LEC 13

CSE 122

Collections

Questions during Class?

Raise hand or send here

sli.do #cse122

BEFORE WE START

Talk to your neighbors:

What plans do you have for after this course ends?

Instructor Ido Avnon

TAs Abby Williams
Chloë Mi Cartier
Connor Sun
Cynthia Pan
Katharine Zhang
Marcus Sanches
Rohini Arangam

Lecture Outline

- Announcements
- Optional
- Collections
- Importance of Testing/Bugs
- JUnit
- Example

Announcements

- Programming Assignment 3 (P3) due tomorrow!
  - Due August 8th by 11:59 PM
- Quiz 2 TOMORROW in section!
- Reminder on Final Exam
  - Part 1: In section August 15th
  - Part 2: in lecture August 16th

Final Exam Part 2 (Friday August 16th)

- Slightly longer quiz (60 minutes, 4 questions)
- In lecture (this classroom PCCAR 192)
  - Please come 5-10 minutes early
  - Bring: pencil, ID card, notes
- Unlimited paper notes
- Paper exam, no electronics
- Resources: out Friday

Final Exam Part 1

- **NOT A PAPER EXAM!**
- A one-on-one presentation of your culminating project with your TA in section!
  - Run-through of your code
  - Reflection on your code and process
- Worth two ESN grades (given by the TA you present to)
- More info and resources: Friday!

Lecture Outline

- Announcements
- Optional
- Collections
- Importance of Testing/Bugs
- JUnit
- Example

Optional

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

- A variable that can *sometimes* be initialized
- `Optional<String> keepPlaying = Optional.empty();`
- `Optional<Integer> maxValue = Optional.of(-1);`

Like a collection, Optional uses <> to denote the type it contains..

- e.g., `Optional<String>, Optional<Integer>, Optional<Point>`

Optional Methods

Method	Description
`Optional.empty()`	Creates an empty `Optional` object
`Optional.of(…)`	Creates an `Optional` object holding the object it's given
`isEmpty()`	Returns `true` if there *is no* value stored, and `false` otherwise
`isPresent()`	Returns `true` if there *is* a value stored, and `false` otherwise
`get()`	Returns the stored object from the `Optional` (if one is stored; otherwise throws a `NoSuchElementException`)

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)

Why Optional?

Using `Optional` can help programmers avoid `NullPointerExceptions` by making it explicit when a variable may or may not contain a value.

- Remember – `null` refers to the absence of an object!

There are other `Optional` methods (that you should explore in your own time if you're interested) that can be really useful to cleanly work with data that may or may not be present.

Lecture Outline

- Announcements
- Optional
- **Collections**
- Importance of Testing/Bugs
- JUnit
- Example

Collections: What *classes* have we seen so far?

…

Array,
ArrayList,
Linked List,
Stack,
HashSet & HashMap,
TreeSet & TreeMap

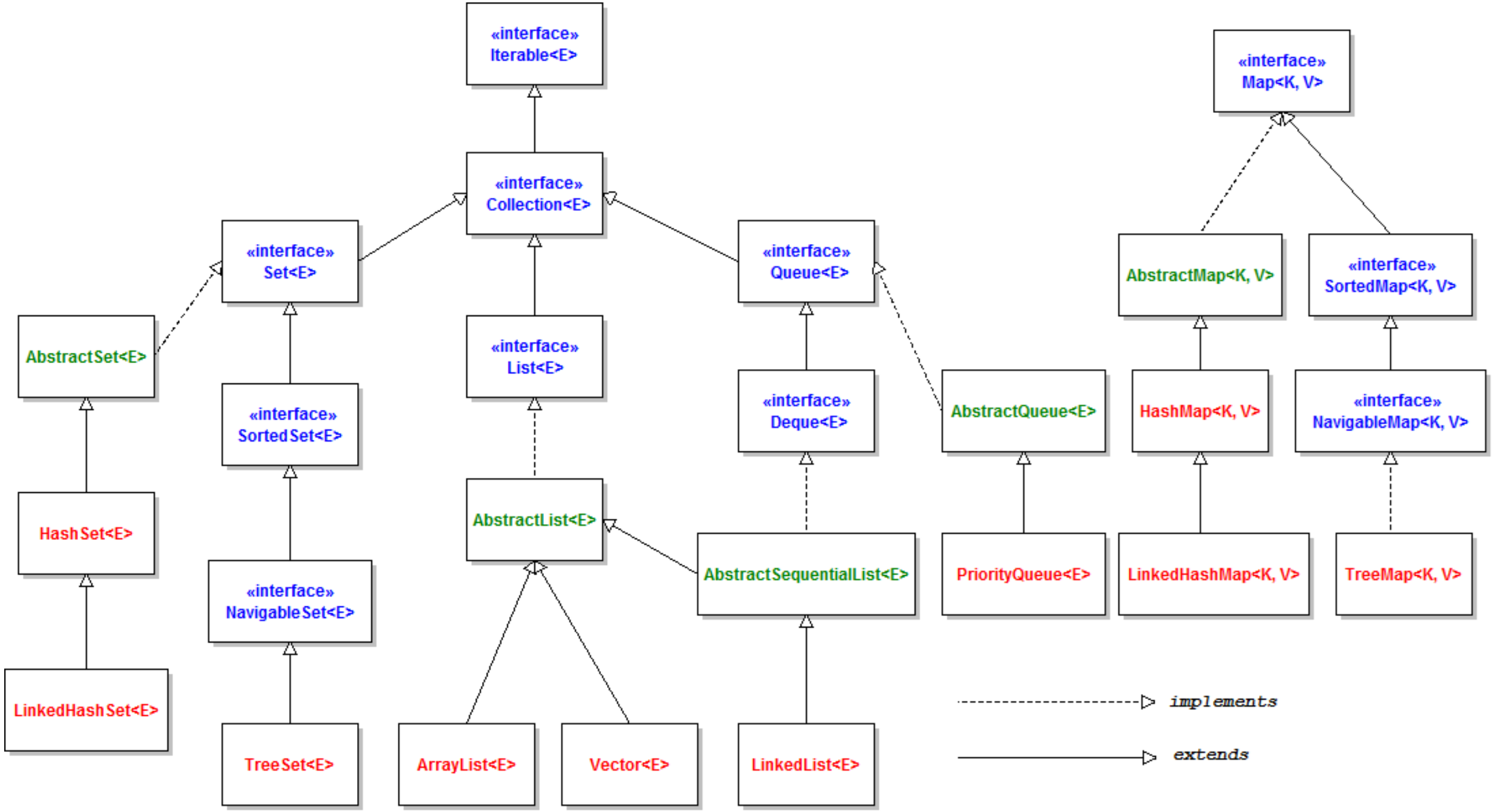
Collections: What *interfaces* have we seen so far?

…

Set,
Queue,
List,
Comparable

Java `Collection`

- An *extremely* general interface that every data structure we have talked about indirectly implements
- Methods in the interface
  - `add`
  - `remove`
  - `contains`
  - `isEmpty`
  - `size`
  - And more…
- `Map`'s `values()` method returns a `Collection` !!!


«interface»
Iterable<E>
«interface»
Collection<E>
«interface»
Set<E>
«interface»
List<E>
«interface»
Queue<E>
AbstractSet<E>
«interface»
SortedSet<E>
«interface»
NavigableSet<E>
HashSet<E>
LinkedHashSet<E>
TreeSet<E>
AbstractList<E>
ArrayList<E>
Vector<E>
«interface»
Deque<E>
AbstractSequentialList<E>
LinkedList<E>
AbstractQueue<E>
PriorityQueue<E>
«interface»
Map<K, V>
AbstractMap<K, V>
HashMap<K, V>
LinkedHashMap<K, V>
«interface»
SortedMap<K, V>
«interface»
NavigableMap<K, V>
TreeMap<K, V>
implements
extends

Lecture Outline

- Announcements
- Optional
- Collections
- **Importance of Testing/Bugs** 
- JUnit
- Example

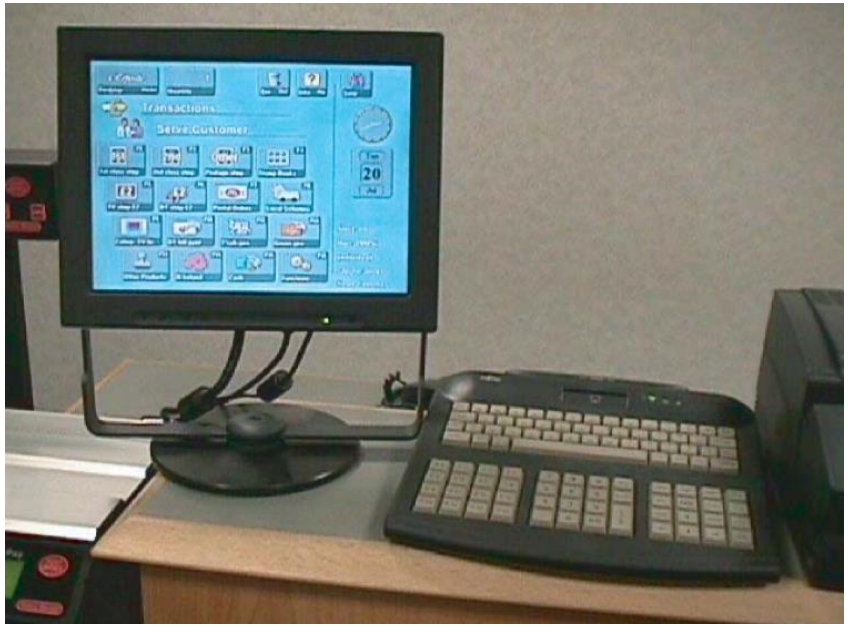
Importance of Testing

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

slido

Please download and install the Slido app on all computers you use

🍏 A - What bugs have you experienced?

ⓘ Start presenting to display the poll results on this slide.

Lecture Outline

- Announcements
- Optional
- Collections
- Importance of Testing/Bugs
- JUnit
- Example

Using a Testing Framework

- `Unit Test` – a method that compares what your codes does against what you *expect* it to do
- `Testing Framework` – a library of code that gives you special tags and key words for your unit tests so that you can click the "test" button instead of the "run" button and you get a list of tests with info like green check mark passes or error m

Like a music tuner! Technology specifically built to compare what your instrument sounds like against what it's expected to sound like

JUnit Basics

- `JUnit` – a unit testing framework for the Java language
  - `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(“Ido Avnon");
        list.add(“And his amazing TAs");
        list.add("CSE 122");

        assertEquals(“Ido Avnon", list.get(0));
    }
}
```

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(“Ido Avnon");
        list.add(“And his amazing TAs");
        list.add("CSE 122");

        assertEquals(“Ido Avnon", list.get(0));   //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(“Ido Avnon");
        list.add(“And his amazing TAs");
        list.add("CSE 122");

        assertEquals(“Ido Avnon", list.get(0));
        assertEquals(“And his amazing TAs", list.get(2));
    }
}
```

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(“Ido Avnon");
        list.add(“And his amazing TAs");
        list.add("CSE 122");

        assertEquals(“Ido Avnon", list.get(0));
        assertEquals(“And his amazing TAs", list.get(2)); //FALSE
    }
}
```

Testing Tips

- Write many tests for each method
  - Test that your method does what you want it to do
  - Test combinations of your method being used with other methods
- Write a test method per distinct case
  - Test that different states of input don't break your code (empty or null params)
  - Test that code correctly enters all boolean checks (loops, if/else)
- 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 *diverse* tests –> more confidence!
- Try to think adversarially and try to break your own code with tests, How do you "user-proof" your code?
- **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! (Test Driven Development)
  - **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

Lecture Outline

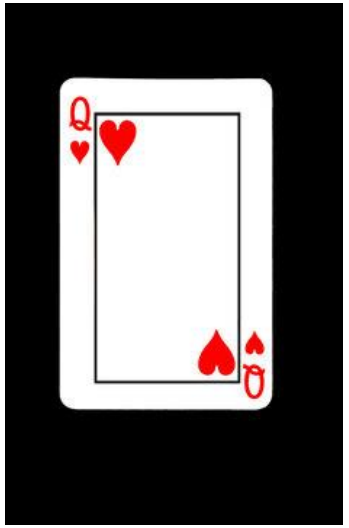
- Announcements
- Optional
- Collections
- Importance of Testing/Bugs
- JUnit
- **Example**

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

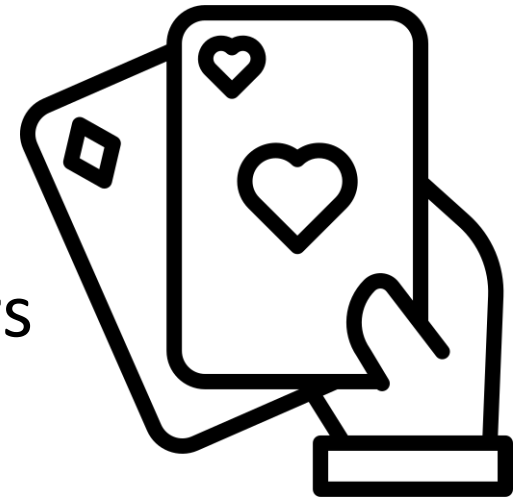
  - For example, for the Queen of Hearts card
    - The suit is hearts ♡
    - The value is Queen (represented as 12)



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()`

slido

Please download and install the Slido app on all computers you use

What test cases can you think of for the Card class?

ⓘ Start presenting to display the poll results on this slide.

slido

Please download and install the Slido app on all computers you use

What test cases can you think of for the BattleManager class?

ⓘ Start presenting to display the poll results on this slide.

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)`