Lecture Set #6: Encapsulaton, "this", junit testing and Libraries

1. Review of Parameter passing
2. this
3. public vs. private Choices
4. junit testing
5. Libraries

Parameters and Methods

- Recall that methods / constructors can have parameters

```
public Student (String newName, int IDDesired) {
    name = newName;
    id = IDDesired;
    tokenLevel = 3;
}
```

- What is printed by the following?

```
String newName = "Joe";
Student s = new Student(newName + " Schmoe", 123456789);
System.out.println (s.name);
System.out.println (newName);
```

- Joe Schmoe
  Joe

How Does Java Evaluate Method / Constructor Calls?

```
int newName = "Joe";
Student s = new Student
   (newName + " Schmoe", 123456789);
```

1. Arguments are evaluated using stack in effect at call site (place where method called)
   - `newName + " Schmoe"`, evaluates to `Joe Schmoe`
   - `123456789` evaluates to `123456789`
2. Stack frame (temporary addition to stack) created to associate method parameters with values
3. Stack frame put into stack
4. Body of method executed in modified stack
5. Stack frame removed from stack

this

- a reference to the current object. (Only makes sense in a non-static method.)
- In an instance method, this is the object that is assumed
  - easy to refer to members (data or methods) using the assumed object
  - difficult to refer to the whole object without having a name to call it
- Only use when needed – using it all the time makes the code more difficult to read

Public Declarations

- public variables/methods and classes
  - Keyword `public` used in declaration
  - Every user of an object can access any `public` element
- Sometimes access should be restricted!
  - To avoid giving object users unnecessary info (keep API small)
  - To enforce consistency on instance variables

Private Declarations

- private variables, methods and classes

```
private int tokenLevel = 3;
```

- Private variables / members cannot be accessed outside the class definition
- Declaring instance variables private means they can only be modified using public methods

What Should Be Public / Private?

- Class interface = API = public variables / methods
- Only make something public if there is a reason to
- Why? Encapsulation
  - As long as interface is preserved, class can change without breaking other code
  - The more limited the interface, the less there is to maintain
- Rule of thumb
  - Make instance variables private
  - Implement `set` / `get` methods
  - Make auxiliary methods private

Separate: API and the workings of the class

- Design so that
  - you can change how the class works without having to change the API
  - the only things in the API are things the user will absolutely need (make the interface as simple as possible)
- Demonstrations in Class
  - Significantly Modifying the Student class – without changing the API (or the driver)
  - The Cat class and its drivers
    - with adding a copy constructor
  - Project 3
    - API described – you are using those classes
    - documentation / comments needed

Floating Point Calculations

What will this print?

```
public class SimpleMath {
   public static void main(String[] args) {
        if (3.9 - 3.8 == 0.1) {
                System.out.println("I am a very smart computer.");
        } else {
                System.out.println("I can't do simple arithmetic.");
        }
   }
}
```

→ I can't do simple arithmetic.
- Why?
- Conversion of floating point to binary leads to precision errors!
- What can we do?

Floating Point Calculations (cont.)

Two important rules:

- You can never use == to compare floating point values. Instead, check if two numbers are within a certain tolerance of each other.
- Never use floating point values to represent money, e.g., 3.52 to represent $3.52. Instead, use integer 352 to represent 352 pennies.

The problem

- Problems:
  - need to be able to make sure all parts are tested
  - need to know in testing exactly which part was not as expected
  - need to be able to keep the tests for modifications made later
- Unit testing helps overcome this problems of making sure everything is tested
  - Unit testing: test each class and each part of the class (unit) individually
  - Goal is to eliminate inconsistencies between the API and the actual working of the code

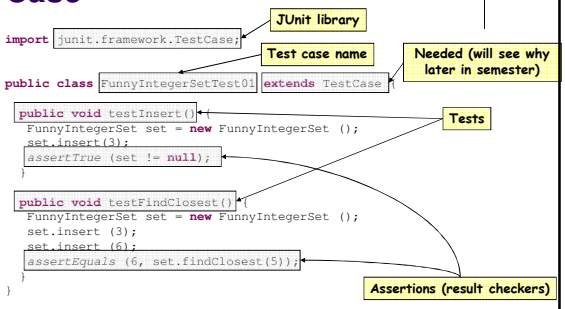
Unit Testing

- Unit testing helps overcome this problems of making sure everything is tested in a structured way
  - Unit testing: test each unit individually (micro level – each method or specifically each interaction described in the API)
  - Goal is to eliminate errors within classes
- Needs for unit testing
  - Method for defining tests = inputs, expected outputs
  - Method for running tests
  - Method for reporting results
- One possibility: write a driver for each class
  - Driver class contains main method
  - main method creates objects in class to be tested, calls methods, prints outputs
  - User checks outputs, determines correctness
  - Good: easy, no special tools needed
  - Bad: tedious, relies on human inspection of outputs
- Another approach: JUnit

JUnit

- A unit-testing tool for Java
- Includes capabilities for:
  - Test definition, including output checking
  - Test running (execution)
  - Result reporting
- Seamless integration with Eclipse
- Note
  - In this class we will use JUnit 3.8.1
  - So, when given a choice select **JUnit 3**

Structure of a JUnit 3.8.1 Test Case



A Test Case Is … A Class!

- assertion checkers
  - **`assertTrue(`***`expression`***`);`**
    - If `statement` is true, keep running test; otherwise, halt test, report "fail"
  - **`assertFalse(`***`expression`***`);`**
    - If `statement` is false, keep running test; otherwise, halt test, report "fail"
  - **`assertEquals(`***`expression1, expression2`***`);`**
    - If `expression1`, `expression2` equal, keep running test; otherwise, halt test, report "fail"
- If test terminates without failing an assertion and without throwing an uncaught exception, then it passes that test
- It continues with all subsequent tests regardless of passing or failing the current test

Hints on Testing

- Give names to tests that relate to class being tested
- Develop some tests before you code
  - Helps you to clarify what you are supposed to be doing
  - Gives you some ready-made tests to run while you code
- Use tests to debug
- How many tests?
  - Statement coverage: develop tests to make sure each statement in class is executed at least once (including constructors)
  - Decision coverage: develop tests to make each condition (if statement) in program both true and false
  - You should at least reach statement coverage in your own testing

Taking Care of Corner Cases

- FancyWord example from CVS
  - String of "" was a corner case that we needed to test for
  - Write new test cases or new asserts in the test cases that already exist to take care of this
- What about null references as corner cases?

```
public void testNullAndEmpty(){
  FancyWord a = new FancyWord(null);
  assertEquals(null,a.toString());
  FancyWord b = new FancyWord("");
  assertEquals("",b.toString());
}
```


Documentation Types

- Three Styles
  - `// ...`
  - `/* ... */`
  - `/** ... */`
- Two Purposes
  - Internal – those reading code
  - External – those using the class

Javadoc Documentation Standard

- When documenting a method, list exceptions that method can throw
  - Use `@exception` tag
  - Be sure to include unhandled exceptions that operations in method may throw
- Example:

```
/**
 * Returns the year part of a date string
 * @param d date string in mm/dd/yyyy format
 * @return an integer representing the date
 * @exception IndexOutOfBoundsException
 * @exception NumberFormatException
 */
public static int getYear(String d) {
  …
}
```


Libraries in Java

- Library: implementation of useful routines that are shared by different programs
- Java mechanism for creating libraries: packages
  - Package: group of related clases
  - Example: `java.util` (contains `Scanner` class)
- To use a class from a package, you can use a fully qualified name (package name + class name):

```
java.util.Scanner s = new java.util.Scanner(System.in);
```

- You can also import the class in the beginning of the file

```
import java.util.Scanner;
```

- To import class in a package:

```
import java.util.*;
```

(Imports `Scanner` as well as other classes in package)

Package java.lang

- A special package containing widely used classes:
  - `String`
  - `Math`
  - etc.
- `java.lang.*` is *automatically imported* by every Java program

Package Management

- A class can be added to a package by including:
  `package` <name of package>;
  in source file (usually very first line)
- The variables / methods provided by a class / package are often called its API (= Application Programmers Interface)
- APIs should be documented
- java.lang documentation:
  http://java.sun.com/j2se/1.3/docs/api/java/lang/package-summary.html
- On the resources page of the class web site – javadoc generated descriptions.

String API & Math API

- `String` implements lots of string functions
  - `StringExample.java`
- `Math` implements lots of mathematical functions
  - `MathExample.java`