CSE 11
Accelerated Intro to Programming
Lecture 3

Greg Miranda, Summer 1 2021

This lecture is being recorded

Announcements

- PA0.5 due tonight @ 11:59pm
- PA1 due tonight @ 11:59pm
- Quiz 1 due tomorrow@ 11:59pm
- PA2 released today
  - Covered in Discussion
- Make-up Lecture tomorrow – same time, same zoom link

No-class Monday

```
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(6, 3, 8));
}
```

see notes

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

field

- 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 form within the class
      - Then we use **this.** to refer to methods within the class (same 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

field

myName . length()

↑ access fields/methods of myName

- 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
- 2nd big lesson:
  - Indexes – indexing into Strings to access the characters
    - Something we will be working with as we go forward

start at 0

- Another String method:
  - String myWeirdName = myFullName.replace(“e”, “WEIRD”);
- What did replace() do?
- What’s the value of myFullName after calling replace()?

↳ did not change

- 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()

Strings are immutable → cannot be modified → cannot change original string

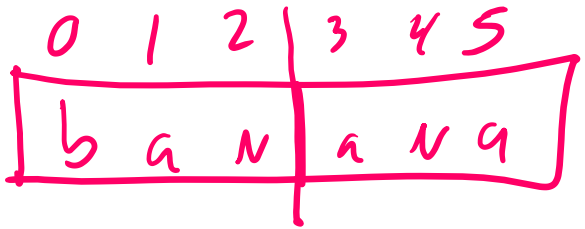
- String helloTwice = h.repeat(2);
- String manyHello = h.repeat(20);
- What if we want to find if another String appears in a String, like a search?
  - int index = myFullName.indexOf("Joseph");
  - What if the String is not in my name?
    - int anotherIndex = myFullName.indexOf("Orange");
      - 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 → testing ↓
    - 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



length = 6

cut at 6/2 → 3

0 → 3

- 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

1 method at a time
test it
get it working

New Data Type

- Previous data types:
  - String → class
  - int → primitive
- 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?

yes
↳ true

- 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

not equal

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;

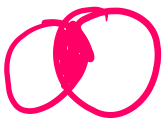
true

&& and

both sides must be true for && to be true

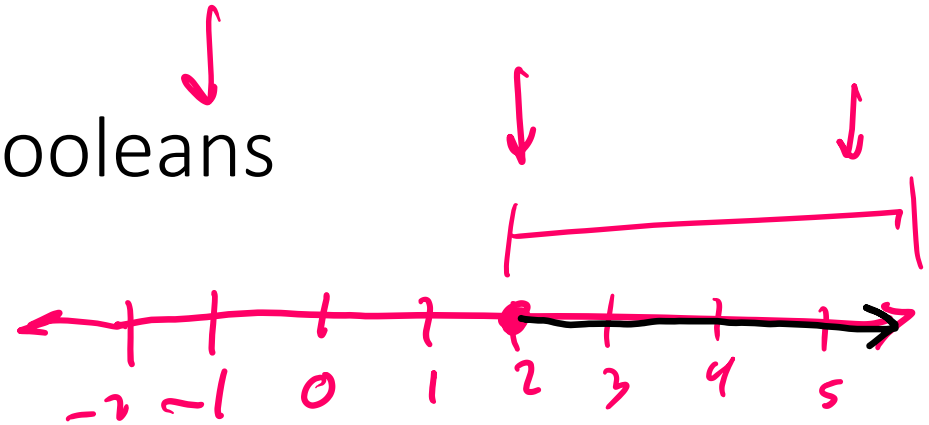
|| or

only one side must be true for || to be true



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:

numberLine1 (int number)

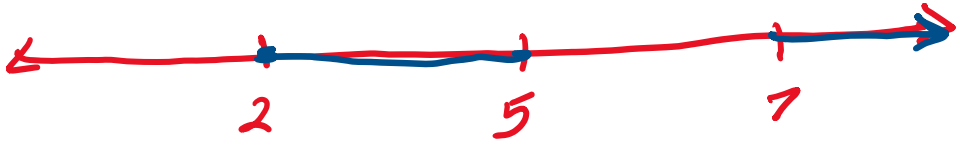
numberLine(2) true
5 true
-1 false

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

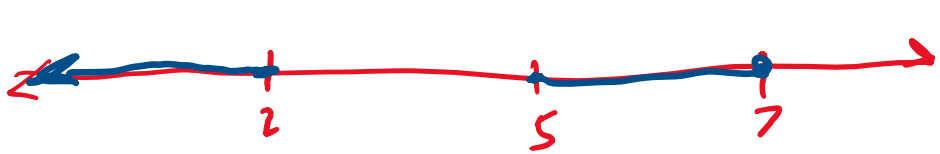
- What does this number line look like?

&& before ||

0 A



21 B



2 C

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 interested 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: