# CS 635 Advanced Object-Oriented Design & Programming
Spring Semester, 2016
Doc 3 Code Smells, Refactoring, Unit Tests
Jan 28, 2016

# Review

Object-Oriented Programming is good as it promotes

- Code reuse
- More readable code
- More maintainable code
- Better designs

# Basic OO Heuristics

Keep related data and behavior in one place

A class should capture one and only one key abstraction

Beware of classes that have many accessor methods defined in their public interface

# OO History

Objects as a formal concept in programming - Simula 67

Smalltalk introduced the term object-oriented programming - 1970s

Became dominant programming methodology
    Early and mid 1990s

# So Why is Software Still so Bad?

# Code Smell

Hint that something has gone wrong somewhere in your code

http://c2.com/cgi/wiki?CodeSmell

# Lists of Code Smells

Coding Horror: Code Smells

http://www.codinghorror.com/blog/2006/05/code-smells.html

Cunningham wiki c2

http://c2.com/cgi/wiki?CodeSmell

# Comments

There's a fine line between comments that illuminate and comments that obscure.

Are the comments necessary?

Do they explain "why" and not "what"?

Can you refactor the code so the comments aren't required?

And remember, you're writing comments for people, not machines.

http://blog.codinghorror.com/code-smells/

# Uncommunicative Name, Vague Identifier

meetsCriteria
flag

Does the name of the method succinctly describe what that method does?

Could you read the method's name to another developer and have them explain to you what it does?

If not, rename it or rewrite it.

# Inconsistent Names

Pick a set of standard terminology and stick to it throughout your methods.

If you have Open(), you should probably have Close().

# Type Embedded in Name

Avoid placing types in method names;

it's not only redundant, but it forces you to change the name if the type changes.

# Conditional Complexity

Watch out for large conditional logic blocks

Particularly blocks that tend to grow larger or change significantly over time.

Consider alternative object-oriented approaches such as

- decorator,
- strategy, or
- state.

# Dead Code

Ruthlessly delete code that isn't being used.

That's why we have source control systems!

# Code Smell - Utility Method

Utility methods are a sign that related data and operations are not together

# Java & OO

In many situations we can not OO in Java

Can not keep data and operations together in many of Java's existing classes

Ruby, Objective-C & Smalltalk allow you to add to existing classes

# Result

Can't practice OO in small cases

Develop poor habits

Lose benefits of OO but don't noticce

# One Responsibility Rule

"A class has a single responsibility: it does it all, does it well, and does it only"

Bertrand Meyer

Try to describe a class in 25 words or less, and not to use "and" or "or"

If can not do this you may have more than one class

# Duplicate Code

Duplicate Code

Duplicate Code

Duplicate Code

Duplicate Code

Duplicate Code

Duplicate Code

Duplicate Code

# Long Method - Large Class

The average method size should be less than 8 lines of code (LOC) for Smalltalk and 24 LOC for C++

The average number of methods per class should be less than 20

The average number of fields per class should be less than 6.

The class hierarchy nesting level should be less than 6

The average number of comment lines per method should be greater than 1





Mark Lorenz, *Object-Oriented Software Development: A Practical Guide*, 1993, Appendix I Measures and Metrics

# Long Parameter List

```
a.foo(12, 2, "cat", "<tr>", 19.6, x, y, classList, cutOffPoint)
```

# Divergent Change

If, over time, you make changes to a class that touch completely different parts of the class, it may contain too much unrelated functionality.

Consider isolating the parts that changed in another class.

# ShotGun Surgery

If a change in one class requires cascading changes in several related classes,

consider refactoring so that the changes are limited to a single class.

# Middle Man

If a class is delegating all its work, why does it exist?

Cut out the middleman.

Beware classes that are merely wrappers over other classes or existing functionality in the framework.

# Feature Envy

A method seems more interested in a class other than the one it is in.

# Data Clumps

Same three or four data items together in lots of places

# Primitive Obsession

Don't use a gaggle of primitive data type variables as a poor man's substitute for a class.

If your data type is sufficiently complex, write a class to represent it.

# Switch Statements

How do you program without them?

# Lazy Class

Classes should pull their weight.

Every additional class increases the complexity of a project.

If you have a class that isn't doing enough to pay for itself,
can it be collapsed or combined into another class?

# Data Class

Class with just fields and setter/getter methods

Data classes are like children.

They are okay as a starting point, but to participate as a grownup object, they need to take some responsibility

# Inappropriate Intimacy

Watch out for classes that spend too much time together,
or classes that interface in inappropriate ways.

Classes should know as little as possible about each other.

# Message Chains

location = rat.getRoom().getMaze().getLocation()

# Negative Slope

```
if (foo) {
    if (bar) {
        if (cat = dog) {
            if (rat < 10) {
                ...
```

# Temporary Field

Field is only used in certain circumstances

Common case

- field is only used by an algorithm
- Don't want to pass around long parameter list
- Make parameter a field

# Refused Bequest

Subclass does not want to support all the methods of parent class

Subclass should support the interface of the parent class

# Solution Sprawl

If it takes five classes to do anything useful, you might have solution sprawl.

Consider simplifying and consolidating your design.

# Refactoring

# Refactoring

Changing the internal structure of software that changes its observable behavior

Done to make the software easier to understand and easier 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

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

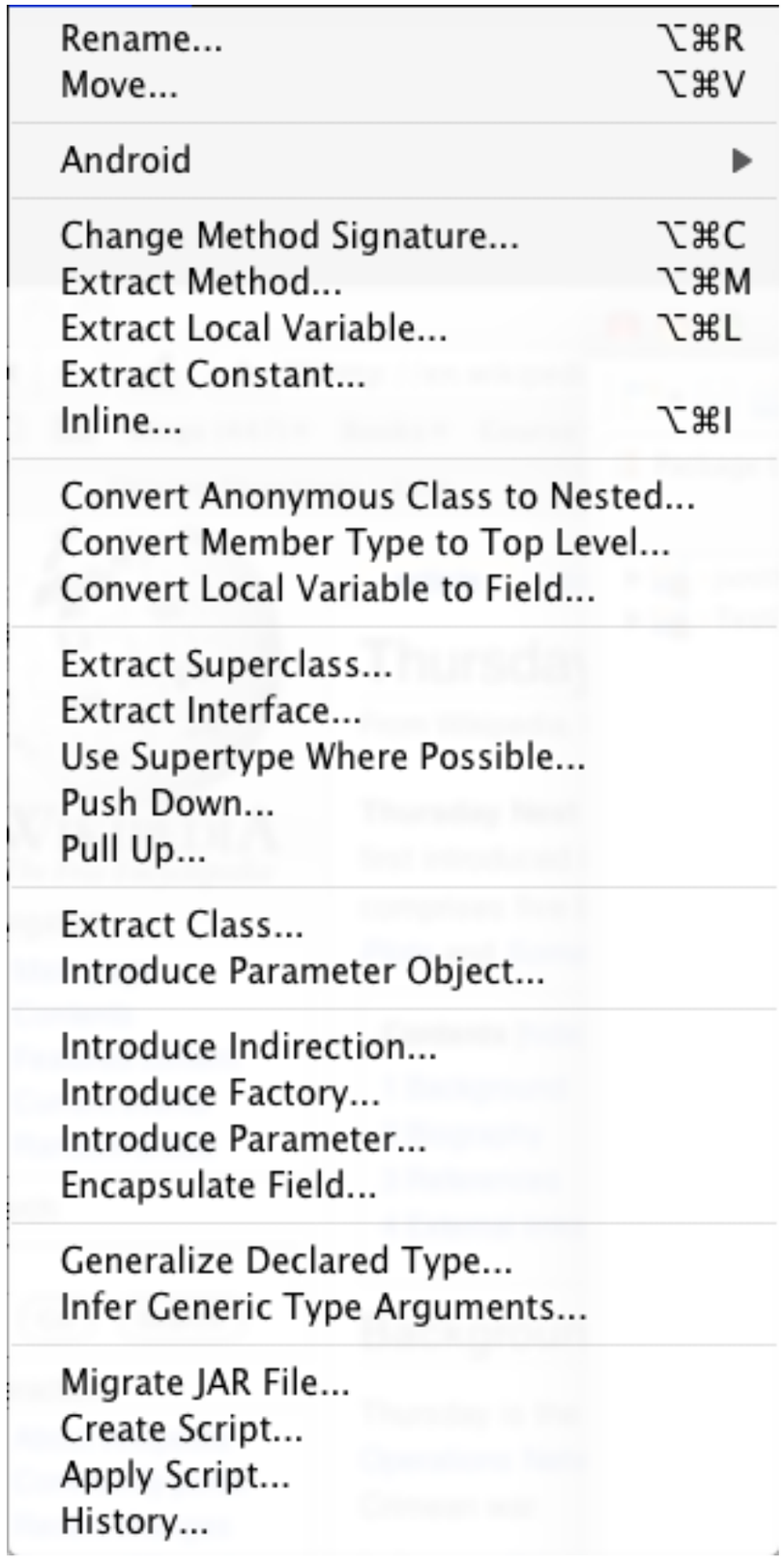
Test should be self-checking

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

Are your IDE refactoring tools bug free?

# Eclipse Refactoring

# Eclipse Refactoring Menu



# Rename Class

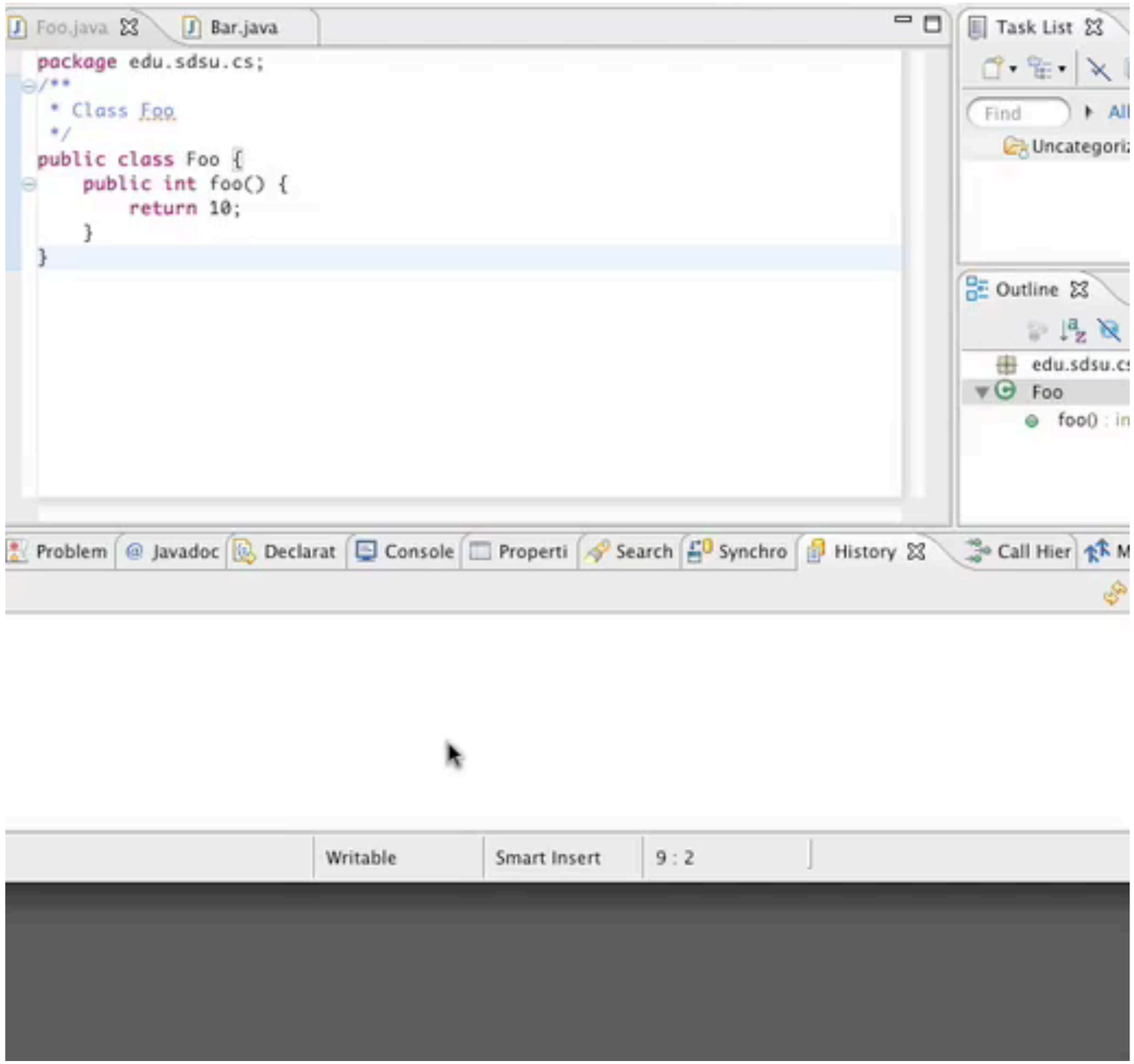
```
public class Foo {
        public int foo() {
            return 10;
    }
}
```

```
public class NewFoo {
        public int foo() {
            return 10;
    }
}
```

```
public class Bar {
    public int bar() {
        Foo test = new Foo();
        return test.foo() + 99;
    }
}
```

```
public class Bar {
    public int bar() {
        NewFoo test = new NewFoo();
        return test.foo() + 99;
    }
}
```

# Eclipse Rename



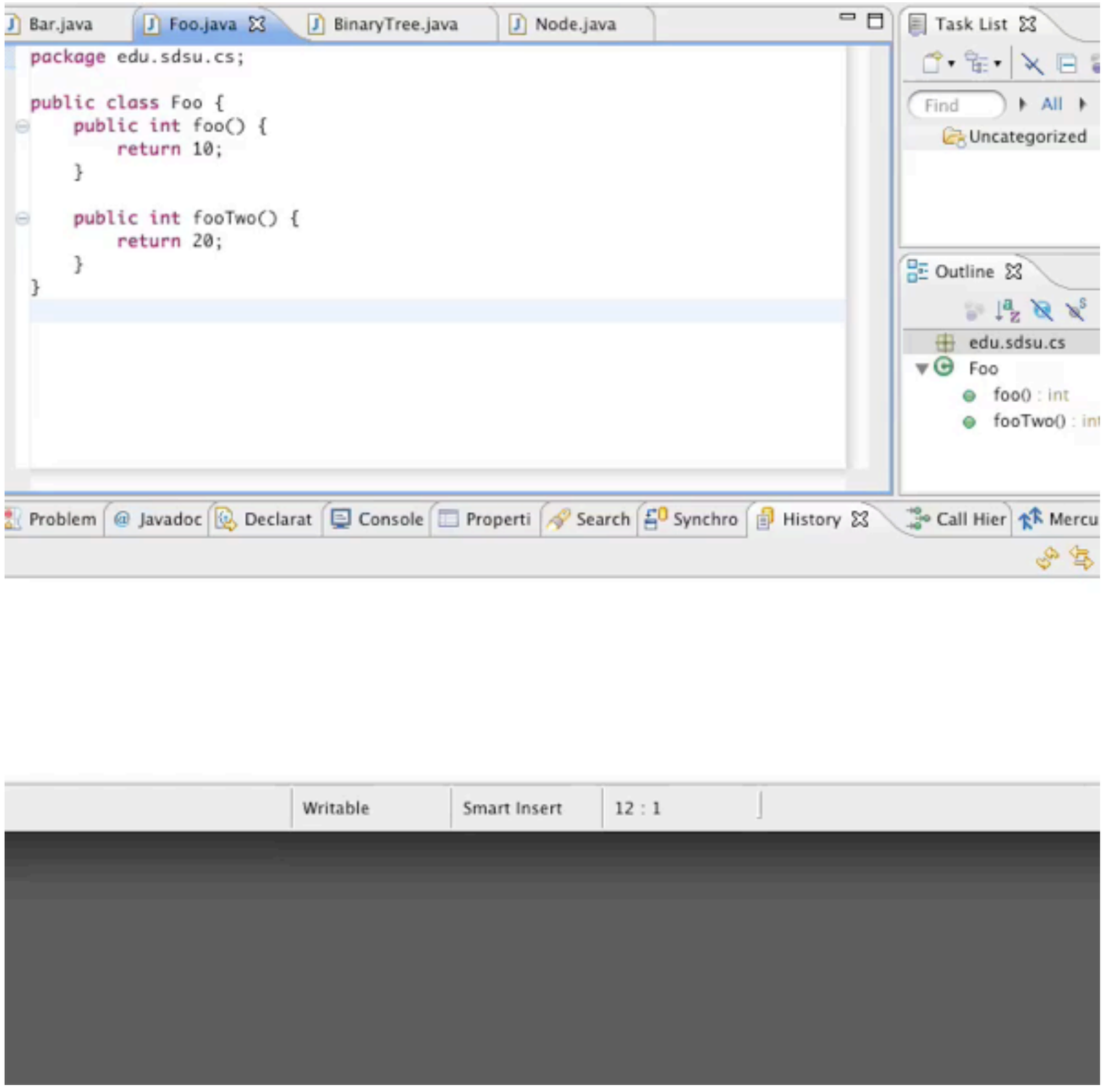
# Move

```
public class Bar {
      public int helperMethod(Foo test) {
            return test.foo() + test.fooTwo();
      }

      public int callHelper() {
            Foo data = new Foo();
            return helperMethod(data);
      }
}
```

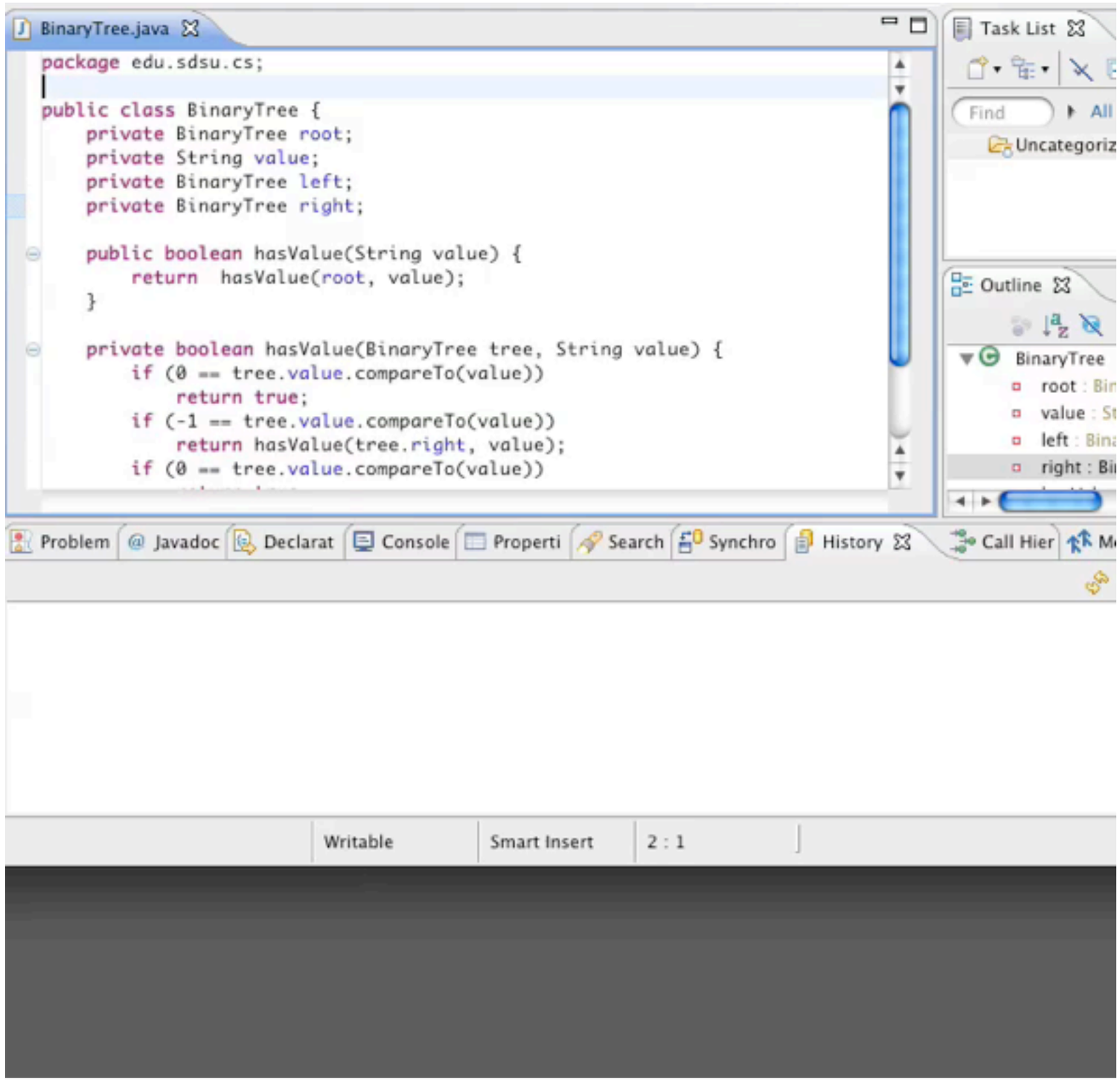
```
public class Foo {
      public int foo() { return 10;}

      public int fooTwo() { return 20; }
}
```

```
public class Bar {
      public int callHelper() {
            Foo data = new Foo();
            return data.sum();
      }
}

public class Foo {
      public int foo() { return 10;}

      public int fooTwo() {return 20; }

      public int sum() {
            return foo() + fooTwo();
      }
}
```

# Eclipse Move



# Extract Class



# Refactoring Tool Issue

People tend to only use the features they know

# Refactoring Tool Issue

Is a tool hard to use because I am unfamiliar with it or is it just hard to use

# Refactoring by 41 Professional Programmers

| | Number of Programmers used Refactoring | Total Times used |
|---|---|---|
| IntroduceFactory | 1 | 1 |
| PushDown | 1 | 1 |
| UseSupertype | 1 | 6 |
| EncapsulateField | 2 | 5 |
| Introduce Parameter | 3 | 25 |
| Convert Local to Field | 5 | 37 |
| Extract Interface | 10 | 26 |
| Inline | 11 | 185 |
| Modify Parameters | 11 | 79 |
| Pull up | 11 | 37 |
| Extract Method | 20 | 344 |
| Move | 24 | 212 |
| Rename | 41 | 2396 |





From Refactoring Tools: Fitness for Purpose, Emerson Murphy-Hill and Andrew P. Black,http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.139.191&rep=rep1&type=pdf

# Try In Eclipse

Rename
Move
Encapsulate Field
Extract Method
Extract Class

# 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

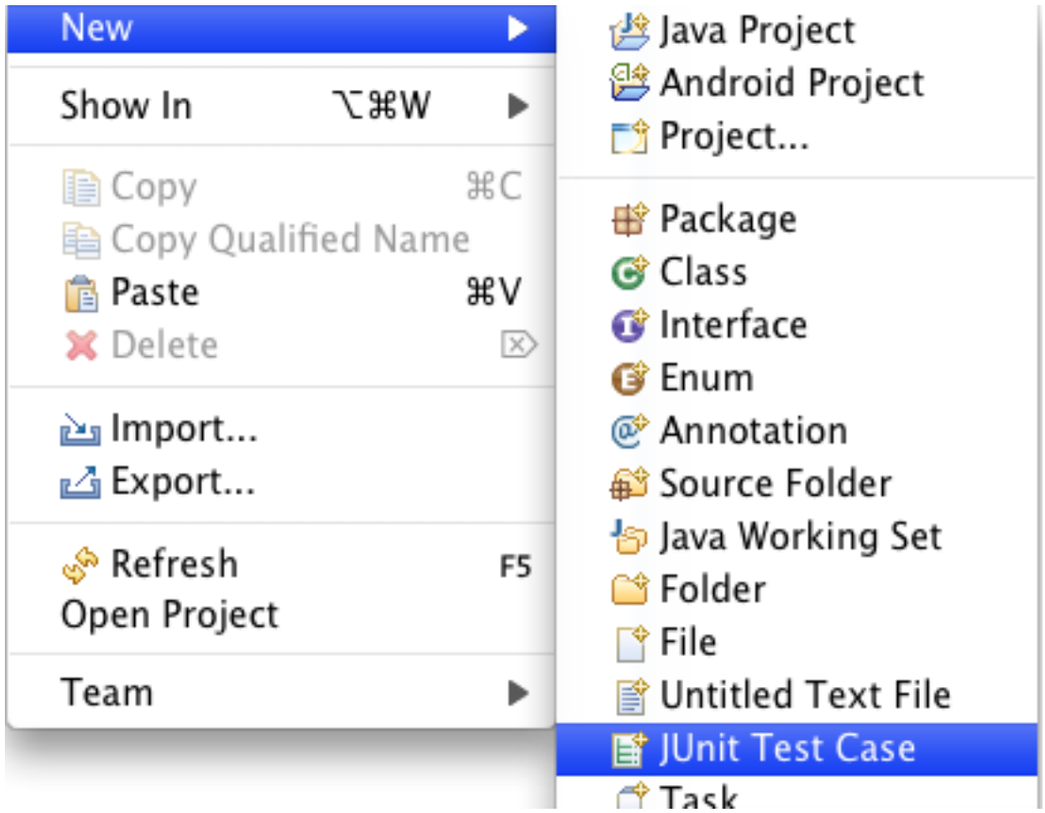
# XUnit Versions

| 3.x | 4.x |
| --- | --- |
| Old version | Current version 4.8.1 |
| Works with a versions of Java | Uses Annotations |
| | Requires Java 5 or later |

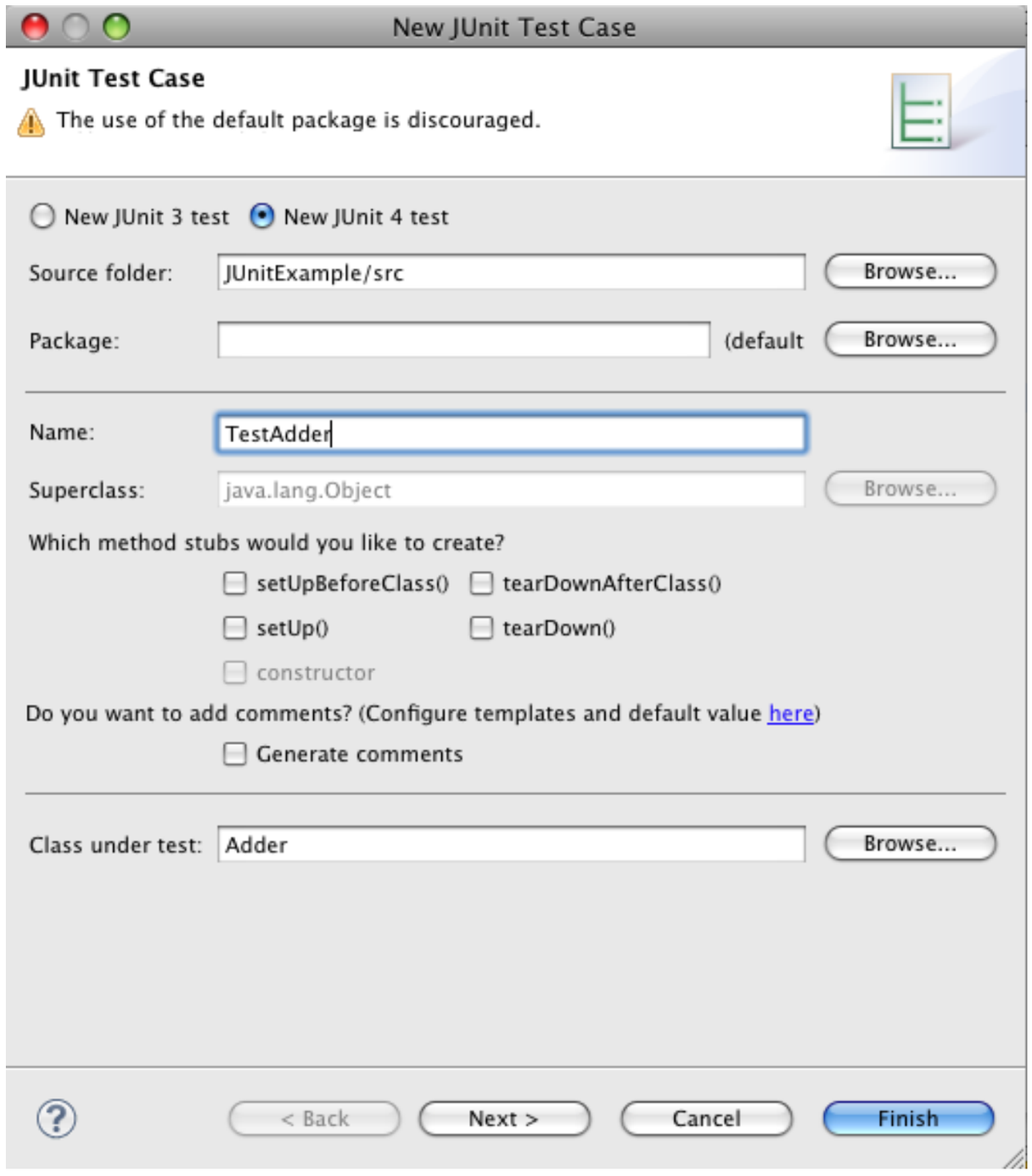
# Simple Class to Test

```
public class Adder {
        private int base;
        public Adder(int value) {
                base = value;
        }

        public int add(int amount) {
                return base + amount;
        }
}
```

# Creating Test Case in Eclipse



# Creating Test Case in Eclipse



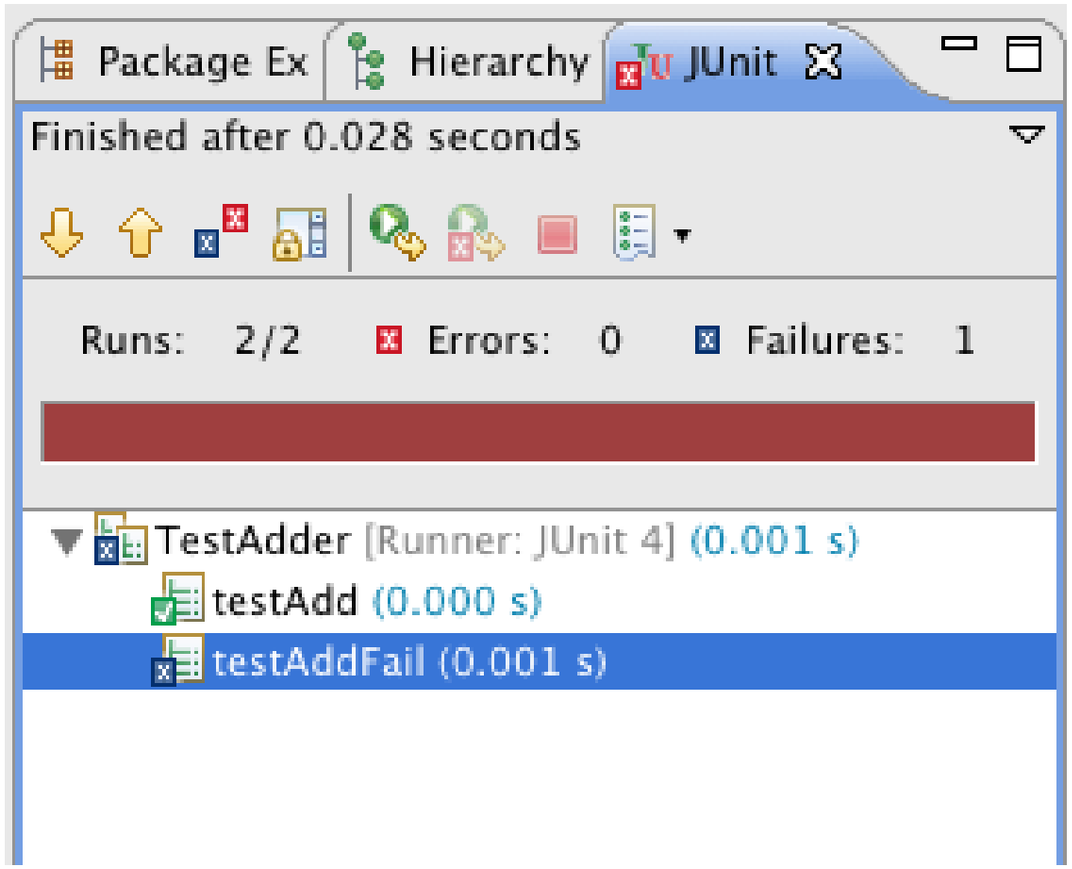

Fill in dialog window & create the test cases

# Test Class

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

public class TestAdder {

    @Test
    public void testAdd() {
        Adder example = new Adder(3);
        assertEquals(4, example.add(1));
    }

    @Test
    public void testAddFail() {
        Adder example = new Adder(3);
        assertTrue(3 == example.add(1));
    }
}
```

# Running the Tests

# The result


Package Ex
Hierarchy
JUnit
Finished after 0.028 seconds
Runs: 2/2
Errors: 0
Failures: 1
TestAdder [Runner: JUnit 4] (0.001 s)
testAdd (0.000 s)
testAddFail (0.001 s)

# Assert Methods

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





For a complete list see http://kentbeck.github.com/junit/javadoc/latest/

# Annotations

After
AfterClass
Before
BeforeClass
Ignore
Rule
Test

# Using Before

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

import org.junit.Before;
import org.junit.Test;

public class TestAdder {
        Adder example;
        @Before
        public void setupExample() {
                example = new Adder(3);
        }

        @Test
        public void testAdd() {
                assertEquals(4, example.add(1));
        }
}
```