LEC 16

CSE 122

JUnit Testing

Questions during Class?

Raise hand or send here

sli.do #cse122

BEFORE WE START

Talk to your neighbors:

What is your favorite thing to cook? If you don't cook, what's your favorite thing to eat :P

Music: 122 24wi Lecture Tunes

Instructors Miya Natsuhara and Joe Spaniac

TAs

Ailsa	Chaafen	Helena	Megana	Sahej
Alexander	Chloe	Jessie	Mia	Shivani
Ambika	Claire	Katharine	Minh	Smriti
Andy	Colin	Kavya	Nicolas	Steven
Arkita	Colton	Ken	Poojitha	Vinay
Atharva	Connor	Kyle	Rohini	Zane
Autumn	Elizabeth	Logan	Ronald	
Ayush	Hannah	Marcus	Rucha	

Lecture Outline

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

Announcements

- Quiz 2 tomorrow in quiz section (Thurs, Feb 29)
  - Review Quiz Logistics for rules and policies
- Programming Assignment 3 (P3) due tomorrow (Thurs, Feb 29)
- Creative Project 3 (C3) will be released Friday, Mar 1
  - Last assignment!
- Final Exam: **Wednesday, March 13th 12:30 – 2:20 PM**
  - Left-handed seating request form on EdStem
  - Exam page posted with details (read through and bring questions on Friday)

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- **Importance of Testing**
- JUnit
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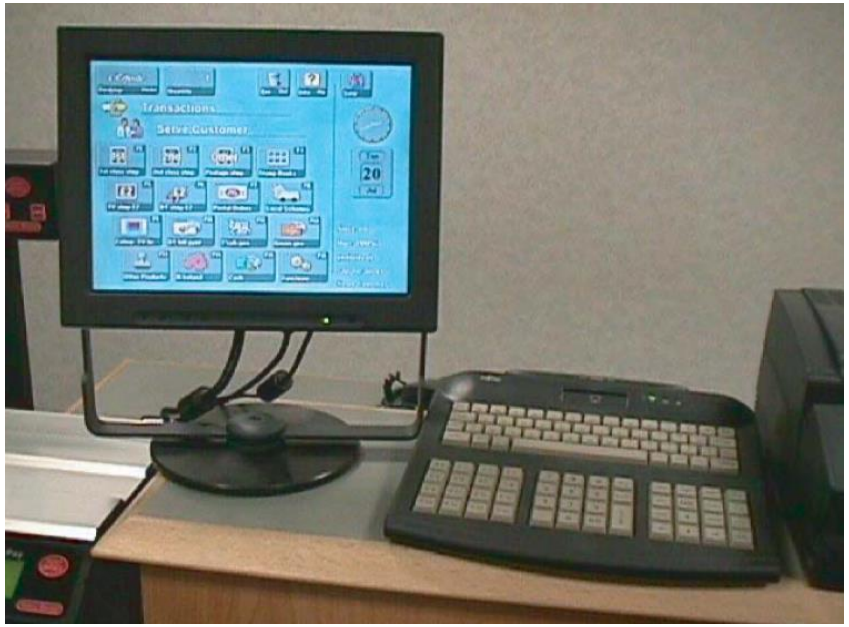
Importance of Testing

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

Source: Hackaday



The Horizon IT System for The UK Post Office

Source: Fujitsu.com

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("Joe Spaniac");
        list.add("Miya Natsuhara");
        list.add("CSE 122");

        assertEquals("Joe Spaniac", list.get(0));
    }
}
```

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public class ArrayListTest {
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        assertEquals("Joe Spaniac", list.get(0));     // TRUE!!
    }
}
```

JUnit Testing

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        list.add("Joe Spaniac");
        list.add("Miya Natsuhara");
        list.add("CSE 122");

        assertEquals("Joe Spaniac", list.get(0));
        assertEquals("Miya Natsuhara", list.get(2));
    }
}
```

JUnit Testing

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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("Joe Spaniac");
        list.add("Miya Natsuhara");
        list.add("CSE 122");

        assertEquals("Joe Spaniac", list.get(0));
        assertEquals("Miya Natsuhara", list.get(2));              // FALSE!!
    }
}
```

JUnit Testing

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public class ArrayListTest {
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        list.add("Joe Spaniac");
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        assertEquals("Joe Spaniac", list.get(0));
        assertEquals("CSE 122", list.get(2));
    }
}
```

JUnit Testing

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

        assertEquals("Joe Spaniac", list.get(0));
        assertEquals("CSE 122", list.get(2));              // TRUE!!!
    }
}
```

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("Joe Spaniac");
        list.add("Miya Natsuhara");
        list.add("CSE 122");

        assertEquals("Joe Spaniac", list.get(0));
        assertEquals("CSE 122", list.get(2));

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

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("Joe Spaniac");
        list.add("Miya Natsuhara");
        list.add("CSE 122");

        assertEquals("Joe Spaniac", list.get(0));
        assertEquals("CSE 122", list.get(2));

        assertTrue(list.size() == 3);            // TRUE!!
    }
}
```

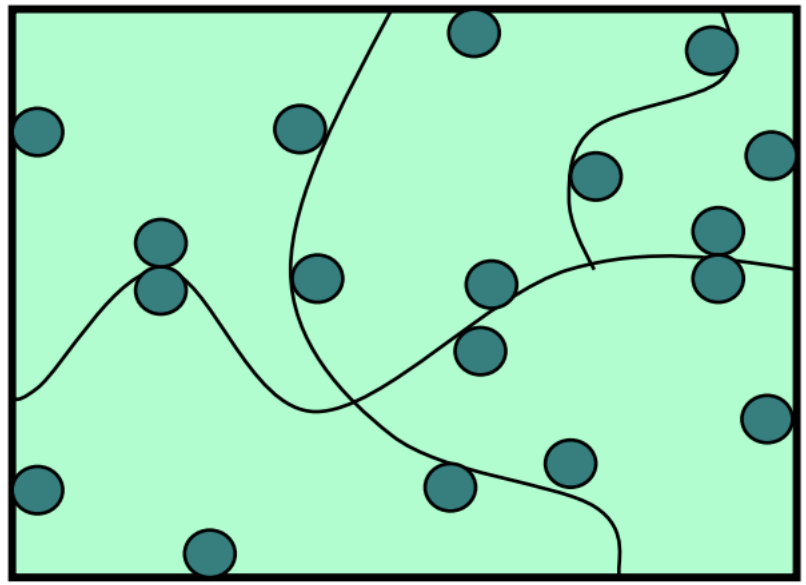
JUnit Tips

- 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!

In-Class: Remix – Courses Taught

How Many Test Cases Is Enough?

- In general, more *diverse* 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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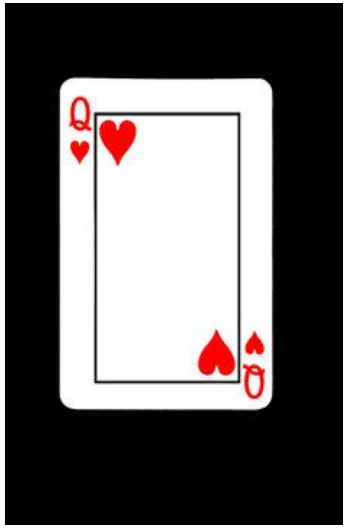
Card Class

- Each card has a suit (♠ ♣ ♦ ♥) and a value (e.g., 2, 3, 10, J, Q, K)
  - Note: value represented as an `int`

Ace	2	3	4	5	6	7	8	9	10	Jack	Queen	King
1	2	3	4	5	6	7	8	9	10	11	12	13

  - For example, for the Queen of Hearts card
    - The suit is hearts ♥
    - The value is Queen (represented as 12)



Card Class

- `public Card(int value, String suit)`
  - Throws an `IllegalArgumentException` if `value` or `suit` is invalid
- `public String getSuit()`
- `public int getValue()`
- `public String toString()`
- `public boolean equals(Object other)`

BattleManager Class

- Assumes two players
- Setup: 52-card deck is split between the two players evenly
- Each round:
  - Each player flips their top card
  - The player with the higher *value* card takes both cards
    - Aces are considered "high" – they beat all other values
  - If the cards have the same value, "battle"
    - Each player places 3 cards face down, then flips a new card, and the player with the higher value card takes all cards
      - (If this is another battle, repeat previous process)
- Goal: one player has all 52 cards

BattleManager Class

- `public BattleManager()`
- `public BattleManager(Queue<Card> deck1, Queue<Card> deck2)`
- `public void deal()`
- `public boolean gameOver()`
- `public int getPlayer1DeckSize()`
- `public int getPlayer2DeckSize()`
- `public void play()`

Practice : Pair

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What test cases can you test for the Card class?
What about the BattleManager class?

Spend 2 minutes brainstorming specification testing

Then 2 minutes brainstorming clear-box testing

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Challenge: Floating Point Numbers

- Another name for `doubles` 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

```
0.7 + 0.1
0.7999999999999999
```

- 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)`