JUnit Testing

Talk to your neighbors:

What is your favorite “classic” mobile game?
(e.g. candy crush, temple run, fruit ninja, 2048, etc)

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Lecture Outline

• Announcements

• Optional

• Importance of Testing

• JUnit

• Example: Tic Tac Toe
Announcements

• Final Exam on Wed + Fri @ 10:50 – 11:50am PCAR 192
  - Review session on Monday Aug 14
  - More resources/policies on course website
• Programming Assignment 3 due Sunday, Aug 13
• Resub 6 due Tuesday, Aug 15
Exam Format

• 6 questions in total, each will receive one ESN grade
  - Some questions might have sub-parts
  - Reminder: Quiz and Exam grades are all mixed into the same bucket

• General format
  - 3 Questions: Mix of Conceptual, Mechanical/Tracing, Debugging Problems
  - 3 Questions: Programming Problems
  - Wednesday – 3 questions
  - Friday – 3 questions

• See sections 11, 13, and 14 for practice handwriting problems
• Practice finals posted on course website
Exam Logistics

Most important bits

• Wednesday and Friday @ 10:50am – 11:50am in PCAR 192
• Seat assignments
• Don’t cheat
  - Only have the exam open during the time (don’t’ start early; don’t work after)
  - No electronic devices
• You can bring one 8.5x11 inch paper with notes (front and back)
  - Will also provide a reference sheet (see course website)
• Bring husky card + pencil

Questions? Raise hand or ask on sli.do (#cse122)
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Optional

Optional is a Java class that is used to handle situations where a value is sometimes there.

You give Optional a type to hold (or potentially not hold) when you are referring to its type.

e.g., Optional<String>, Optional<Integer>, Optional<Point>
### Optional Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optional.empty()</td>
<td>Creates an empty Optional object</td>
</tr>
<tr>
<td>Optional.of(...)</td>
<td>Creates an Optional object holding the object it's given</td>
</tr>
<tr>
<td>isEmpty()</td>
<td>Returns true if there is no value stored, and false otherwise</td>
</tr>
<tr>
<td>isPresent()</td>
<td>Returns true if there is a value stored, and false otherwise</td>
</tr>
<tr>
<td>get()</td>
<td>Returns the stored object from the Optional (if one is stored; otherwise throws a NoSuchElementException)</td>
</tr>
</tbody>
</table>

The Optional class has more than just these methods, but these are what you’ll need to focus on for this class!
Optional Methods

isEmpty(), isPresent(), and get() are called like normal instance methods (on an actual instance of Optional).

Optional.of(...) and Optional.empty() are called differently

(Like the Math class methods)
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(PCM) Importance of Testing

Software, written by people, controls more and more of our day-to-day lives.

Bugs (just like the ones we all write) are just as easy to write in this software.

Stakes can be quite high so bugs can have catastrophic effects.

Source: Hackaday
Practice: Pair

Bugs you’ve experienced

Can you think of a bug(s) you’ve experienced or heard of that have had serious effects?

If you can’t, can you think of any absurd bugs you’ve seen?
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JUnit Basics

• import statements to give you access to JUnit method annotations and assertion methods!

• Method Annotations
  - @Test
  - @DisplayName
  - …

• Assertion Methods
  - assertEquals(expected, actual)
  - assertTrue(boolean)
  - assertFalse(boolean)
  - …
JUnit Testing

```java
import org.junit.jupiter.api.*;
import static org.junit.jupiter.api.Assertions.*;
import java.util.*;

public class ArrayListTest {
    @Test
    public void testAddAndGet() {
        List<String> list = new ArrayList<>();
        list.add("Hunter Schafer");
        list.add("Miya Natsuhara");
        list.add("CSE 122");

        assertEquals("Hunter Schafer", list.get(0));
        assertEquals("Miya Natsuhara", list.get(1));
        assertEquals("CSE 122", list.get(2));

        assertTrue(list.size() == 3);
    }
}
```

put object into some expected state
Use assert statements to check if observed state is what we expect
Using JUnit

• Each @test method should be independent
  - i.e. set up its own state, make all relevant assertions
• An @test fails if any assert statement fails
• JUnit executes @test methods in an arbitrary order
Using JUnit - Tips

- one `@test` method per distinct case (i.e., empty case, one element, even, odd, some edge case, ...)
  - Might also want to test calling multiple methods to check that they work together as expected
- `assertEquals(expected, actual, message)` can provide a description of what the line is testing
- Good coding practices still apply
  - Eg. you can write helper methods in your test file
How Many Test Cases Is Enough?

- In general, more tests → more confidence!
- Try to think adversarially and try to break your own code with tests
- Specification Testing (based on the spec) vs. Clear-box Testing (based on how you know your implementation works)
  - Specification Testing you can do *before* writing your solution!
  - Clear-box Testing you do *after* you've written your solution.
- Test a wide variety of different cases
  - Think about **boundary or "edge" cases** in particular, where the behavior should change
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What test cases can you think of for the TicTacToe spec?
Closed or open box tests?

Closed box testing - write tests based on a **specification** independent of any implementation.

Open box testing - write tests for a particular implementation.

Test Driven Development - write tests *before* the implementation
**Part B:** Consider the following method. For each of the following commented Points, fill in the table for which conditions are always true (under any circumstance), only sometimes true, or never true at each comment. You can abbreviate A=always, S=sometimes and N=never.

```java
public Set<String> mystery(Set<String> s, int n) {
    Set<String> s2 = new HashSet<>();
    // Point A
    if (n <= 0) {
        throw new IllegalArgumentException();
    }
    // Point B
    if (!s.isEmpty()) {
        Iterator<String> it = s.iterator();
        // Point C
        while (it.hasNext()) {
            // Point D
            if (it.next().length() > n) {
                s2.add(it.remove());
                n--;
            }
        }
    }
    // Point E
    return s2;
}
```

<table>
<thead>
<tr>
<th>Condition</th>
<th>Point A</th>
<th>Point B</th>
<th>Point C</th>
<th>Point D</th>
<th>Point E</th>
</tr>
</thead>
<tbody>
<tr>
<td>s.isEmpty()</td>
<td></td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>s2.isEmpty()</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n &gt; 0</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>