

# CSE 11

# Accelerated Intro to Programming

## Lecture 3

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This lecture is being recorded

# Announcements

- PA0.5 due tonight @ 11:59pm
- PA1 due tonight @ 11:59pm
- Quiz 1 due tomorrow@ 11am
- PA2 released today
  - Covered in Discussion

```
class Example {  
    int average(int n, int m, int o) {  
        return (n + m + o) / 3;  
    }  
    String withDotAtTheEnd(int n) {  
        return n + ".";  
    }  
    String ans = this.withDotAtTheEnd(this.average(3, 5, 7));  
}
```

# JShell

- The Java Shell tool (JShell) is an interactive tool for learning the Java programming language and prototyping Java code.
- The way to think about the environment of JShell:
  - Sort of inside a class
    - Can start writing field definitions and trying things out
  - Good tool for experimentation
    - Can write one field definition or method definition at a time

- Make a String
  - `String h = "hello";`
    - JShell immediately prints out the string
  - `String h2 = "he" + "llo";`
    - Evaluates the expression, shows us the value
- Methods already defined by Java that we can use
  - String – is built-in Java class (i.e. already defined in Java)
    - Defines many methods

- `String myName = "Greg";`
- `int nameLen = myName.length();`
  - Note: these method calls are using something other than **this**
    - We can call methods on many different kinds of values in Java
    - When we define a method within a class and call that method from within the class
      - Then we use **this** to refer to methods within the class
    - When call a method that's in another class
      - We use a particular value and then use that method
        - That method is going to be able to use information about that class to get its answer
- `length()` – does something different depending on which value it's called from

- Other String methods:
  - `String myFullName = "Gregory Joseph Miranda";`
  - `String middle = myFullName.substring(8, 14);`
    - What did the method `substring()` do?

- `length()` and `substring()`
  - 2 methods defined on Java's built-in `String` class
  - Can use them to do different types of calculations with `String`
- A bunch more `String` methods to come...
- Main point:
  - `String` value – can use these existing methods to do this calculations
- 2<sup>nd</sup> big lesson:
  - Indexes – indexing into `Strings` to access the characters
    - Something we will be working with as we go forward



- Another String method:
  - `String myWeirdName = myFullName.replace("e", "WEIRD");`
- What did `replace()` do?
- What's the value of `myFullName` after calling `replace()`?
- Keep track of the String methods you learned about in your own notes
  - These methods are all written down online
    - Java documentation – we would be able to see all these methods
      - Quick search: [Java string documentation](#)
        - Many String methods we could use
        - `repeat()`

- `String helloTwice = h.repeat(2);`
- `String manyHello = h.repeat(20);`
- What if we want to find if another String appears in a String, like a search?
  - `int index = myFullName.indexOf("Joseph");`
  - What if the String is not in my name?
    - `int anotherIndex = myFullName.indexOf("Orange");`
      - What happened?
  - 0+ – index where we found the String
  - -1 – didn't find the String
- Just a few more String methods
  - Working with the idea that there is built-in stuff in Java that we are going to be able to use
    - This will help us write interesting programs that work with and manipulate text

- String example program

```
class StringExamples {  
}
```

- Write a method called firstHalf that:
  - Takes a String and returns a new String that has just the first half of the characters from the input String
- When writing a method:
  - Think about what some examples are and what we expect the results to be:
    - We can write these down as fields
    - Then we can easily check if we are right after running the program
  - Examples first – then build up into the implementation
    - Do on paper/whiteboard first – then type them in

- One of the first things to think about is:
  - What method (or methods) out of the methods we saw on strings is going to be useful here
    - We will be able to accomplish this only with methods we have seen so far

- This showed us how to implement a method from a word problem prompt
- We thought through some examples
  - Which helped us to refine our understanding
- We experimented a little bit
  - Figured out we are okay with this empty String result
- This is the process we should use when implementing methods
  - i.e. Programming Assignments

# New Data Type

- Previous data types:
  - String
  - int
- Examples
  - `boolean b1 = 4 < 5;`
  - `boolean b2 = 5 < 4;`
- New data type:
  - Boolean
    - Uses different kinds of operators
      - Comparison operators

- String – many different types of strings, infinite # of strings
  - Only limited by how much memory is in our computer
- int – somewhat limited
  - -2,147,483,648 to 2,147,483,647
- Boolean – only two values
  - true / false
    - Represents the answers to yes or no questions
      - $4 < 5$ 
        - Asking the question: is 4 less than 5?

- Many boolean operators
  - `boolean b3 = 4 == 4;`    `//checks for equality`
  - `boolean b4 = 4 == 5;`
    - `=` is not the same as `==`
      - `=` is used to create or initialize a field definition
      - Assignment operator
  - `boolean b5 = 5 > 4;`
  - `boolean b6 = 5 >= 4;`
    - As well as `<=`
- All of these are ways to compare numbers
  - Gives true/false (yes or no) answers
- What happens if we use it to compare Strings?
  - `boolean stringComp = "a" < "b";`



- Useful idea when learning a new feature
  - Ask if it works with other things you've worked with before
- Comparison operators like `<` and `>` do not type check
  - Only numeric types work with Java's type checking
- What about `==` on Strings?
  - `boolean stringComp = "a" == "a";`
    - `==` does produce an answer on Strings
  - `boolean stringComp = "a" == "b";`
  - Does produce an answer, but not recommended for Strings
  - We will talk more about comparing Strings for equality in future weeks
  - Only use `==` for numeric comparisons in this course

- Main lesson:
  - 2 new values
    - true/false
  - With new data type boolean
  - New relational and comparison operators that work with booleans
    - < >
    - <= >=
    - ==
  - Another comparison operator
    - !=
    - boolean b7 = 4 != 5;
    - boolean b8 = 5 != 5;
    - Opposite of the == answer

# Boolean Operations

- What can you do given a boolean?
  - What if we want to ask more than simple questions
    - Are two things true at the same time?
    - Is one of two things true?

- Combining booleans into another boolean

- `boolean and1 = true && true;`
- `boolean and2 = true && false;`
- `boolean and3 = false && true;`
- `boolean and4 = false && false;`

- `boolean or1 = true || true;`
- `boolean or2 = true || false;`
- `boolean or3 = false || true;`
- `boolean or4 = false || false;`

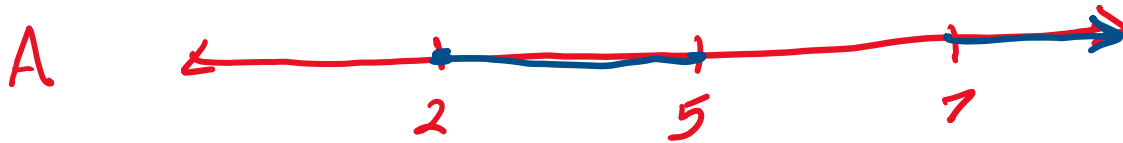
# Methods with Booleans

- Number line 1
- Problem:
  - Write a method that takes a number and returns true if it's in the region in our number line example
  - Examples:

```
boolean numberLine2(int number) {  
    return (number > 5) && (number < 7) || (number < 2);  
}
```

- What does this number line look like?

2 5 before 11



# More Complicated Questions with Methods

- Write the method to calculate absolute value that takes a number and returns the negation if it's less than 0, or that number otherwise
- Examples:
  - `int abs1 = this.absolute(-2);`     `//should produce 2`
  - `int abs2 = this.absolute(4);`     `//should produce 4`

```
int absolute(int number) {  
}
```

- Important comparison we need to do here
  - Is the number less than 0?
    - `number < 0`
  - Don't want to return true or false, we want to return the right number
- New Java syntax:
  - if statement



# So far...

- 3 different kinds of data
  - int
  - String
  - boolean
- Very simple kinds of data
  - Tons of information that can't be represented by only these 3 types of data
    - Applications keep track of much more than a single piece of informatino
      - Chess game
      - Microsoft Office
      - Google Documents

# Compound Data

- Central concepts in this course
  - Methods
    - We will keep coming back to this
  - Compound Data
    - Need to know how to combine simple pieces of data together into more complicated structures
    - Idea
      - Take multiple pieces of information
      - Package them together
      - Using that packaged together information

- Going to learn more about what this thing called class is
  - We've been using this idea of this keyword **class**
    - Writing example classes with everything inside them
  - More about what's going on when we use a class
    - When we make a class
    - How we use them to package up data
- Examples of packing data together
  - Drawing / graphing

- Drawing / Graphing - common piece of compound data
  - Tons of different fields use it
    - Art on paper, physics, engineering
  - Points, coordinates, really matter
- Points are not defined by a single number
  - Crucial to understanding points on a coordinate plane, or points anywhere
    - There are 2 numbers, packaged together that mean something
  - This also gives us a visual, graphical representation of the data
    - We can see that there are 2 numbers involved in defining the point in the upper right
- What is it going to look like to specify the shape of a point in Java?
  - Let's construct some points and do some computation

- At the top of the file, above ExamplesLec class - add class Point

```
class Point {  
    int x;  
    int y;  
}
```

- What's different about these field definitions than ones we've written before?

- What's different about these field definitions than field definitions we've written before?
  - No equals
- Every time we've written something before, we've had something on the right-hand side
  - A number or a calculation
    - `int examplesOfNum = 4 + 5;`
- We don't have that here. Why?
  - This point class is going to describe all possible points
  - Can't just pick and say:
    - "I'm only going to represent the point where x is 4 and y is 5 with this class"

- Point is going to describe the shape of any points that are made up of 2 integers
  - Without specifying any particular point
- In a different part of the program:
  - We will specify particular points
- These are uninitialized field definitions
  - Field definitions without a value
    - No value given to these
  - These are the most common kinds of field definitions that we write

# Constructor

- Next thing we need to write something that looks like a method

```
Point (int x, int y) {  
    this.x = x;  
    this.y = y;  
}
```

- What makes this different than a method?



- In many way, this is not exactly like methods we've written before
  - The shape looks kind of like a method
  - Main thing different:
    - The only thing that appears before the parenthesis: **the name of the class**
    - That's what makes this really special
- This has a name:
  - Constructor
    - We write constructors by writing the name of the class before the open parenthesis
      - Instead of writing some return type and some name
    - Special kinds of methods:
      - Used for creating new Points in this case
      - We use the constructor so we can create many different points using the same class

- For now, ignore the body of the constructor....
  - Treat this as cookie cutter code
  - Always going to do the same pattern when we make a class
    - Name of the class
    - List of parameters that exactly match the fields
    - In the body, one line per parameter
      - Says `this.<name> = <name>;`
  - Future weeks we will get into more detail how constructors work
    - Too many details to cover right now...
    - For now, just use this pattern

# Creating Points

- Let's use the Point class to create several points
  - New syntax coming...
- `Point fourFivePoint = new Point(4, 5);`
- `Point negOneThreePoint = new Point(-1, -3);`
- What's different here?

- This is a way we can write a program that represents the two points that were drawn earlier
  - This gives us the ability to represent these as values inside Java
- Let's run it...
  - What is this going to print?

- It's useful to think about a picture representation of these Point values
  - Not only do we have the graph
  - But it's possible to draw these Points we created as pictures

# Objects

- Formal definition in Java:
  - Things that get created with new are called **objects**
  - Each time we use the **new** keyword with the name of the class and values for each of the fields
    - We say we created a new object
- Something interesting happened
  - Wrote a program that used new
- What did it print out?

- Print out the same kind of things as the example classes we've used all along
  - Says **new**
  - The name of that class
  - Inside it lists the fields and their values
- The same process is happening for the Points we created with new as the ExamplesLec class
  - This tells us something about what's going on behind the scenes
    - Whenever we use **run**, something is happening
      - It's printing out a whole bunch of stuff

- Now we see exactly what is happening behind the scenes
  - When we do **run**
    - It's using new to create a single ExamplesLec object
      - Just makes one of them
    - Then it print it out
  - It's as if it said:
    - **new** ExamplesLec
    - And then printed out all the fields inside ExamplesLec
  - There really is an ExamplesLec object that got created
    - Just like the two Point objects that were created



- So what is that going to look like in terms of this picture?
  - What should we draw to capture the idea that there is an ExamplesLec object that got created?

- Something we could do to see the difference
  - Make another field:
    - Not going to create a Point here
    - Point fourFivePointAgain = this.fourFivePoint;
      - Use one that already exists
  - What is going to print out now?
  - What is the contents of ExamplesLec going to be now?
  - What are possible things this could look like next?

- Objects are created
  - Whenever we have a field that is referring to an object
    - It just stores a reference to the object
  - The object is created and just sits there
    - And many fields can reference the same object

# Class Methods

- Previously we talked about methods
  - How to write them
  - How to call them
- How do we write methods that work with this compound data?
  - Like Points
- We should be able to write methods that do things with points

- Let's look at a simple method first
  - quadrant
    - takes no parameters
    - returns a string of which quadrant the points is in
  - What is the method header going to look like for this?
- Examples:
  - Make sure we understand what it should return for a few different cases
  - String quadA =
    - What should we write to call quadrant()?
    - What did we write before?
      - `this.quadrant();`
        - Does this still work?

- There is a rule based on how we call methods based on the classes of the objects that we are using
  - We have to use an object of the class that contains the method we want to call in order to call it
- To call `quadrant()`
  - We can't use **this**
    - **this** is referring to the `ExamplesLec` object
    - We have to use one of the `Points`
- The thing before the dot in the method call
  - Has to be a reference to an object of the class that contains the method

- Since `quadrant()` is defined inside the `Point` class
  - The object here has to be a reference to an object of the `Point` class
- `String quadA = this.fourFivePoint.quadrant();`
  - This is what we need to use to call the `quadrant` method on the `fourFivePoint` object
- “We call the method on a reference to an object”
  - `this.fourFivePoints` - the reference to the object we are using
  - `quadrant()` - the method we are calling

- `String quadA = this.fourFivePoint.quadrant();`
  - What should this produce?
- Another example:
  - `String quadB = this.negOneThreePoint.quadrant();`
    - What does this produce?



- The same method, `quadrant()`, is called
  - But it changes its answer depending on which reference to an object we use to call it
- That means that whatever we write in the body of `quadrant`
  - Better depend on the values of the reference we used to call this method
    - Better depend on those values because we need to get different answers for these 2 lines
- The way this will work in the body of `quadrant`
  - We are going to use the keyword **this** again
    - The way we have used the keyword **this** before
- Introduce a new rule for this

- `if (this.x > 0 && this.y > 0) { ... }`
  - When we say `this.x`, the value that we get when we look up `this.x`
    - Is the value of `x` on the object we used to call the method
      - In the first case:
        - We used the object that has `this.fourFivePoint` to call the method
      - In the second case:
        - We used the object `this.negOneThreePoint` to call the method
    - In the first case, `this.x` will be 4
    - In the second case, `this.x` will be -1
    - In the first case, `this.y` will be 5
    - In the second case, `this.y` will be -3
  - The reference we get for `this` inside a method is always related to the reference that appeared before the method call

- `if (this.x > 0 && this.y > 0) { ... }`
  - How do we finish this?

# Weekly Pay Problem

- `weeklyPay`: takes a number of hours worked and an hourly rate, and returns the pay with overtime (over 40 hours) counting as double the rate
- Examples: