L2: Intro to Java

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CompSci 201: Spring 2024

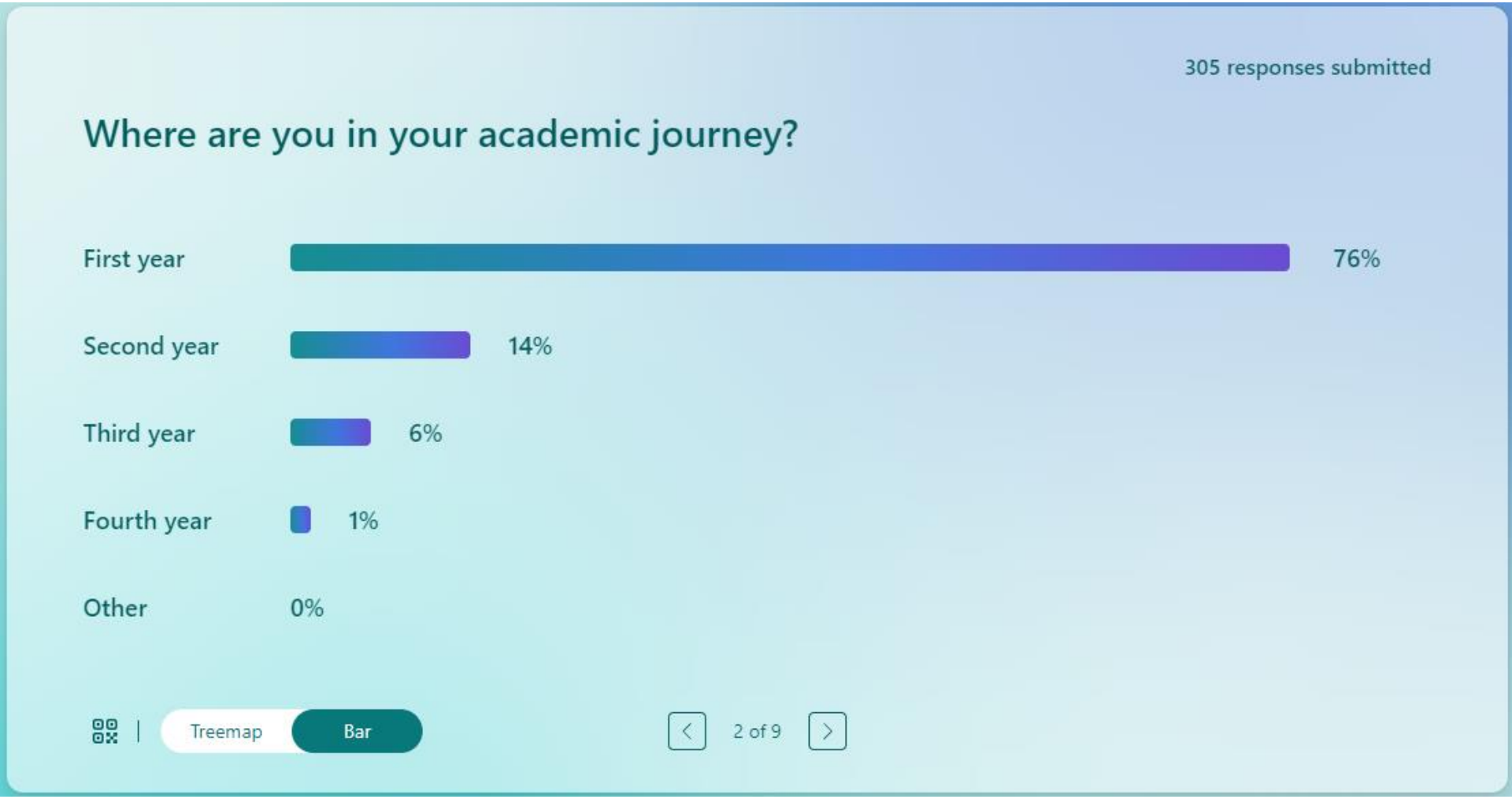
1/17/24

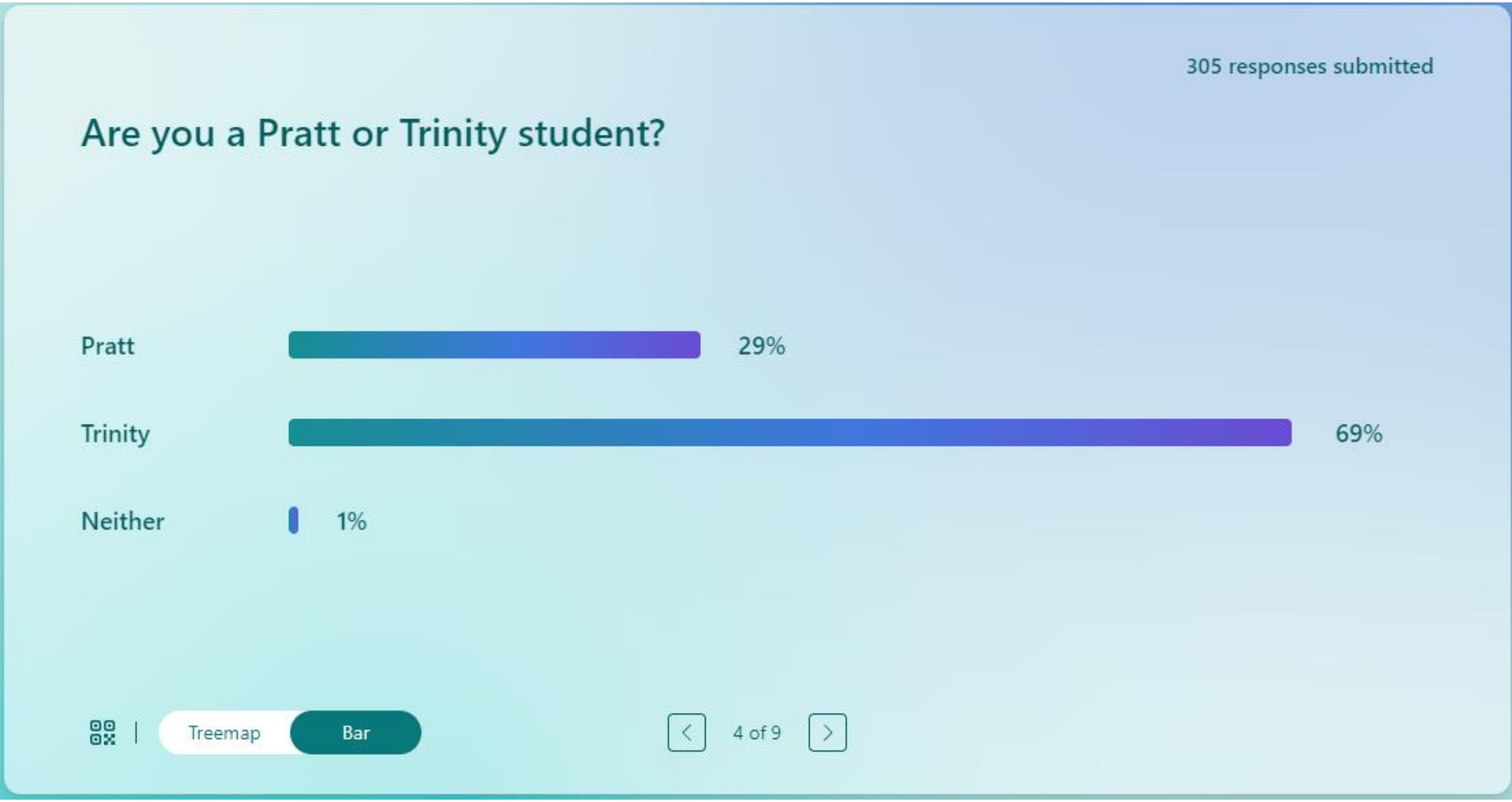
Logistics, Coming up

- This Friday, 1/19
  - First discussion section meetings
- Next Monday, 1/22
  - Intro to OOP (object-oriented programming) in Java
- Next Wednesday 1/24
  - Interfaces, Implementations, ArrayList data structure
  - First APT set (short programming exercises) due
    - Can discuss with peers, but **code must be your own.** Policies page

Helper Hours

- **What:** Drop-in time to ask TAs questions about course content (Concepts, Java, APTs, Projects).
- **When:** Sunday-Thursdays
- **Where:** In-person and virtual options
- **How:**
  - Try / think on your own
  - OhHai queue to post your question
  - Talk with a TA for ~5-15 minutes
  - Iterate
- **Details:** See the Getting Help page of the website.


305 responses submitted
Where are you in your academic journey?
First year
76%
Second year
14%
Third year
6%
Fourth year
1%
Other
0%
Treemap
Bar
2 of 9


305 responses submitted
Are you a Pratt or Trinity student?
Pratt
29%
Trinity
69%
Neither
1%
Treemap
Bar
4 of 9

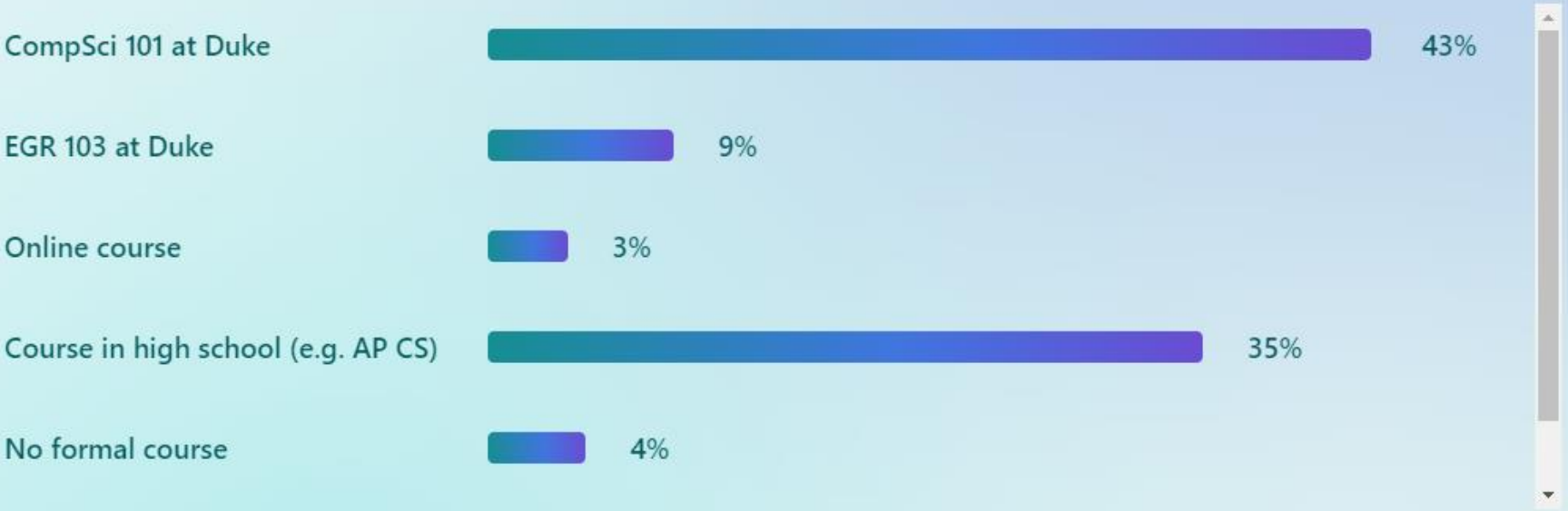
305 responses submitted

Why did you decide to take CS 201 Data Structures and Algorithms? Select all that apply.

5 of 9

305 responses submitted

What programming course did you last take?



Treemap | Bar

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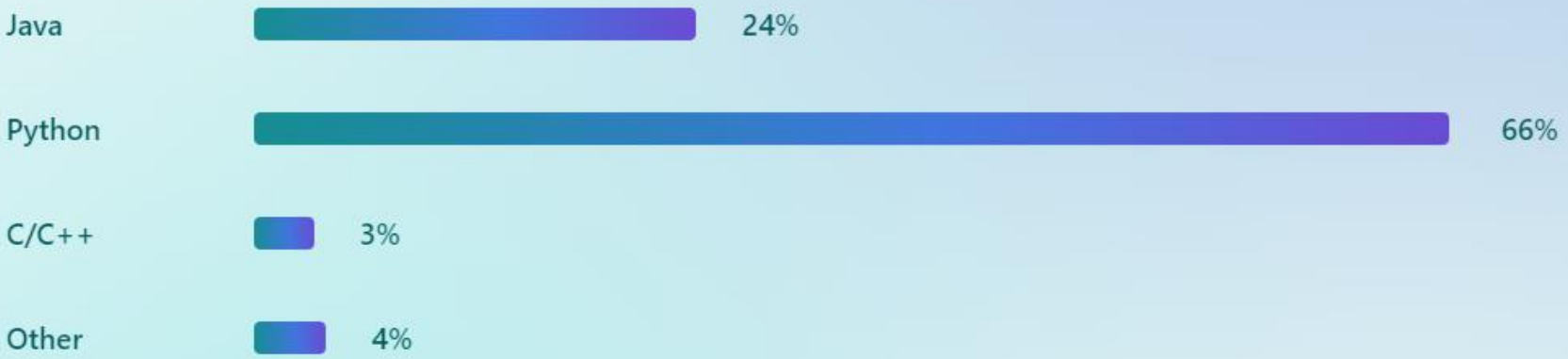
305 responses submitted

With what programming language do you have the most experience / do you consider your "first" or "primary" language?



Treemap | Bar

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Goals for 201?

- Become proficient in Java / coding
- Improve problem-solving skills
- Learn real-world applications to other fields
- Learn to better communicate and collaborate
- Decide if want to pursue/major in CS
- Build a foundation for more CS classes

Fred Brooks, why is programming fun?

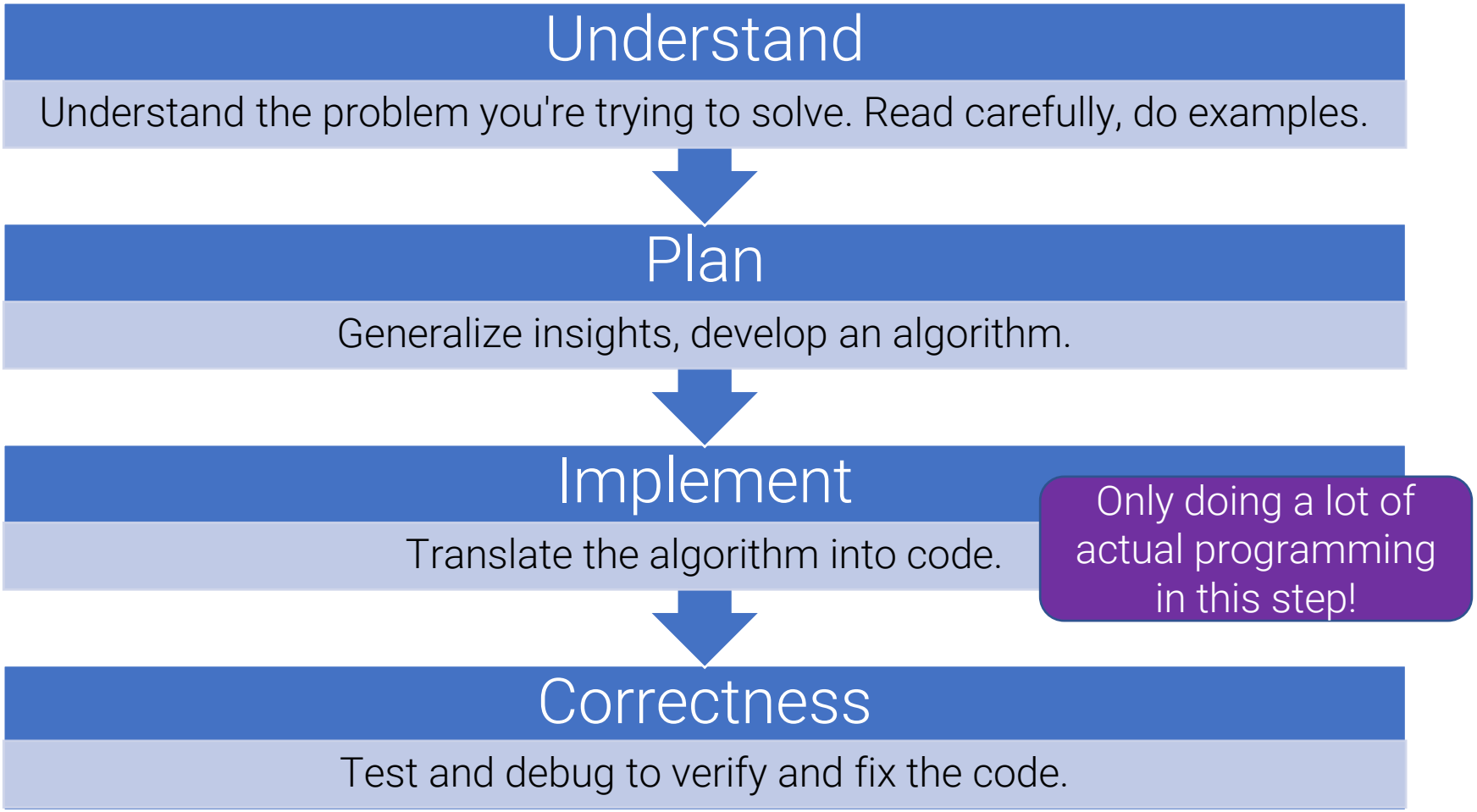
- Duke ‘53
- Founded CompSci @ UNC ‘64
- Turing award ’99

1. Sheer joy of making things.
2. Pleasure of making things that are useful.
3. Fascination of fashioning complex puzzle-like objects of interlocking moving parts.
4. Joy of always learning.
5. Delight in working in such a tractable medium.

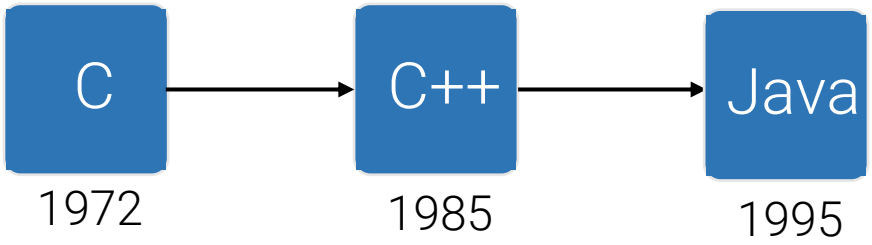
Fred Brooks, cont.

- …Few media of creation are so flexible, so easy to polish and rework, so readily capable of realizing grand conceptual structures…
- …[Programming] is fun because it gratifies creative longings built deep within us and delights sensibilities [we all have in common.]

An Algorithmic Problem-Solving Process: UPIC



A very brief history of Java



- C. Streamlined language developed for writing operating systems and low-level systems utilities.
- C++. Can do everything in C (manual memory management), adds support for object-oriented programming (OOP).
- Java. Requires OOP, Automatic memory management, stronger compile time guarantees, more device independent.

Java is a compiled language

How is the program you write in source code translated into something instructions the machine can *execute?*

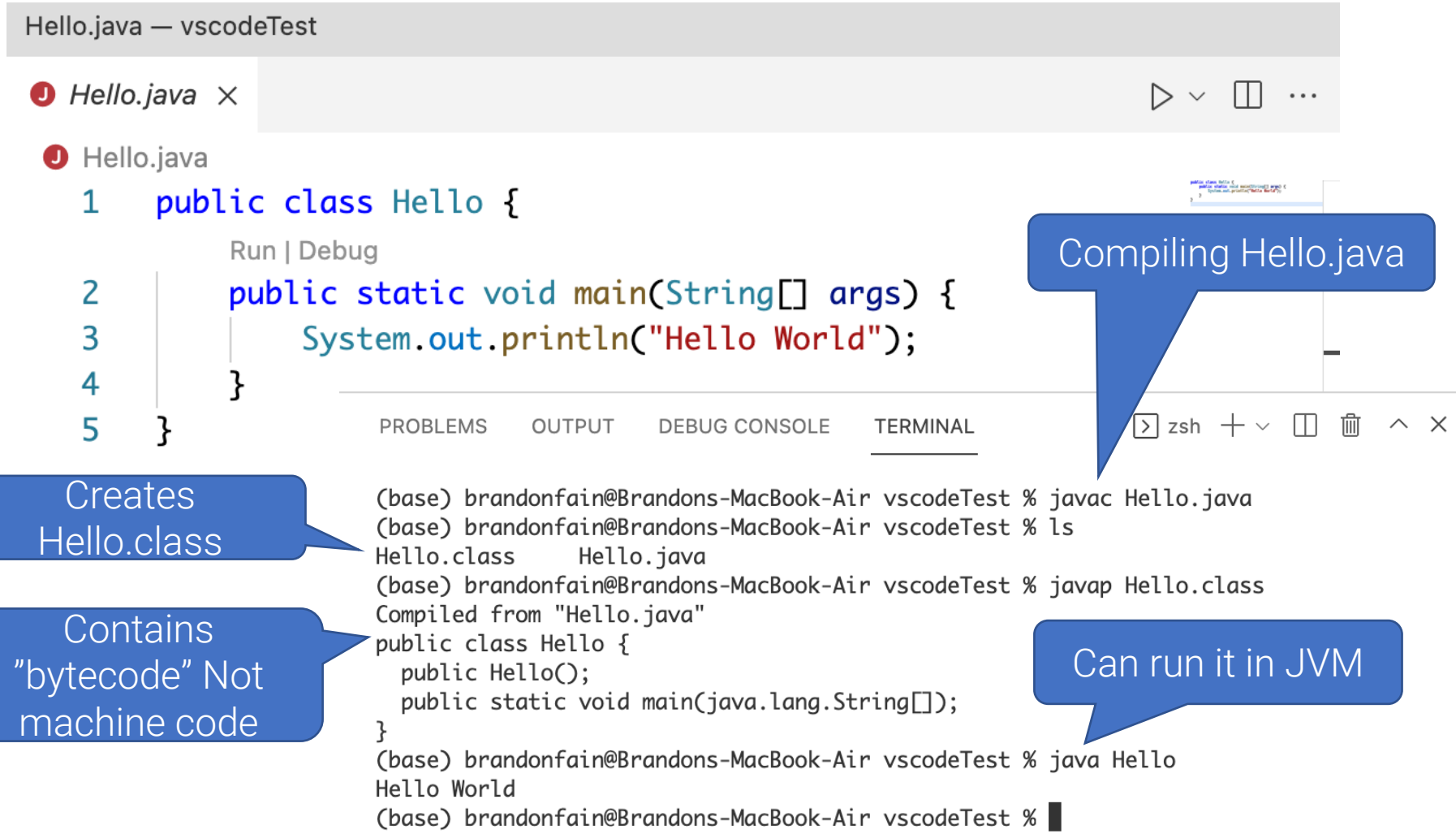
Compiled

- All at once
- Compiler is another program that translates source code into machine code.
- Run the *executable*, the output of the compiler.

Interpreted

- Line at a time
- Interpreter is another program that translates *and* runs a program line by line.
- Python is an interpreted language.

The “Java Virtual Machine”

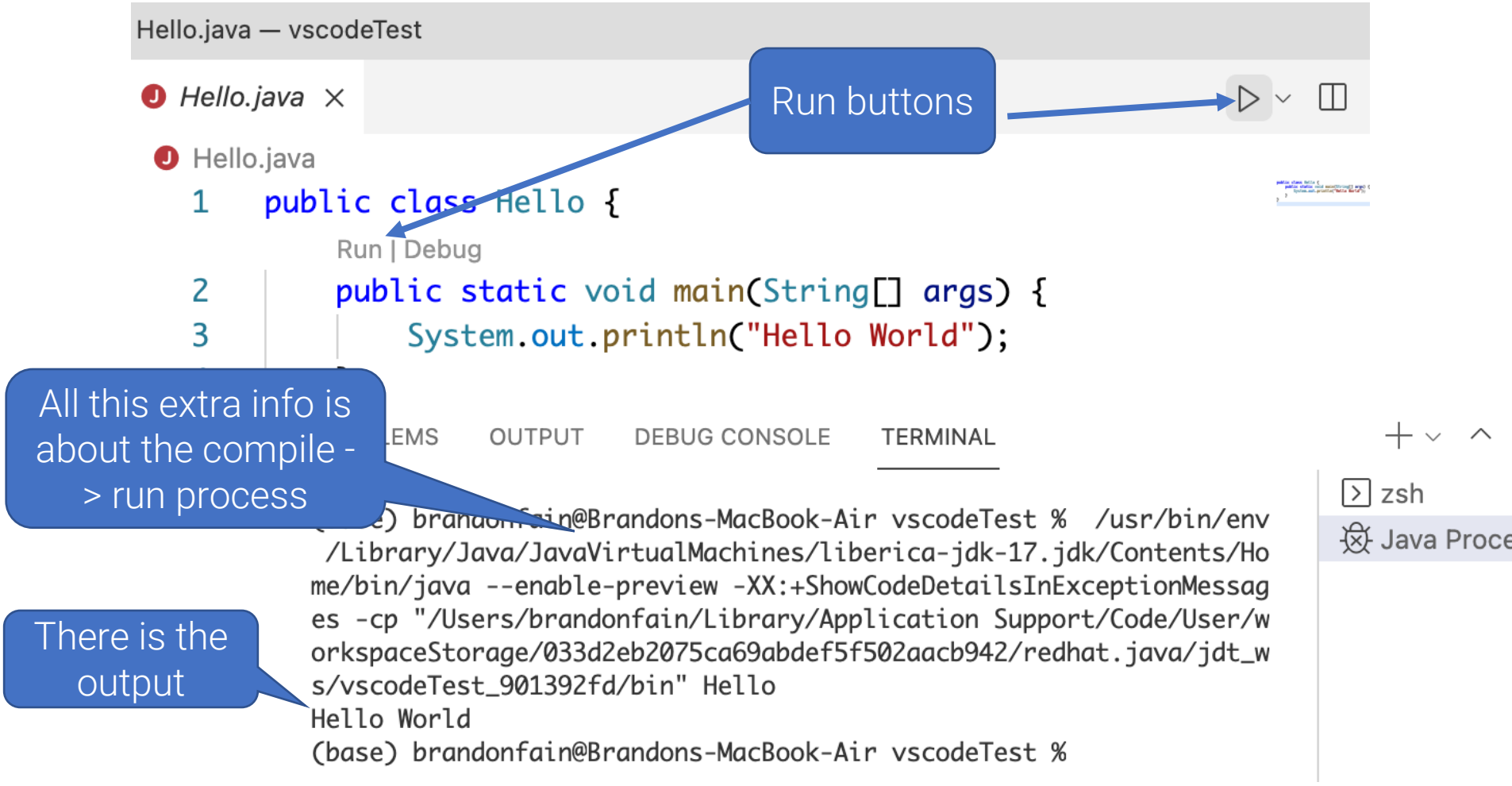


Interlude: Compile and Run Java

Command	Meaning	Details
javac	Compile .java files to .class files	• **javac file.java** compiles and creates **file.class** • **javac *.java** compiles **all** .java files in current directory to .class files.
java	Run java class files	**java file** executes the main method of **file.class**. Must have already been compiled from **file.java**.

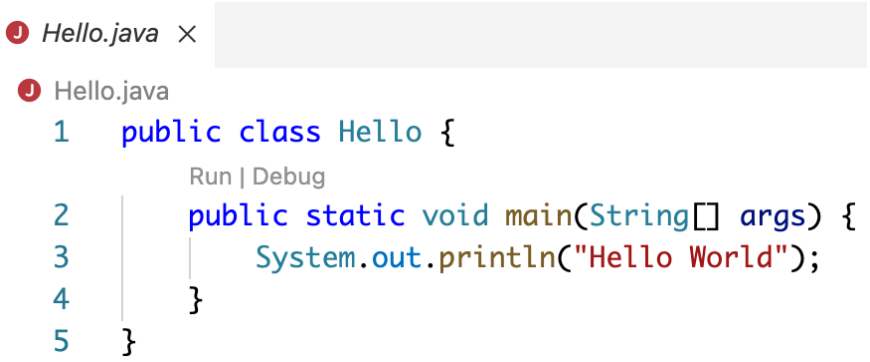
See the javac documentation for more options

Pressing the “run” button in VS Code does these steps for you



Basic anatomy of a Java program

- Each Java source code file **`<className>.java`** contains at least **`public className`**.



- To ***run*** a program, must have a **`public static void main`** (PSVM) method

- Larger projects have multiple classes / .java files; only one needs a PSVM to start program.

Java uses { } to denote blocks and ; to end statements

Block.java

```
1   public class Block {
        Run | Debug
2       public static void main(String[] args) {
3           int x = 4;
4           if (x % 2 == 0) {
5               System.out.println("even");
6           }
7           else {
8               System.out.println("odd");
9           System.out.println("will this print?");
10          }
```

; ends a *statement* / denotes an operation

{…} denotes a block of code, e.g., for an if statement, loop, or method

```
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL
(base) brandonfain@Brandons-MacBook-Air examples % javac Block.java
(base) brandonfain@Brandons-MacBook-Air examples % java Block
even
```

even

block.py

```
1   x = 4
2   if (x % 2 == 0):
3       print("even")
4   else:
5       print("odd")
6   print("will this print?")
```

```
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL
(base) brandonfain@Brandons-MacBook-Air examples % python3 block.py
even
will this print?
```

even
will this print?

newline ends statement in Python

And indentation denotes blocks.
Still a style convention in Java!

Java is **strongly typed**

Must be explicit about the **type** of every variable.

Type.java > ...

```java
public class Type {
    Run | Debug
    public static void main(String[] args) {
        int x = 5;
        System.out.println(x/2);
    }
}
```

Prints 2

type.py

```python
x = 5
print(x/2)
```

Prints 2.5

Type.java > ...

```java
public class Type {
    Run | Debug
    public static void main(String[] args) {
        int x = 5;
        System.out.println((double)x/2);
    }
}
```

Prints 2.5

Notice also that every method must specify the *type* of what it returns (void means nothing).

Can **cast** to convert types `(NewType) var`

Strong typing allows the compiler to help you avoid mistakes

StrongTyping.java 1

StrongTyping.java > StrongTyping > main(String[])

```
1   public class StrongTyping {
2       public static String getFirstWord(String s) {
3           return s.split(" ")[0];
4       }
        Run | Debug
5       public static void main(String[] args) {
6           System.out.println(getFirstWord(201));
7       }
8   }
9
```

PROBLEMS 2 OUTPUT DEBUG CONSOLE TERMINAL

```
(base) brandonfain@Brandons-MacBook-Air examples % javac StrongTyping.java
StrongTyping.java:6: error: incompatible types: int cannot be converted to
String
        System.out.println(getFirstWord(201));
                                        ^
```

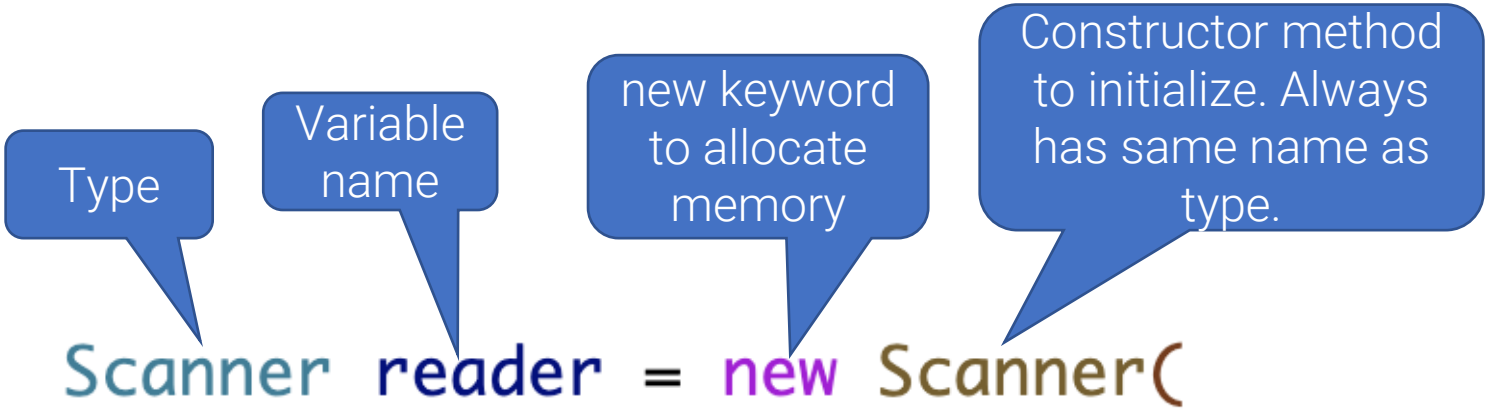
Java primitive types

- Primitive types in Java: Don't need **`new`** to create.
  - **`byte`**, **`short`** (rarely used in this course)
  - **`int`**, **`long`** (common integer types)
  - **`float`**, **`double`** (common decimal number types)
  - **`boolean`** (true or false)
  - **`char`** (for example, **`'a'`** or **`'x'`**)

Java basic operators

`+, -`	Add, subtract
`*, /`	Multiply, divide (careful with divide, `5/4` gives `1`)
`%`	Modulus (remainder in int division, if % 2 == 0 then even, if % 2 == 1 then odd)
`<, <=`	Less than, less than or equal to
`>, >=`	Greater than, greater than or equal to
`==`	Equal **(only for primitive types!!!)**
`!`	Logical NOT (!a means a must not be true)
`&&`	Logical AND (a && b means **a and b** need to be true)
`||`	Logical OR (a || b means at **a, b, or both** need to be true)

Java reference types

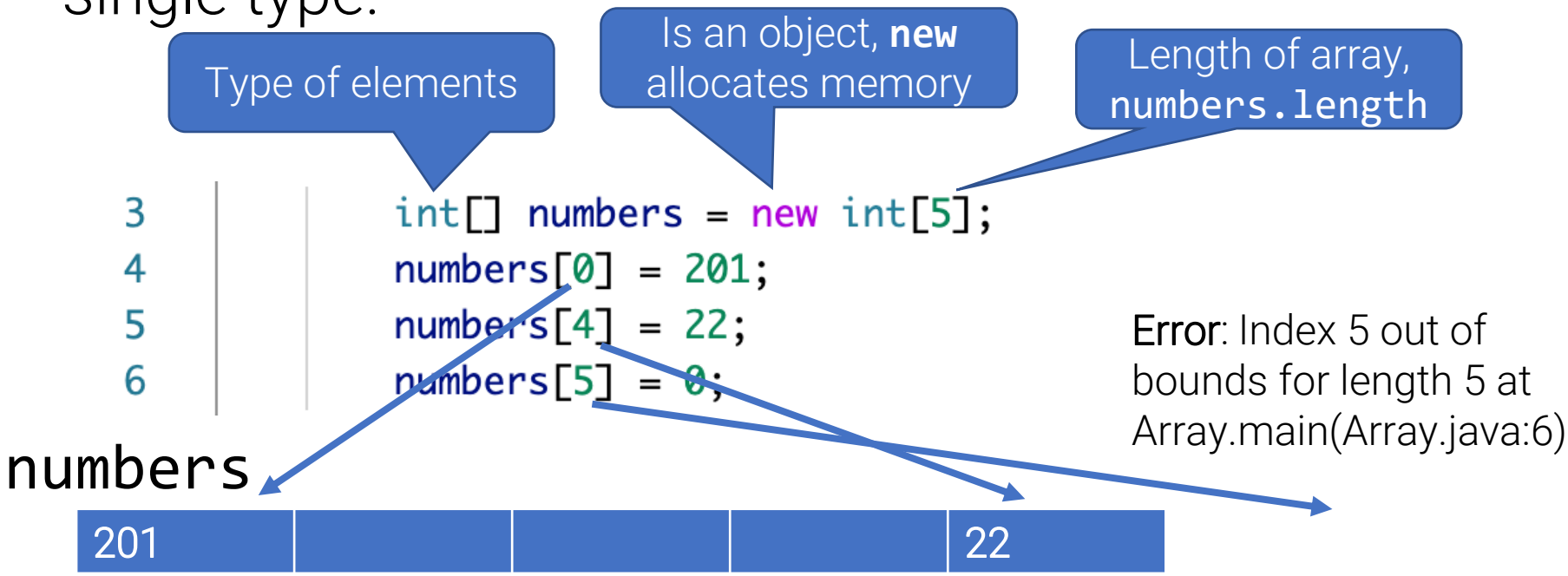


- Variable stores a ***reference*** to an ***object***, i.e., a place in memory.
- Can access instance variables and method calls with the ***dot operator***.

```
while (reader.hasNext()) {
    String word = reader.next();
```

Java arrays

An ***array*** holds a *fixed* number of values of a single type.



Shorthand for pre-initialized Array: `int[] myArray = {1, 2, 3};`

Special Case: String

- **NOT** primitive, but can initialize in two ways:
  - `String s = “Hello”;`
  - `String s = new String(“Hello”);`

- **+** is *overloaded* to concatenate Strings:
  - `String s = “Hello”;`
  - `String t = “ World”;`
  - `System.out.println(s + t);` prints “Hello World”

- **NOT** an array, but can access i-th char:
  - `char c = t.charAt(1);`
  - `System.out.println(c);` prints “W”

Java Strings: concepts and methods

Strings are objects that hold an array of characters.

H	i		C	S		2	0	1	!
0	1	2	3	4	5	6	7	8	9

```
3       String message = "Hi CS 201!";
4       System.out.println(message.length());
5       System.out.println(message.charAt(0));
6       System.out.println(message.substring(0, 4));
7       System.out.println(message.equals("Hi CS 201!"));
```

10

'H'

"Hi C"

True

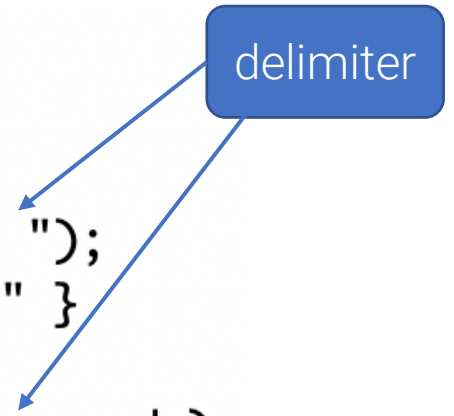
Can even convert to **`char[]`** and back

```
9       char[] letters = message.toCharArray();
10      String originalMessage = new String(letters);
```

More String methods: `split` and `join`

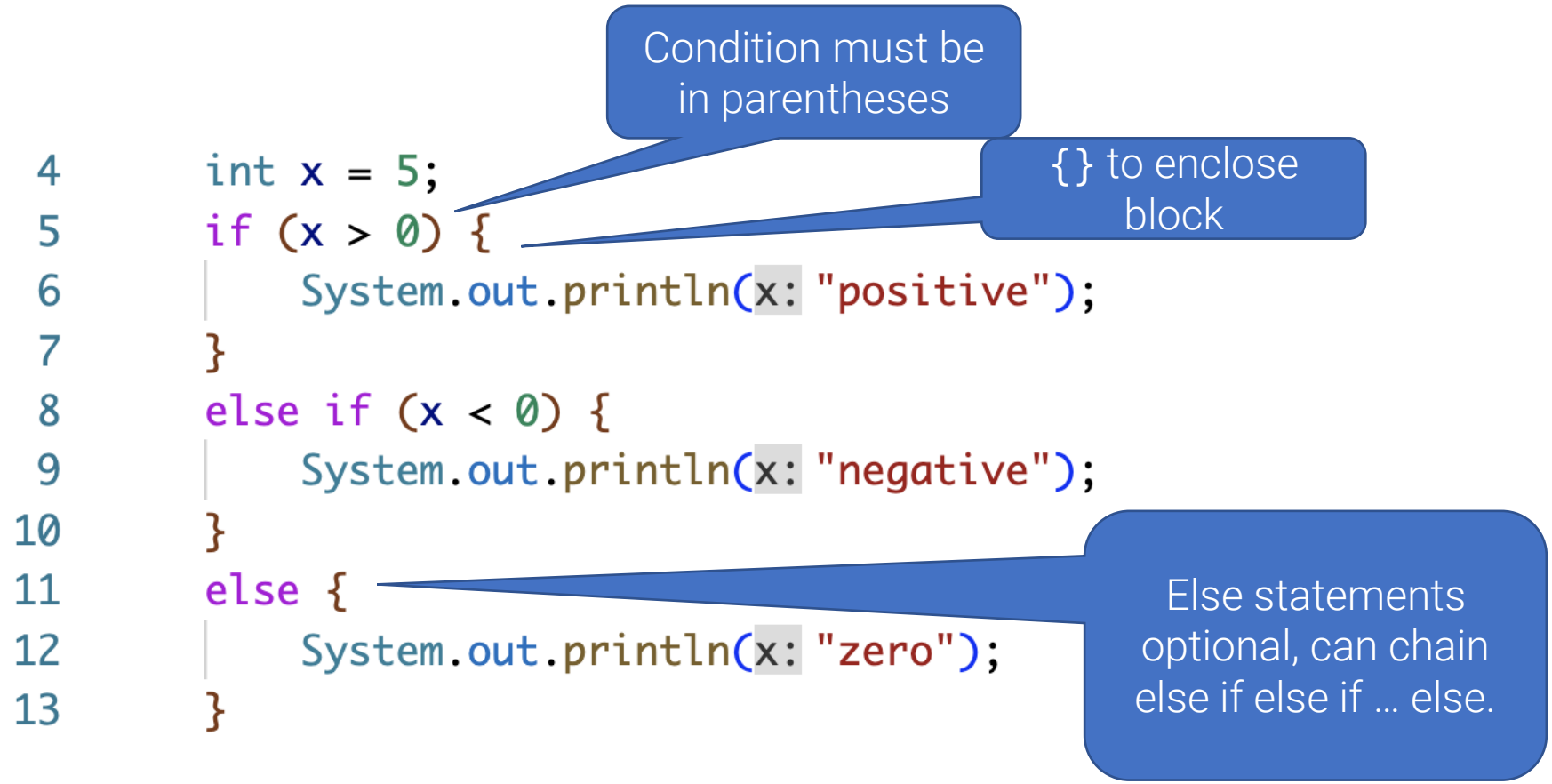
Can **`split`** a String into an array of Strings or **`join`** an array of Strings to one String.

```
jshell> String original = "hello cs 201";
original ==> "hello cs 201"

jshell> String[] words = original.split(" ");
words ==> String[3] { "hello", "cs", "201" }

jshell> String combined = String.join(" ", words);
combined ==> "hello cs 201"
```



See the full String documentation here

Java conditionals




```
4       int x = 5;
5       if (x > 0) {
6           System.out.println(x: "positive");
7       }
8       else if (x < 0) {
9           System.out.println(x: "negative");
10      }
11      else {
12          System.out.println(x: "zero");
13      }
```

Java loops

Creates an **int** variable, starting at 0, accessible only inside the loop block.

Loop while **i < numbers.length**

Increase **i** by 1 each time through loop

number takes each value in **numbers** in sequence

Regular **for**

```
 8        for (int i=0; i<numbers.length; i++) {
 9            System.out.println(numbers[i]);
10        }
```

Enhanced **for**, "for-each" loop

```
12        for (int number : numbers) {
13            System.out.println(number);
14        }
```

while

```
16        int i=0;
17        while (i < numbers.length) {
18            System.out.println(numbers[i]);
19            i++;
20        }
```

Note on Java characters

Java characters are ordered, comparable, correspond to integer values.

```
 9      for (char ch='a'; ch <= 'z'; ch++) {
10          System.out.printf("Char: %c, Val: %d%n", ch, (int)ch);
11      }
```

```
Char: a, Val: 97
Char: b, Val: 98
Char: c, Val: 99
Char: d, Val: 100
Char: e, Val: 101
Char: f, Val: 102
Char: g, Val: 103
Char: h, Val: 104
Char: i, Val: 105
Char: j, Val: 106
Char: k, Val: 107
Char: l, Val: 108
Char: m, Val: 109
Char: n, Val: 110
```

Values are how characters are *encoded* on a machine (ASCII)

WOTO

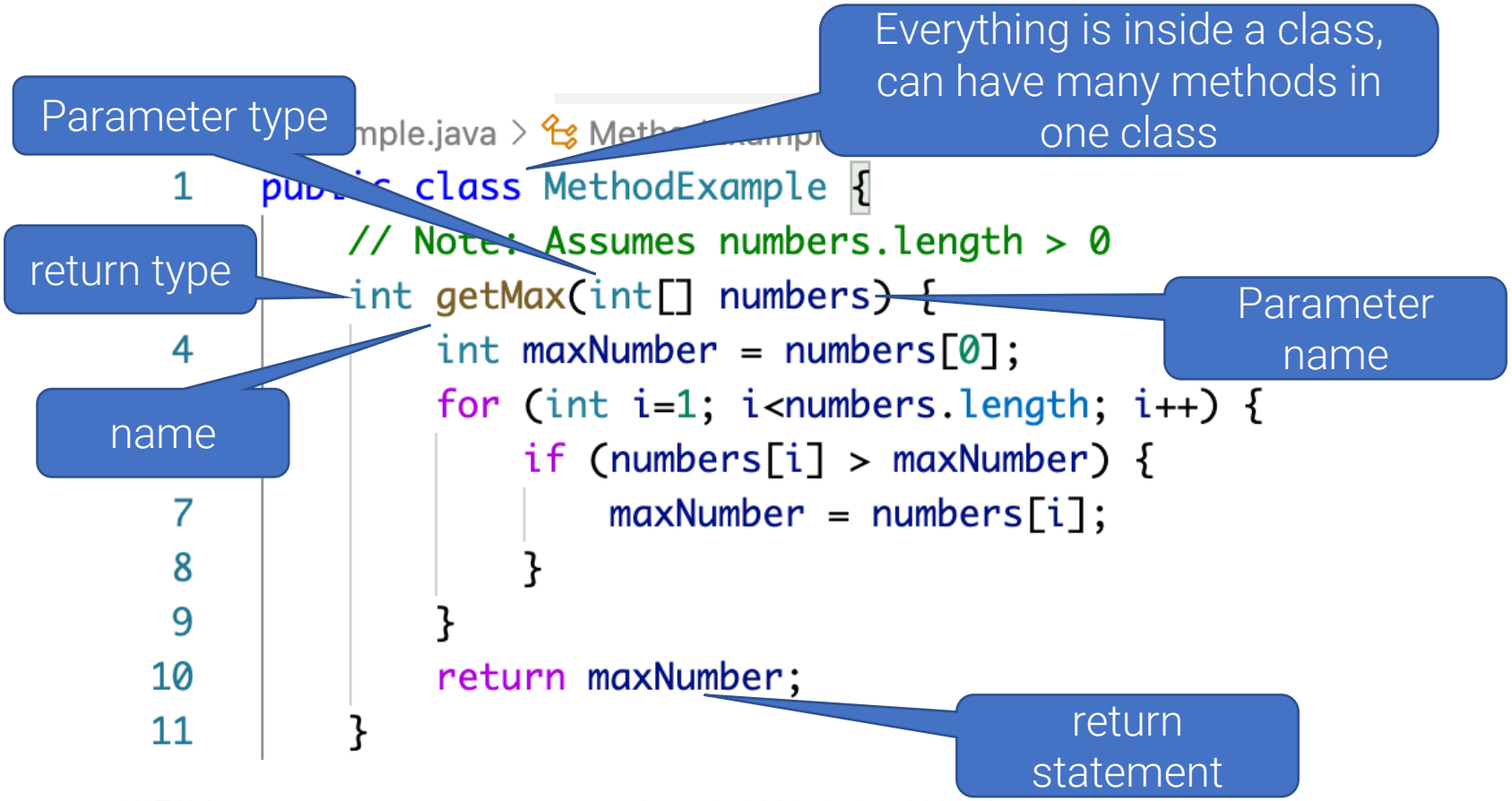
Not graded for correctness, just participation.

Try to answer *without* looking back at slides and notes.

But do talk to your neighbors!

Anatomy of Java methods

A function defined in a class. No “regular” functions in Java, all methods.



Static vs. Non-static Methods

- Non-static methods are called on a created **object**. Has access to object data *and* arguments.

- Static methods are called on the **class**. Only has access to arguments. Often utility "functions."

StaticExample.java > ...

```
1   public class StaticExample {
        Run | Debug
2       public static void main(String[] args) {
3           String s = "Hello World!";
4           System.out.println(s.split(" ")[0]);
5
6           System.out.println(Math.sqrt(4.0));
7       }
8   }
```

Note that `split` is called on a String object

Whereas `sqrt` is called on the `Math` class

Anatomy of a Java collections data structure

- An import statement:

ArrayListExample.java > ...

```
1   import java.util.ArrayList;
```

  - Goes outside the class, top of the file

```
ArrayList<Integer> list = new ArrayList<>();
```

Collections type

Element type

Variable name

Allocate memory

Call constructor method to initialize

Java API ArrayList data structure

`ArrayList` is most like a Python list

- Access by index access but can grow dynamically
- Uses **`add(), get(), size(), contains()`**

```
4       public static void main(String[] args) {
5           ArrayList<Integer> intList = new ArrayList<>();
6           intList.add(1);
7           intList.add(2);
8           int sum = 0;
9
10          for (int i=0; i<intList.size(); i++) {
11              sum += intList.get(i);
12          }
13          System.out.println(intList.contains(5));
```

`.add()` appends to end of list

`.size()` returns number of elements

`.get(i)` returns i'th index element

`.contains(x)` returns `true` if `x` in list

ArrayList methods reference

Method	Notes
`add(element)`	Appends **`element`** to end of list
`get(index)`	Returns the **`index`** position element (starting with 0)
`contains(element)`	Searches list, returns **`true`** if **`element`** is in the list, else **`false`**.
`size()`	Returns the (integer) number of elements in the list
`set(index, element)`	Assigns **`element`** to the **`index`** position (starting at 0), overwriting the previous value.
`remove(index)`	Remove the **`index`** position element

See the full ArrayList documentation

Live Coding