Object-Oriented Programming and JUnit Testing

Reading:

- L&C, App B
- `http://www.vogella.com/tutorials/JUnit/article.html`

Classes

- Class Definition

```
class ClassName:
    attributes and methods
```

- Public Attribute

```
name (optional = value)
```

- Private Attribute

```
__name (optional = value)
```

Note: A programmer convention only
Access IS NOT prevented by interpreter

- Conventional Word “self”

Used to refer to your own object in Python
You may use another word, but “self” is the commonly accepted convention.

- Class Definition

```
public class Classname
{
    attributes and methods
} // end of class definition
```

- Public Attribute

```
public (static) type name (optional = value);
```

- Private Attribute

```
private (static) type name (optional = value);
```

Note: Access IS prevented by compiler

- Reserved Word “this”

Used similarly to “self” in Python
You **must** use the reserved word “this”.
Not required in as many places in the code,
e.g. not needed in method parameter lists.

Classes

- Constructor Method

```
def __init__ (self, parameter):
    self.parameter = parameter
```

- Public Method

```
def name (self, parameters):
    statements
```

- Private Method

```
def __name (self, parameters):
    statements
```

Note: A programmer convention only

Access IS NOT prevented by interpreter

- Constructor Method

```
public ClassName (parameter)
{
    this.parameter = parameter;
}  // end of method
```

- Public Method

```
public type name (parameters)
{
    statements;
}  // end of method
```

- Private Method

```
private type name (parameters)
{
    statements;
}  // end of method
```

Note: Access IS prevented by compiler

Classes

- Method Return Value

```
def name (self, parameters):
     return expression
```

- Method Overloading

```
def name (self, param = None):
     if param is None:
               1st version of statements
     else:
               2nd version of statements
```

- Method Return value

```
public type name (parameters)
{
     return expression of type;
}  // end of method
```

- Method Overloading

```
public type name ( )    // no parameter
{
     1st version of statements;
}  // end of first "name" method

public type name (type param)
{
     2nd version of statements;
}  // end of second "name" method
```

Python "Magic" Methods

- Magic Methods

```
__str__(self)          # representation

__cmp__(self, other) # compare objects
```
(Supports operator overloading for >, <, etc.)

```
__add__(self, other) # and sub, mul, div, etc
```
(Supports operator overloading for +, -, *, /, etc

```
__eq__(self, other)   # check equality

__iter__(self)         # returns an iterator
```
(Supports "for item in items" type of loop)

```
__del__(self)          # clean up
```

- Java Equivalents

```
public String toString()     // representation

public int compareTo(that)   // compare objs.
```
(Supports implementing Comparable interface)

Note: Operator overloading is NOT supported

```
public boolean equals(that) // check equality

public Iterator<T> iterator()   // returns an
                                // iterator
```
(Supports "for (type item : items)" for-each loop and implementing Iterable<T> interface)

```
protected void finalize()      // clean up
```

Creating / Deleting Objects

- Instantiating an Object

```
myObject = ClassName(. . .) # … are values
                    # for constructor's
                    # parameters
```

- Creating an Alias

```
yourObject = myObject  # … both variables
                       # refer to the same
                      # object
```

- Deleting an Object

```
myObject = None    # deletes object
                   # (if there is no alias)
```

- Instantiating an Object

```
ClassName myObject = new ClassName(. . . );
// ... are values for constructor's
// parameters
```

- Creating an Alias

```
ClassName yourObject = myObject;  // both vars
                                   // refer to the
                                  // same object
```

- Deleting an Object

```
myObject = null;  // deletes object
                  // (if there is no alias)
```

Inheritance / Interfaces

- Inheritance

```
# OO Concept:  A Cat is an Animal
class Cat(Animal):
   attributes and methods
```

- Multiple Inheritance

```
class ClassName(Class1, Class2, …):
   attributes and methods
```

- Inheritance

```
// OO Concept:  A Cat is an Animal
public class Cat extends Animal
{
   attributes and methods
} // end of class
```

- No Multiple Inheritance

Java doesn't support more than one parent class

- Interfaces

Java supports implementing multiple interfaces

```
public class ClassName implements Int1, Int2, …
{
} // end of class
```

Inheritance / Interfaces

- Polymorphism

```
class Pet:                  # abstract parent class
   def makeSound(self):
        raise NameOfError("text")

class Dog(Pet):             # concrete child class
   def makeSound(self):
        print "Woof Woof"

class Cat(Pet):             # concrete child class
   def makeSound(self):
        print "Meow"

spot = Dog()
spot.makeSound()            # Woof Woof
fluffy = Cat()
fluffy.makeSound()          # Meow

# Attempt to create/use an abstract class
fubar = Pet()
fubar.makeSound()    # raises an Error
                     # at run time
```

- Polymorphism

In Java, a reference to any object may be saved as a reference to the type of a parent class or of any implemented interface:

If Cat class and Dog class extend Pet class, we can do these "widening" conversions:

```
Dog d = new Dog();
Pet p = d;          // our Pet is a Dog
p = New Cat();      // and is now a Cat
```

And call any Pet method on variable p:

```
p.anyPetMethod(. . .);   // on Dog/Cat
```

If a method parameter needs to be a Pet,

```
public void methodName(Pet p) {…}
```

we can pass a Dog or a Cat object to it:

```
methodName(d);       // pass it a Dog
methodName(new Cat()); // or Cat
```

If Pet is an abstract class, we can't create a Pet object (causes a compilation error)

```
Pet p = new Pet();     // compile error
```

Inheritance / Interfaces

- Polymorphism

If a method definition requires returning a reference to a class or interface, it may return a reference to an object of the class, a child class, or an implementing class.

If Pet class implements Comparable<T>, Dog and Cat class also implement it. If we invoke a method with a return value of type Comparable<T>:

```
Comparable<T> c = methodName( . . . );
```

It can return a Dog or a Cat object:

```
public Comparable<T> methodName(. . .)
{
    if (some boolean expression)
          return new Dog();
    else
  return new Cat();
}
```

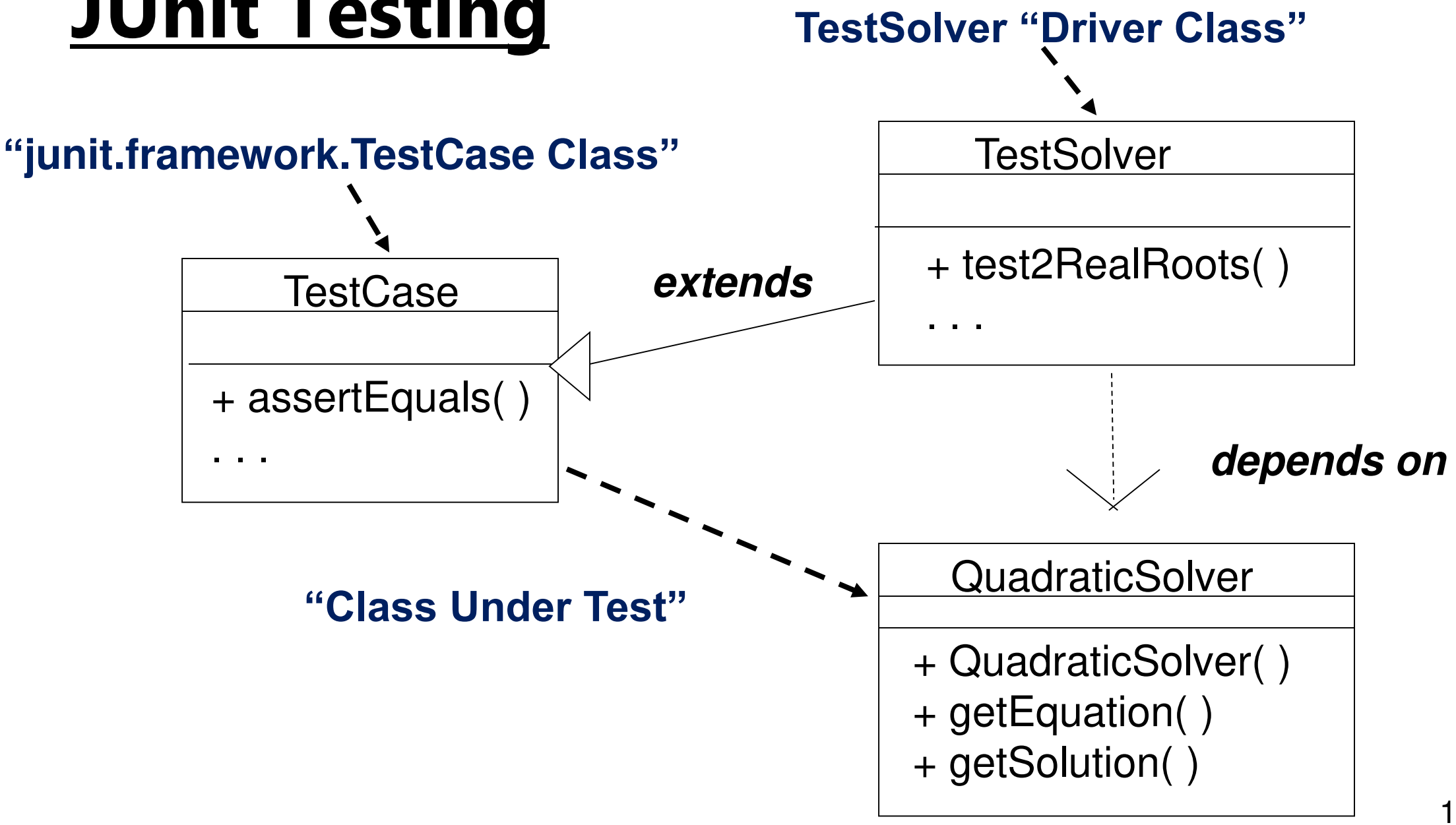
JUnit Testing

- ***Testing*** is critical to developing software quality
- Good test plans are difficult to specify but also difficult to document precisely in English
- Good testing must be ***repeatable***
- Good testing is tedious so you will be tempted to cut corners and omit out some needed testing
- Testing is a good candidate for ***automation***
- Some SW development methodologies such as "Extreme Programming" require ***daily builds*** and ***automated testing***

JUnit Testing

- When you develop Java code for the **`QuadraticSolver`** class, you use the CLI class itself as the "driver" to enter and execute the test cases from the table in the assignment
- You manually enter the test case values and visually verify whether the response provided is correct or not
- This is labor intensive and error prone!!
- The ***JUnit*** framework helps us build a "test case" class to automate testing of a "class under test"

JUnit Testing



JUnit Testing

- Useful method inherited from **`TestCase`** class:

```
assertEquals(Object expected, Object actual)
```

```
assertEquals("expected", cut.toString( ));
```

- The **`assertEquals`** method flags *discrepancies* between the "expected" value and the result returned by the "class under test" method( )
- **`assertEquals`** method automatically displays the *difference* between the "expected value" and the actual return value received

JUnit Testing

- Other useful **assert...** methods

```
assertEquals(double expected_value,
             double actual_value,
             double threshold_value)
```

- Automatically compares absolute difference between first two parameters with a *threshold*

```
assertEquals(4.3, cut.getDbl(), 0.1);
```

JUnit Testing

- Useful assert… methods for **`boolean`** data type
- Automatically expects returned value is **`true`**

```
assertTrue(cut.getBoolean());
```

- Automatically expects returned value is **`false`**

```
assertFalse(cut.getBoolean());
```

JUnit Test for QuadraticSolver

```
import junit.framework.TestCase;

public class TestSolver extends TestCase {
   private QuadraticSolver cut;                    // a reference to an object of
                                                   //  the "class under test"

   public TestSolver()
   {
       // nothing needed here
   }

  // First of six test case methods for the QuadraticSolver class
   public void test2RealRoots()
  {
   cut = new QuadraticSolver(1, 0, -1);
   assertEquals("Solving: 1x\u00b2 + 0x -1 = 0", uut.getEquation());
   assertEquals("Root 1 is 1.0\nRoot 2 is -1.0", uut.getSolution());
  }
}
```

JUnit Testing

- Test Case Execution

```
1 test failed:
  TestSolver
    test2RealRoots
    test2ImaginaryRoots
    testOnly1Root
    testLinear
    testNoSolution
    testAnySolution
File: C:\Documents and Settings\bobw\My
  Documents\bobw\public_html\CS110\Project1\
   JUnitSolution\TestSolver.java  [line: 48]
Failure: expected:<......> but was:<...1...>
```

(I removed part of "should be" string constant to create an error)

JUnit Testing

- The Java code in the **`TestCase`** class(es) precisely documents all the test cases
- It allows them to be run *automatically*
- It allows people other than the test designer to run them *without* knowing the details of how they work
- It *prevents oversights* in identification of any discrepancies in the results
- **Caveat:**
  - When you get errors, check both the ***test case*** code and the code of the ***class under test***
  - The error may be caused in *either or both* places