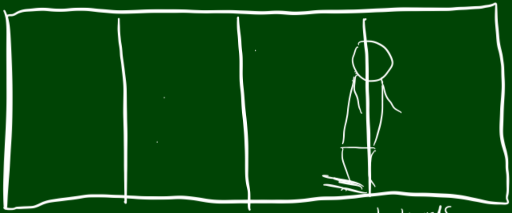
CSE 143

Computer Programming II

More `ArrayIntList`; pre/post; exceptions; debugging



Sometimes, you just have to go backwards.

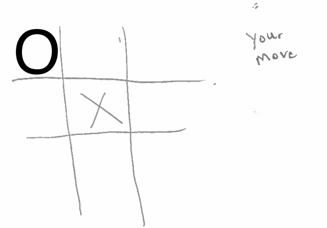
Questions From Last Time

- Do you recommend reading the textbook?
- Are TAs allowed to help with “style” at the IPL?
- Is there extra credit?
- Do you like eclipse?
- Do you have to use the “this” keyword?

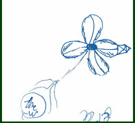
```
public class Example {
   int number;
   public incrementNumber() {
      //Both of the following two lines work!
      //this.number++;
      //number++;

   }
}
```

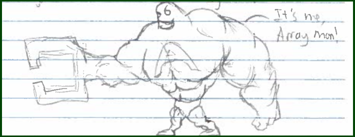
More Questions From Last Time

- How many programmers does it take to change a lightbulb? (none, that's a hardware problem)
- What is your favorite pizza flavor? (I'm not sure. I'll get back to you on this one.)
- Why is it called Piazza?
- What is the meaning of life? (42)
- Knock Knock (Who's there?)
- What's up? How was your day? (the ceiling; good)



Drawings

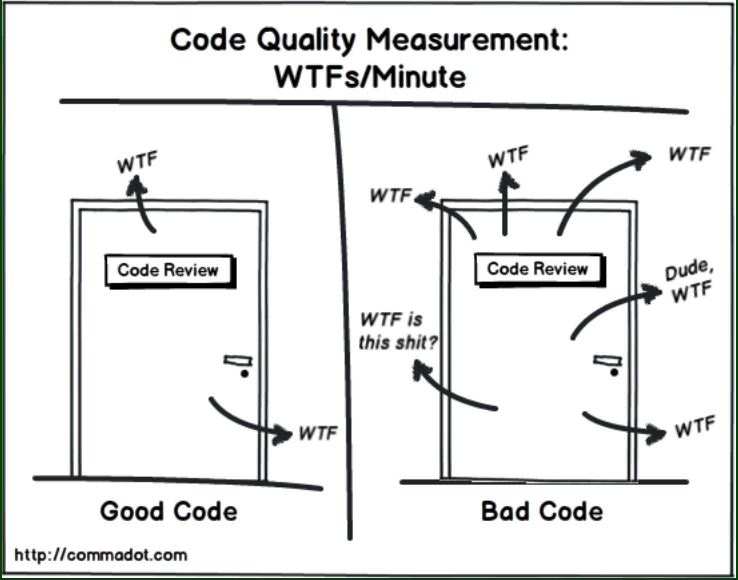



It's me,
Array Man!

HI

did you take the picture
yeah
is it good?
let me check
shit.

WTF's per Minute



Rubber Ducky, You're The One!

What is this code supposed to do? What does it do?

```java
public class WTF {
   public static void main(String[] args) {
      int i = 0;
      while (i < 10) {
         System.out.println("Whee!");
         i = i++;
      }
      System.out.println("Done!");
   }
}
```

Rubber Duck Debugging

Rubber Duck Debugging is the idea that when your code doesn't work, you talk to an inanimate object about what it does to find the error.

The idea is to **explain** what your code is supposed to do vs. what it is doing. Many times, the action of saying it out loud helps solve the problem.

Using Fields Directly vs. Using Instance Methods

```java
public class Circle {
   int radius;
   int x, y;

   public Circle(int radius, int x, int y) {
      this.radius = radius;
      this.x = x;
      this.y = y;
   }

   public void setX(int x) {
      this.x = x;
   }
   public int getX() {
      return this.x;
   }

   /* There are two possible implementations of moveRight... */
   public void moveRight(int numberOfUnits) {
      this.x += numberOfUnits;
   }
   public void moveRight(int numberOfUnits) {
      this.setX(this.getX() + numberOfUnits);
   }
}
```

Why Use Fields vs. Instance Methods?

Why Use Fields Directly?

- It's sometimes more readable to use the fields directly
- The code is sometimes shorter

Why Use Getters and Setters?

- What happens if we change the implementation (e.g. `Point location` instead of `int x, y`)?
- If there is code that checks validity of inputs, then we only put it in one place

Duplicated Code: Methods

Redundant add Methods

```java
/* Inside the ArrayIntList class... */
public void add(int value) {
   this.set(size, value); /* THIS LINE IS DUPLICATED BELOW!!! */
   this.size++;           /* THIS LINE IS DUPLICATED BELOW!!! */
}

/* Inserts value into the list at index. */
public void add(int index, int value) {
   for (int i = size; i > index; i--) {
      this.set(i, this.get(i-1));
   }
   this.set(size, value); /* THIS LINE IS DUPLICATED ABOVE!!! */
   this.size++;           /* THIS LINE IS DUPLICATED ABOVE!!! */
}
```

The fix is to call the more general add method from the less general one. (As a rule of thumb, methods with fewer arguments are less general.)

So, we'd replace the first method with:

Fixed add Method

```java
public void add(int value) {
   add(this.size, value);
}
```

Duplicated Code: Constructors

We'd like to have two constructors for `ArrayIntList`:

- One that uses a default size
- One that uses a size given by the user

Redundant Constructors

```
/* Inside the ArrayIntList class... */
public ArrayIntList() {
   this.data = new int[10];
   this.size = 0;
}

public ArrayIntList(int capacity) {
   this.data = new int[capacity];
   this.size = 0;
}
```

This is a lot of redundant code! How can we fix it?

Fixed Constructor

Java allows us to call one constructor from another using `this`(...):

```
public ArrayIntList() {
   this(10);
}
```

Implementing `remove`

(size = 5)	3	8	2	45	6	0	0	0
	`list[0]`	`list[1]`	`list[2]`	`list[3]`	`list[4]`	`list[5]`	`list[6]`	`list[7]`

`list.remove(2)`:

(size = 3)	3	8	**45**	**6**	0	0	0	0
	`list[0]`	`list[1]`	`list[2]`	`list[3]`	`list[4]`	`list[5]`	`list[6]`	`list[7]`

How do we remove from the middle of the list?

- Shift over all elements starting from the index to remove at
- Set the last element to 0 (Do we need to do this?)
- Decrement the size

Class CONSTANTS

Looking back at the constructor, what's ugly about it?

```
public ArrayIntList() {
   this(10);
}
```

The 10 is a "magic constant"; this is really bad style!! We can use:

`public static final` **type name = value**

to declare a class constant.

So, for instance:

`public static final int DEFAULT_CAPACITY = 10`.

Class CONSTANT

A class constant is a **global**, **unchangable** value in a class. Some examples:

- `Math.PI`
- `Integer.MAX_VALUE`, `Integer.MIN_VALUE`
- `Color.GREEN`

Illegal Arguments

```java
public class Circle {
   int radius;
   int x, y;
   ...

   public void moveRight(int numberOfUnits) {
      this.x += numberOfUnits;
   }
}
```

Are there any arguments to `moveRight` that are “invalid”?

Yes! We shouldn’t allow negative numbers.

The implementor is responsible for (1) telling the user about invalid ways to use methods and (2) preventing a malicious user from getting away with using their methods in an invalid way!

Preconditions

Precondition

A **precondition** is an assertion that something must be true for a method to work correctly. The objective is to tell clients about invalid ways to use your method.

Example Preconditions:

- For `moveRight(int numberOfUnits)`:

```
// pre: numberOfUnits >= 0
```

- For `minElement(int[] array)`:

```
// pre: array.length > 0
```

- For `add(int index, int value)`:

```
// pre: capacity >= size + 1; 0 <= index <= size
```

Preconditions are important, because they explain method behavior to the client, but they aren't enough! The client can still use the method in invalid ways!

Exceptions

Exceptions

An **exception** is an indication to the programmer that something `unexpected` has happened. When an exception happens, the program **immediately** stops running.

To make an exception happen:

- `throw new` **ExceptionType**`();`
- `throw new` **ExceptionType**`("`**message**`");`

Common Exception Types

`ArithmeticException`, `ArrayIndexOutOfBoundsException`, `FileNotFoundException`, `IllegalArgumentException`, `IllegalStateException`, `IOException`, `NoSuchElementException`, `NullPointerException`, `RuntimeException`, `UnsupportedOperationException`, `IndexOutOfBoundsException`

Why Use Exceptions?

Exceptions prevent the client from accidentally using the method in a way it wasn't intended. They alert them about errors in their code!

An Example

```java
public void set(int index, int value) {
   if (index < 0 || index >= size) {
      throw new IndexOutOfBoundsException(index);
   }
   this.data[index] = value;
}

public int get(int index) {
   if (index < 0 || index >= size) {
      throw new IndexOutOfBoundsException(index);
   }
   return data[index];
}
```

Uh oh! We have MORE redundant code!

Private Methods

Private Methods

A **private method** is a method that **only the implementor** can use. They are useful to abstract out redundant functionality.

Better set/get

```
private void checkIndex(int index, int min, int max) {
   if (index < min || index > max) {
      throw new IndexOutOfBoundsException(index);
   }
}

public void set(int index, int value) {
   checkIndex(0, size - 1);
   this.data[index] = value;
}

public int get(int index) {
   checkIndex(0, size - 1);
   return data[index];
}
```

Hitting Capacity

Example `ArrayList`

Client View:	29	1	3	9	8	···
	0	1	2	3	4	

Impl. View:	29	1	3	9	8
	a[0]	a[1]	a[2]	a[3]	a[4]

Let's run `add(3, 8)`! Uh oh! There's no space left. What do we do?

Create a new array of *double* the size, and copy the elements!

Resizing (Implementor View)

Before:	29	1	3	9	8
	a[0]	a[1]	a[2]	a[3]	a[4]

Resize:	29	1	3	9	8	0	0	0	0	0
	a[0]	a[1]	a[2]	a[3]	a[4]	a[5]	a[6]	a[7]	a[8]	a[9]

Insert:	29	1	3	**8**	9	8	0	0	0	0
	a[0]	a[1]	a[2]	a[3]	a[4]	a[5]	a[6]	a[7]	a[8]	a[9]

`Arrays` Reference

`binarySearch(`**array**`, `**val**`)`	Returns the index of **val** in **array** if array is sorted; (or < 0 if not found)
`toString()`	Returns a string representation of the array such as `[3, 42, -7, 15]`
`sort(`**array**`)`	Sorts the elements of **array** (this edits the original array!)
`copyOf(`**array**, **len**`)`	Returns a new copy of **array** with length **len**
`equals(`**array1**, **array2**`)`	Returns true precisely when the elements of **array1** and **array2** are identical (according to `.equals`)

Call these with `Arrays.method(arg1, arg2, ...)`

`Arrays` Reference

Postconditions

Postcondition

A **postcondition** is an assertion that something must be true **after a method has run**. The objective is to tell clients what your method does.

Example Postconditions:

- For `moveRight(int numberOfUnits)`:

  ```
  // post: Increases the x coordinate of the circle by numberOfUnits
  ```

- For `minElement(int[] array)`:

  ```
  // post: returns the smallest element in array
  ```

- For `add(int index, int value)`:

  ```
  // post: Inserts value at index in the ArrayList; shifts all
        elements from index to the end forward one index; ensures
        capacity of ArrayList is large enough
  ```

Postconditions are important, because they explain method behavior to the client.