Section 4: Graphs and Testing

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AGENDA

- Graphs
- JUnit Testing
- Test Script Language
- JavaDoc
GRAPHS

Nodes and Edges
GRAPHS

Children of A
Parents of D
GRAPHS

Paths from A to C:
Paths from A to C:

- A -> C
- A -> D -> E -> C

Shortest path from A to C?
Testing
INTERNAL VS. EXTERNAL TESTING

✗ Internal: JUnit
  + How you decide to implement the object
  + Checked with implementation tests

✗ External: test script
  + Your API and specifications
  + Testing against the specification
  + Checked with specification tests
A JUNIT TEST CLASS

- A method with @Test is flagged as a JUnit test
- All @Test methods run when JUnit runs

```java
import org.junit.*;
import static org.junit.Assert.*;

public class TestSuite {
    ...

    @Test
    public void TestName1() {
        ...
    }
}
```
USING JUNIT ASSERTIONS

✖ Verifies that a value matches expectations
  ✖ assertEquals(42, meaningOfLife());
  ✖ assertTrue(list.isEmpty());

✖ If the assert fails:
  + Test immediately terminates
  + Other tests in the test class are still run as normal
  + Results show “details” of failed tests (We’ll get to this later)
# USING JUNIT ASSERTIONS

<table>
<thead>
<tr>
<th>Assertion</th>
<th>Case for failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>assertTrue(test)</td>
<td>the boolean test is false</td>
</tr>
<tr>
<td>assertFalse(test)</td>
<td>the boolean test is true</td>
</tr>
<tr>
<td>assertEquals(expected, actual)</td>
<td>the values are not equal</td>
</tr>
<tr>
<td>assertSame(expected, actual)</td>
<td>the values are not the same (by ==)</td>
</tr>
<tr>
<td>assertNotSame(expected, actual)</td>
<td>the values are the same (by ==)</td>
</tr>
<tr>
<td>assertNull(value)</td>
<td>the given value is not null</td>
</tr>
<tr>
<td>assertNotNull(value)</td>
<td>the given value is null</td>
</tr>
</tbody>
</table>

- And others: [http://www.junit.org/apidocs/org/junit/Assert.html](http://www.junit.org/apidocs/org/junit/Assert.html)
- Each method can also be passed a string to display if it fails:
  - `assertEquals("message", expected, actual)`
CHECKING FOR EXCEPTIONS

- Verify that a method throws an exception when it should:
  - Passes if specified exception is thrown, fails otherwise
- Only time it’s OK to write a test without a form of `asserts`

```java
@Test(expected=IndexOutOfBoundsException.class)
public void testGetEmptyList() {
    List<String> list = new ArrayList<String>();
    list.get(0);
}
```
“But don’t I need to create a list before checking if I’ve successfully added to it?”
SETUP AND TEAR-DOWN

- Methods to run before/after each test case method is called:
  ```java
  @Before
  public void name() { ... }
  @After
  public void name() { ... }
  ```

- Methods to run once before/after the entire test class runs:
  ```java
  @BeforeClass
  public static void name() { ... }
  @AfterClass
  public static void name() { ... }
  ```
public class Example {
    List empty;

    @Before
    public void initialize() {
        empty = new ArrayList();
    }

    @Test
    public void size() {
        ...
    }

    @Test
    public void remove() {
        ...
    }
}
Test Writing Etiquette
The Rules

1. Don’t Repeat Yourself
   ◦ Use constants and helper methods

2. Be Descriptive
   ◦ Take advantage of message, expected, and actual values

3. Keep Tests Small
   ◦ Isolate bugs one at a time – Test halts after failed assertion

4. Be Thorough
   ◦ Test big, small, boundaries, exceptions, errors
public class DateTest {

    ...

    // Test addDays when it causes a rollover between months
    @Test
    public void testAddDaysWrapToNextMonth() {
        Date actual = new Date(2050, 2, 15);
        actual.addDays(14);
        Date expected = new Date(2050, 3, 1);
        assertEquals("date after +14 days", expected, actual);
    }
}
How To Create JUnit Test Classes

- Right-click hw5.test -> New -> JUnit Test Case
- **Important**: Follow naming guidelines we provide
- Demo
JUnit Asserts vs. Java Asserts

- We’ve just been discussing JUnit assertions so far
- Java itself has assertions

```java
public class LitterBox {
    ArrayList<Kitten> kittens;

    public Kitten getKitten(int n) {
        assert (n >= 0);
        return kittens(n);
    }
}
```
ASSERTIONS VS. EXCEPTIONS

- Assertions should check for things that should never happen
- Exceptions should check for things that might happen
- “Exceptions address the robustness of your code, while assertions address its correctness”

```java
public class LitterBox {
    ArrayList<Kitten> kittens;
    public Kitten getKitten(int n) {
        assert(n >= 0);
        return kittens(n);
    }
}

class LitterBox {
    ArrayList<Kitten> kittens;
    public Kitten getKitten(int n) {
        try {
            return kittens(n);
        } catch(Exception e) {
        }
    }
}
```
REMINDER: ENABLING ASSERTS IN ECLIPSE

To enable asserts:
Go to Run -> Run Configurations… -> Arguments tab -> input `-ea` in VM arguments section

Do this for every test file
Expensive CheckReps

- Ant Validate and Staff Grading will have assertions enabled
- But sometimes a checkRep can be expensive
  - For example, looking at each node in a Graph with a large number of nodes
- This could cause the grading scripts to timeout
Expensive CheckReps

✗ Before your final commit, remove the checking of expensive parts of your checkRep or the checking of your checkRep entirely
✗ Example: boolean flag and structure your checkRep as so:

```java
private void checkRep() {
    cheap-stuff
    if(DEBUG_FLAG) { // or can have this for entire checkRep
        expensive-stuff
    }
    cheap-stuff
    ...
```
EXTERNAL TESTS:
TEST SCRIPT LANGUAGE
TEST SCRIPT LANGUAGE

- Text file with one command listed per line
- First word is always the command name
- Remaining words are arguments
- Commands will correspond to methods in your code
# Create a graph
CreateGraph graph1

# Add a pair of nodes
AddNode graph1 n1
AddNode graph1 n2

# Add an edge
AddEdge graph1 n1 n2 e1

# Print the nodes in the graph and the outgoing edges from n1
ListNodes graph1
ListChildren graph1 n1
How To Create Specification Tests

❌ Create .test and .expected file pairs under hw5.test

❌ Implement parts of HW5TestDriver
  + driver connects commands from .test file to your Graph implementation to the output which is matched with .expected file

❌ Run all tests by running SpecificationTests.java
  + Note: staff will have our own .test and .expected pairs to run with your code
  + **Do not** hardcode .test/.expected pairs to pass, but instead make sure the format in hw5 instructions is correctly followed
DEMO: TEST SCRIPT LANGUAGE
JAVADOC API

- Now you can generate the JavaDoc API for your code
- Instructions in the Editing/Compiling Handout
- Demo: Generate JavaDocs