

CSE 326: Data Structures

Unit Testing - JUnit

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Lecture 6

Testing & Debugging

- Testing Goals
 - Verify that software behaves as expected
 - Be able to recheck this as the software evolves
- Debugging
 - A controlled experiment to discover what is wrong
 - Strategies and questions:
 - What's wrong?
 - What do we know is working? How far do we get before something isn't right?
 - What changed?
 - (Even if the changed code didn't produce the bug, it's fairly likely that some interaction between the changed code and other code did.)

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Unit Tests

- Idea: create *small* tests that verify individual properties or operations of objects
 - Do constructors and methods do what they are supposed to?
 - Do variables and value-returning methods have the expected values?
 - Is the right output produced?
- Lots of small unit tests, each of which test something specific; not big, complicated tests
 - If something breaks, the broken test should be a great clue about where the problem is

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Writing Tests

- When?

Before you write the code!!!

- Say what? Why would you do that?
 - Helps you understand the problem and think about code design and implementation
 - Gives you immediate feedback once the code is written

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Where to put the tests?

- DrJava's interactions window (or equivalent)
 - Great way to prototype tests
 - Way too tedious to do any extensive testing
- Main methods
 - Either too many to do a thorough job, or
 - Methods that test too much – hard to isolate problems
- Either way, someone has to check the output
- Better: automate this by writing self-checking tests

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(Classic) JUnit

- Test framework for Java Unit tests
- Idea: implement classes that extend the JUnit TestCase class
- Each test in the class is named testXX (name starting with “test” is the key)
- Each test performs some computation and then checks the result
- Optional: setUp() method to initialize instance variables or otherwise prepare before each test
- Optional: tearDown() to clean up after each test
 - Less commonly used than setUp()

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Example

- Tests for a simple calculator object

```
import junit.framework.TestCase;
public class CalculatorTest extends TestCase {

    public void testAddition() {
        Calculator calc = new Calculator();
        int expected = 7;
        int actual = calc.add(3, 4);
        assertEquals("adding 3 and 4", expected, actual);
    }
    ...
}
```

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Another Calculator Test

```
public void testDivisionByZero() {
    Calculator calc = new Calculator();
    try {
        calc.divide(2, 0); // verify exception thrown
        fail("should have thrown an exception");
    } catch (ArithmeticException e) {
        // do nothing – this is what we expect
    }
}
```

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What Kinds of Checks are Available

- Look in junit.framework.Assert (JavaDocs on www.junit.org)
- Examples
 - assertEquals(expected, actual); // works on any type except // double; uses .equals() for objects
 - assertEquals(message, expected, actual); // all have variations with messages
 - assertEquals(expected, actual, delta); // for doubles to test "close enough"
 - assertFalse(condition);
 - assertTrue(condition);
 - assertNotNull(object);
 - assertNull(object);
 - fail();
 - // and some others

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setUp

- If the tests require some common initial setup, we can write this once and it is automatically executed before each test (i.e., each test starts with a fresh setUp)

```
import junit.framework.TestCase;
public class CalculatorTest extends TestCase {
    private Calculator calc; // calculator object for tests
    /** initialize: repeated before each test */
    protected void setUp() {
        calc = new Calculator();
    }

    // tests as before, but without local declaration/initialization of calc
}
```

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Summary

- Unit tests
 - Verify correct operation of new code
 - Repeated running of tests as code changes increases confidence that changes don't introduce bugs
 - (or makes it much easier to track down problems that do occur)
 - Tests become part of the project history/culture
- Write the tests before you write the code
- If you discover a bug you didn't test for, add a test
- A little up-front effort will pay off in much better quality code and much less time tracking down problems

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