

LEC 16

CSE 122

JUnit Testing

BEFORE WE START

Talk to your neighbors:

TODO TODO TODO TODO

*Music: **TODO***

Instructor Atharva || Shananda

TAs

Abigail	Ambika	Arthur	Atharva
Autumn	Ayush	Chaafer	Chloë
Claire	Colin	Elizabeth	Helena
Jacob	Jasmine	Jaylyn	Kavya
Kevin	Kyle	Marcus	Megana
Mia	Poojitha	Rishi	Rohini
Rucha	Saivi	Shananda	Shivani
Shreya	Smriti	Steven	Zane


Questions during Class?

Raise hand or send here





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Lecture Outline

- **Announcements** 
- Importance of Testing
- JUnit
 - How Much Testing is Enough?
- Example: Brainstorm Test Cases (TFTPlayer)
- Challenge: Floating Point Precision

Announcements

- Programming Assignment 3 (P3) due November 27th
 - Actively have **very limited** IPL access
 - Ask questions on Ed! Expect delays in answering, though...   
- Resubmission Cycle 6 (R6) out now; due November 28th
- Quiz 2 delayed to November 28th
- Creative Project 3 (C3) releasing November 28th
 - Final assignment of the quarter!! 
 - Due December 4th by 11:59 PM
- Final Exam: **Tuesday, December 12th 12:30 – 2:20 PM**
 - More details coming soon on the course website!

Lecture Outline

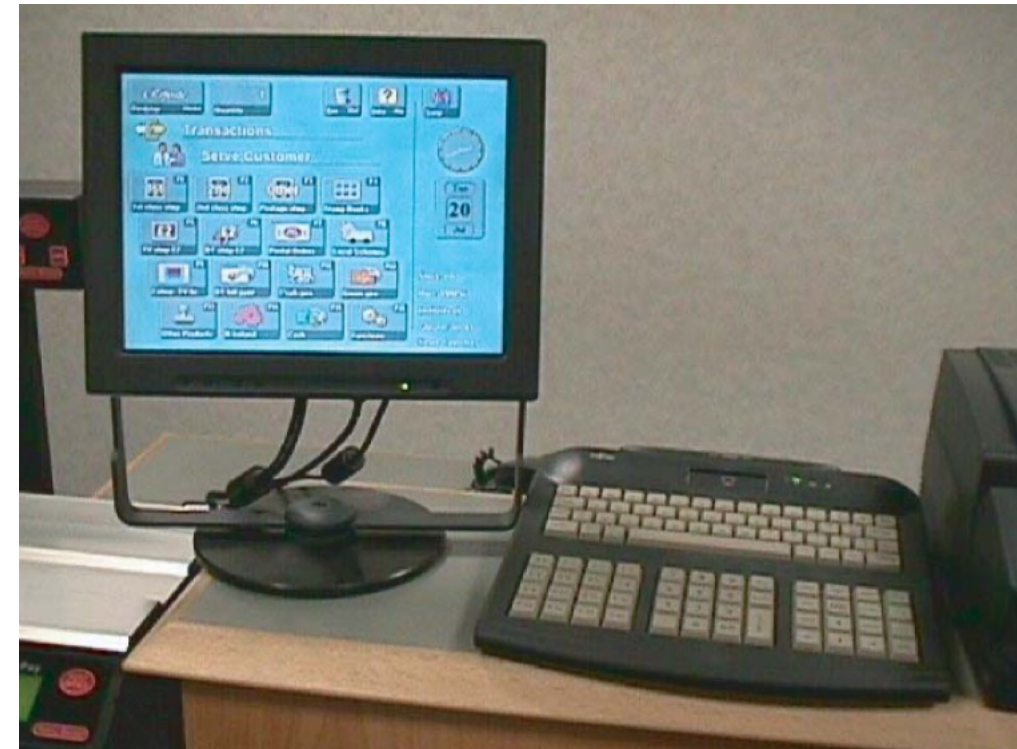
- Announcements
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Importance of Testing

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



The Horizon IT System for The UK Post Office
Source: Fujitsu.com

Importance of Testing

“The Horizon scandal, described as ‘the most widespread miscarriage of justice in UK history’, resulted in more than 700 post office operators being **prosecuted between 1999 and 2015 for theft, fraud and false accounting because of faulty accounting software** installed in the late 1990s... Some spent time in prison, and the scandal has been **linked to four suicides.**”

[Source: The Guardian](#)

Post Office: Horizon scandal victims to receive £600,000 compensation each

Workers whose wrongful convictions for theft and false accounting have been overturned to receive payment from government



📷 The Post Office's Horizon scandal resulted in more than 700 post office operators being prosecuted between 1999 and 2015 for theft, fraud and false accounting. Photograph: Isabel Infantes/PA

Every post office operator whose wrongful conviction over **the Horizon IT scandal has been overturned** will receive £600,000 in compensation from the government, ministers have announced.



Practice : Pair

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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`
 - `assertTrue`
 - `assertFalse`
 - ...

JUnit Testing

```
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 Matsuhara");
        list.add("CSE 122");

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

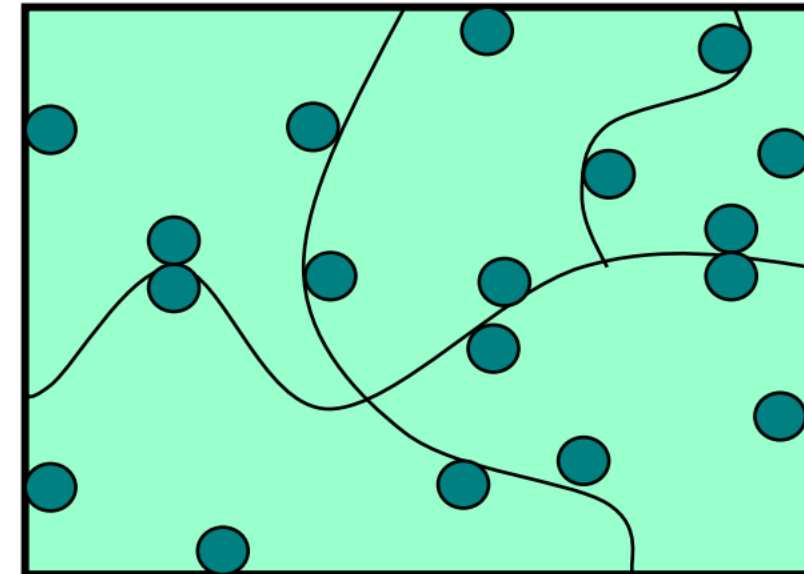
        assertTrue(list.size() == 3);
    }
}
```

JUnit Tips

- Write a test method for individual methods *and* test methods that combine different method calls in different combinations!
- Write a test method per distinct case (i.e., empty case, one element, even, odd, some edge case, ...)
- Use `assertEquals(expected, actual, message)` to provide a description of what case that line is testing
- Testing code is just code. Use good coding practices (e.g., helper methods to reduce redundancy) to help you write code.
 - It can take time, but if you do it well, developing your solution can be a breeze!

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 test for the TFTPlayer class from the PCM?

Rules


- **Start Game:** 10 gold, 0 experiences, level 1
- **Buy Experience:** Spend 4 gold to earn 4 experience
 - Must have sufficient gold. Can't buy XP if already max level (9)
 - Every 20 experience points is converted to 1 level
- **Gain Gold:** Every player earns 3 gold plus some interest
 - **Interest:** Gain 1 additional gold for each 5 gold owned, capped at interest of 5 gold
 - Example: Have 24 gold. Gold gained would be 7 (3 free gold + 4 interest gold)

Rules from the PCM changed a bit from when the lesson was first posted! All should be consistent now!

Spend 2 minutes brainstorming specification testing

Then 2 minutes brainstorming clear-box testing

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Challenge: Floating Point Numbers

- Another name for `double`s are floating point numbers
- Floating point numbers are nice, but imprecise
 - Computers can only store a certain amount of precision (can't store 0.3333333333 repeating forever)
 - Finite precision can lead to slightly incorrect calculations with floating point numbers

$$\begin{array}{r} 0.7 + 0.1 \\ 0.79999999999999999999 \end{array}$$

- Take-away: Essentially can never rely on `==` for doubles. Instead, must define some notion of how far away they can be to be tolerated as the same
 - JUnit: `assertEquals(expected, actual, delta)`