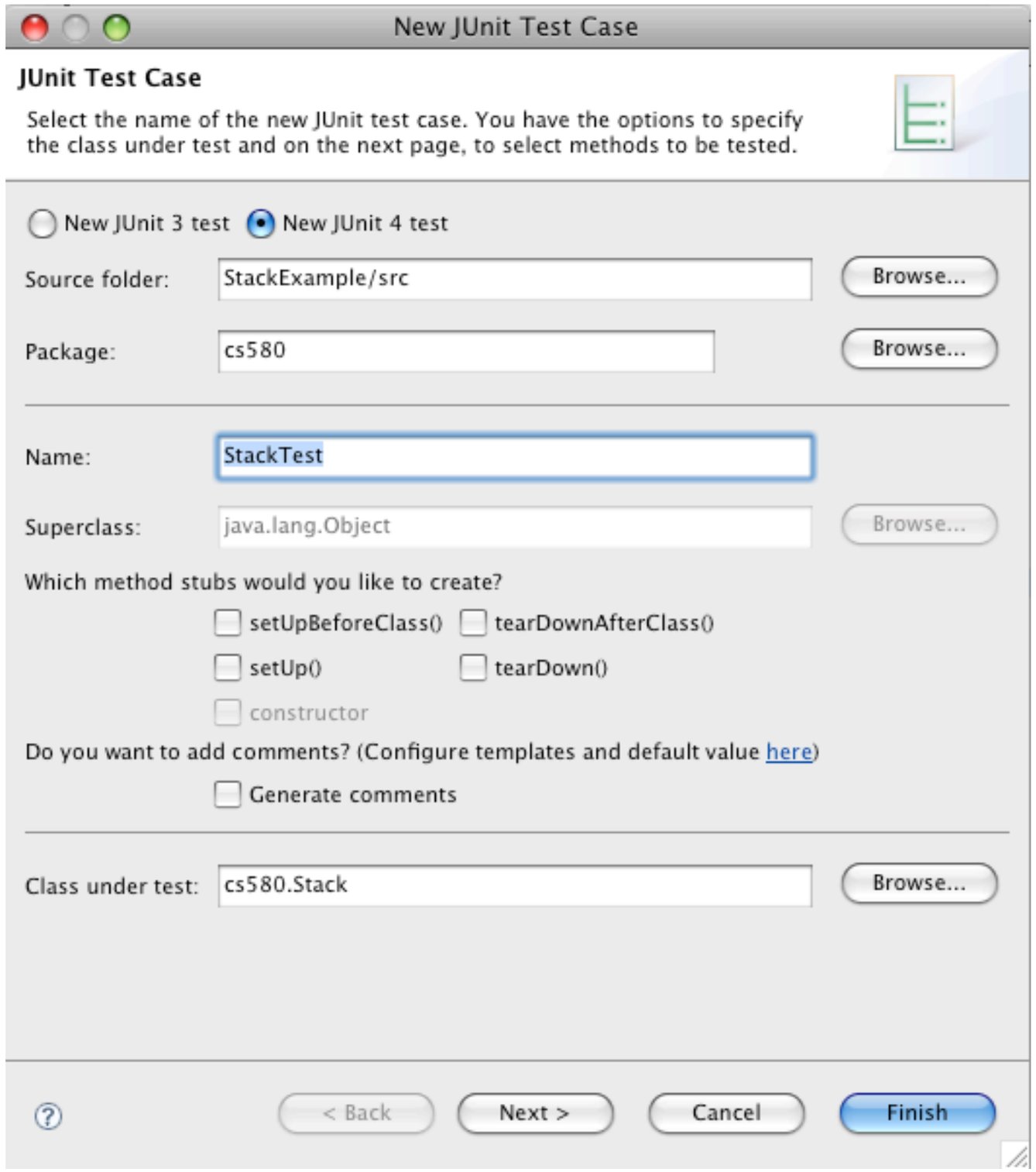
```
public class Stack  {
        int[] elements;
        int topElement = -1;

        public Stack() {
         this(10);
        }

        public Stack(int size) {
                elements = new int[size];
        }

        public boolean isEmpty() {
                return topElement == -1;
        }
}
```

Running JUnit Using Eclipse

Creating Test Case



Running JUnit Using Eclipse



Fill in dialog window & create the test cases

Select Junit test case from the "Run as..." menu

Assert Methods

assertTrue()
assertFalse()
assertEquals()
assertNotEquals()
assertSame()
assertNotSame()
assertNull()
assertNotNull()
fail()

For a complete list see

http://www.junit.org/junit/javadoc/3.8/index.htm/allclasses-frame.html/junit/junit/framework/Assert.html/Assert.html

Testing the Tests

If can be useful to modify the code to break the tests

```
package example;

public class Stack  {
	int[] elements;
	int topElement = -1;

	etc.

	public boolean isEmpty() {
		return topElement == 1;
	}
}
```

Test Fixtures - JUnit 3.x

Before each test setUp() is run

After each test tearDown() is run

```
package example;
import junit.framework.TestCase;

public class  StackTest extends TestCase {
        Stack test;

        public void setUp() {
                test = new Stack(5);
                for (int k = 1; k <=5;k++)
                        test.push( k);
        }

        public void testPushPop() {
                for (int k = 5; k >= 1; k--)
                        assertEquals( "Pop fail on element " + k,  test.pop() , k);
        }
}
```

Testing Exceptions - JUnit 3.x

```
public void testIndexOutOfBoundsException() {

    ArrayList list = new ArrayList(10);
    try {
        Object o = list.get(11);
        fail("Should raise an IndexOutOfBoundsException");
    } catch (IndexOutOfBoundsException success) {}
}
```

Example is from the JUnit FAQ

Refactoring

Changing the internal structure of software without changing its observable behavior

Done to make the software easier to understand and cheaper to modify

When to Refactor

Rule of three

Three strikes and you refactor

When to Refactor

When you add a new function
When you need to fix a bug
When you do a code review

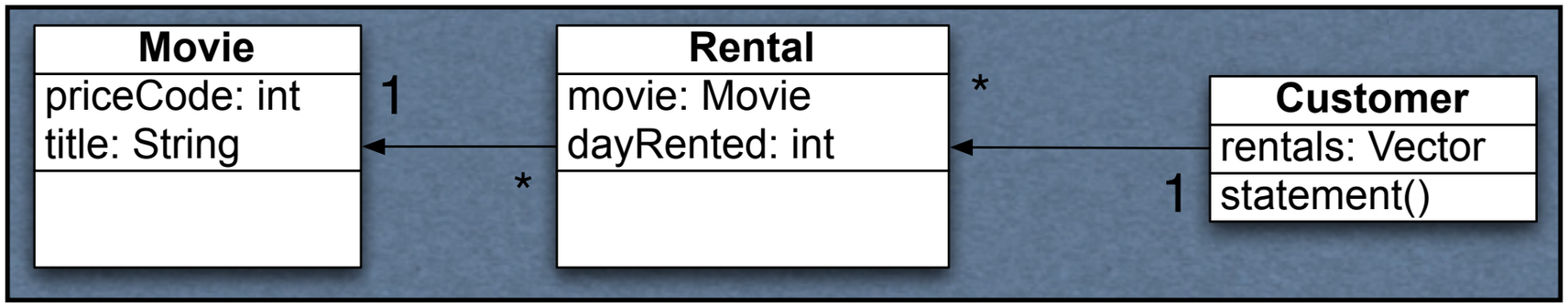
When Refactoring is Hard

Databases

Changing published interfaces

Major design issues

Refactoring First Example




```
public class Movie {
    public static final int CHILDRENS = 2;
    public static final int REGULAR = 0;
    public static final int NEW_RELEASE = 1;

    private String _title;
    private int _priceCode;

    public Movie(String title, int priceCode) {
        _title = title;
        _priceCode = priceCode;
    }
}
```


Example directly from Refactoring: Improving the Design of Existing Code, Martin Fowler, chapter 1.

Customer statement()

```
public String statement() {
        double totalAmount = 0;
        int frequentRenterPoints = 0;
        Enumeration rentals = _rentals.elements():
        String result = "Rental Record for " + getName() + "\n";
        while (rentals.hasMoreElements()) {
                double thisAmount = 0;
                Rental each = (Rental) rentals.nextElement();
                switch (each.getMovie().getPriceCode()) {
                        case Movie.REGULAR:
                                thisAmount += 2;
                                if (each.getDaysRented() > 2)
                                        thisAmount += (each.getDaysRented() -2) *1.5;
                                break;
                        case Movie.NEW_RELEASE:
                                thisAmount += each.getDaysRented() * 3;
                                break;
                        case Movie.CHILDRENS:
                                thisAmount += 1.5;
                                if (each.getDaysRented() > 3)
                                        thisAmount += (each.getDaysRented() - 3) *1.5;
                                break;
                }
                frequentRenterPoints ++;
                if (((each.getMovie().getPriceCode() == Movie.NEW_RELEASE) && each.getDaysRented() > 1)
                        frequentRenterPoints ++;
                result += "\t" + each.getMovie().getTitle() + "\t" + String.valueOf(thisAmount) + "\n";
                totalAmount += thisAmount;
        }
        result += "Amount owed is " + String.valueOf(totalAmount) + "\n";
        result += You earned " + String.vauleOf(frequentRenterPoints) + "frequent renter points";
        return result;
}
```


Example directly from Refactoring: Improving the Design of Existing Code, Martin Fowler, chapter 1.

Comments?

When you add a feature to a program

If needed Refactor the program to make it easy to add the feature

Then add the feature

Before you start refactoring

Make sure that you have a solid suite of tests

Test should be self-checking

Do I need tests when I use my IDEs refactoring tools?

Are your IDE refactoring tools bug free?

How not to Refactor

```
public String statement() {
        double totalAmount = 0;
        int frequentRenterPoints = 0;
        Enumeration rentals = _rentals.elements():
        String result = "Rental Record for " + getName() + "\n";
        while (rentals.hasMoreElements()) {
                double thisAmount = 0;
                Rental each = (Rental) rentals.nextElement();
                switch (each.getMovie().getPriceCode()) {
                        case Movie.REGULAR:
                                thisAmount += 2;
                                if (each.getDaysRented() > 2)
                                        thisAmount += (each.getDaysRented() -2) *1.5;
                                break;
                        case Movie.NEW_RELEASE:
                                thisAmount += each.getDaysRented() * 3;
                                break;
                        case Movie.CHILDRENS:
                                thisAmount += 1.5;
                                if (each.getDaysRented() > 3)
                                        thisAmount += (each.getDaysRented() - 3) *1.5;
                                break;
                }
                frequentRenterPoints ++;
                if (((each.getMovie().getPriceCode() == Movie.NEW_RELEASE) && each.getDaysRented() > 1)
                        frequentRenterPoints ++;
                result += "\t" + each.getMovie().getTitle() + "\t" + String.valueOf(thisAmount) + "\n";
                totalAmount += thisAmount;
        }
        result += "Amount owed is " + String.valueOf(totalAmount) + "\n";
        result += You earned " + String.vauleOf(frequentRenterPoints) + "frequent renter points";
        return result;
}
```

How Not to Refactor

```
public String statement() {
    double totalAmount = 0;
    int frequentRenterPoints = 0;
    Enumeration rentals = _rentals.elements():
    String result = "Rental Record for " + getName() + "\n";
    etc.
```

```
public String statement() {
    initializeStatement();
    etc.
```

```
private void initializeStatement() {
    _totalAmount = 0;
    _frequentRenterPoints = 0;
    _rentals = _rentals.elements():
    _result = "Rental Record for " + getName() + "\n";
}
```


Bad idea – just copying parts of code to other methods and making the local variables fields so the methods can communicate.