Objectives

- Control structures
  - Conditionals
  - Switches
  - Loops
- Arrays
- Command-line arguments

Office Hours

- Monday: 2-3:30 p.m., Zoom and in-person
- Tuesday: 12-1:30 p.m., Zoom only
- Wednesday: 3-4:30 p.m., Zoom and in-person

Review: Java's Library

- What is an API?
- What are some examples of Java classes?
- How do you create an object?
- How do you call a method?
- How do we know what methods are available to call on a specific Java class?
- What classes are included by default in a Java program?
  - How can we use classes that aren't included?
- What are some helpful String methods?

StringBuilders and Strings

- Strings are read-only or immutable
  - Same as Python
- More efficient to use `StringBuilder` to manipulate a `String`
- Instead of creating a new String using
  - ~~`String str = prevStr + " more!";`~~
- Use

```
StringBuilder str = new StringBuilder( prevStr );
str.append(" more!");
```

- Many `StringBuilder` methods
  - `toString()` to get the resultant string back

CONTROL STRUCTURES

Conditional Statements Syntax: `if`

- **Condition** must be surrounded by ()
- Condition must evaluate to a `boolean`
- If body includes *multiple* statements, **must** be enclosed by {}

```
if (condition) {
    body
}
```

```
if (purchaseAmount < availCredit) {
   System.out.println("Approved");
   availableCredit -= purchaseAmount;
}
else
   System.out.println("Denied");
```

Don't *need* { } if only one statement in the body, BUT
Best practice: use { }

Logical Operators

Operation	Python	Java
AND		&&
OR		||
NOT		!

In Python, these are …?

Logical Operators

Operation	Python	Java
AND	`and`	`&&`
OR	`or`	`||`
NOT	`not`	`!`

Control Flow: Conditional Statements

- `if` statement


```
if (purchaseAmount < availCredit) {
   System.out.println("Approved");
   availableCredit -= purchaseAmount;
}
else
   System.out.println("Denied");
```

Block of code

- Everything between { } is a *block of code* and has an associated ***scope***

Control Flow: Conditional Statements

- `if` statement


```
if (purchaseAmount < availCredit) {
   System.out.println("Approved");
   availableCredit -= purchaseAmount;
}
else
   System.out.println("Denied");
```

Block of code

Python Gotcha: Scoping Issues

- Everything between { } is a block of code and has an associated ***scope***

```
if (purchaseAmount < availableCredit) {
        availableCredit -= purchaseAmount;
        boolean approved = true;
}

if( ! approved )
        System.out.println("Denied");
```

Out of scope
Will get a compiler error (cannot find symbol)

How do we fix this code?

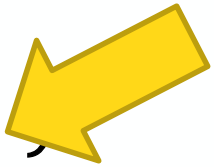
Not Fixed

```
if (purchaseAmount < availableCredit) {
        availableCredit -= purchaseAmount;
        boolean approved = true;

        if( ! approved )  Will never execute
                System.out.println("Denied");
}
```

Almost Fixed

- Move `approved` outside of the `if` statement

```
boolean approved;
if (purchaseAmount < availableCredit) {
        availableCredit -= purchaseAmount;
        approved = true;
}

if( ! approved )
        System.out.println("Denied");
```



```
Compiler error: variable approved
might not have been initialized
```

Fixing Variable Scope Problem

- Move declaration of `approved` outside of the `if` statement *and* initialize

```
boolean approved = false;
if (purchaseAmount < availableCredit) {
        availableCredit -= purchaseAmount;
        approved = true;
}

if( ! approved )
        System.out.println("Denied");
```

Alternative Fix

- Move declaration of `approved` outside of the `if` statement

```
boolean approved;
if (purchaseAmount < availableCredit) {
        availableCredit -= purchaseAmount;
        approved = true;
} else
       approved = false;

if( ! approved )
        System.out.println("Denied");
```

Control Flow: `else if`

- Python Gotcha: in Python, was `elif`

```
if( x % 2 == 0 ) {
   System.out.println("Value is even.");
}
else if ( x % 3 == 0 ) {
   System.out.println("Value is divisible by 3.");
}
else {
   System.out.println("Value isn't divisible by 2 or 3.");
}
```

What output do we get when x is 9, 13, or 6?

Apple's goto fail in SSL (C code but Java is similar)

```
hashOut.data = hashes + SSL_MD5_DIGEST_LEN;
hashOut.length = SSL_SHA1_DIGEST_LEN;
if ((err = SSLFreeBuffer(&hashCtx)) != 0)
    goto fail;
if ((err = ReadyHash(&SSLHashSHA1, &hashCtx)) != 0)
    goto fail;
if ((err = SSLHashSHA1.update(&hashCtx, &clientRandom)) != 0)
    goto fail;
if ((err = SSLHashSHA1.update(&hashCtx, &serverRandom)) != 0)
    goto fail;
if ((err = SSLHashSHA1.update(&hashCtx, &signedParams)) != 0)
    goto fail;
    goto fail;
if ((err = SSLHashSHA1.final(&hashCtx, &hashOut)) != 0)
    goto fail;
```

https://cacm.acm.org/blogcacm/those-who-say-code-does-not-matter/

Apple's goto fail in SSL

```
hashOut.data = hashes + SSL_MD5_DIGEST_LEN;
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    goto fail;
if ((err = SSLHashSHA1.update(&hashCtx, &serverRandom)) != 0)
    goto fail;
if ((err = SSLHashSHA1.update(&hashCtx, &signedParams)) != 0)
    goto fail;
    goto fail;  /* MISTAKE! THIS LINE SHOULD NOT BE HERE */
if ((err = SSLHashSHA1.final(&hashCtx, &hashOut)) != 0)
    goto fail;
```

Lesson: always use braces to mark the body of an if statement, even if it is just one line

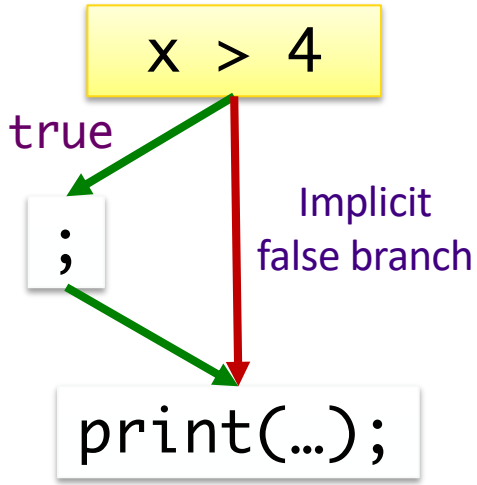
What does this code do?

```
if ( x > 4 );
        System.out.println("x is " + x);
```

What does this code do?

```
if ( x > 4 );
        System.out.println("x is " + x);
```

- ; is a valid statement
- Print statement *always* executes
- Indentation doesn't matter



while loop

```
while (condition) {
    body
}
```

(You probably guessed it!)

Control Flow: `while` Loops

- `while` loop
  - Condition must be enclosed in parentheses
  - Body of loop must be enclosed in `{}` if multiple statements

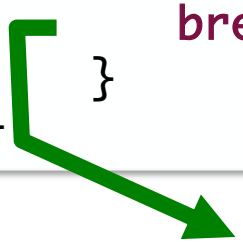
```
int counter = 0;
while (counter < 5) {
        System.out.println(counter);
        counter++;
}
System.out.println("Done: " + counter);
```

shortcut

Changing control flow: break

- Exits the current loop

```
while ( <condition> ) {
    …
    if( <something> ) { // now we're done!
        break;
    }
}
```



Control Flow: `switch` statement

- Similar to an `if/else if` statement
- Works with variables with datatypes `byte`, `short`, `char`, `int`, and `String`

```
int x = 3;
switch(x) {
    case 1:
        System.out.println("It's a 1.");
        break;
    case 2:
        System.out.println("It's a 2.");
        break;
    default:
        System.out.println("Not a 1 or 2.");
}
```

Control Flow: `switch` statement

```
switch(grade) {
        case 'a':
        case 'A':
                System.out.println("Congrats!");
                break;
        case 'b':
        case 'B':
                System.out.println("Not too shabby!");
                break;
        … // Handle c, d, and f …
        default:
                System.out.println("Error: not a grade");
}
```

As of version 3.10, Python has match/case statement:
https://docs.python.org/3/whatsnew/3.10.html

Grades.java

Control Flow: `switch` statement

```
switch(grade) {
        case 'a':
        case 'A':
                System.out.println("Congrats!");
                break;
        case 'b':
        case 'B':
                System.out.println("Not too shabby!");
                break;
        … // Handle c, d, and f …
        default:
                System.out.println("Error: not a grade");
}
```

When grade is ‘a’:

```
Congrats!
```

When grade is ‘B’:

```
Not too shabby!
```

Grades.java

Control Flow: for Loop

```
System.out.println("Counting down…");

for (int count=5; count >= 1; count--) {
    System.out.println(count);
}
System.out.println("Blastoff!");
```

```
for ( <init value>; <condition>; <lastiniteration> ) {

}
```

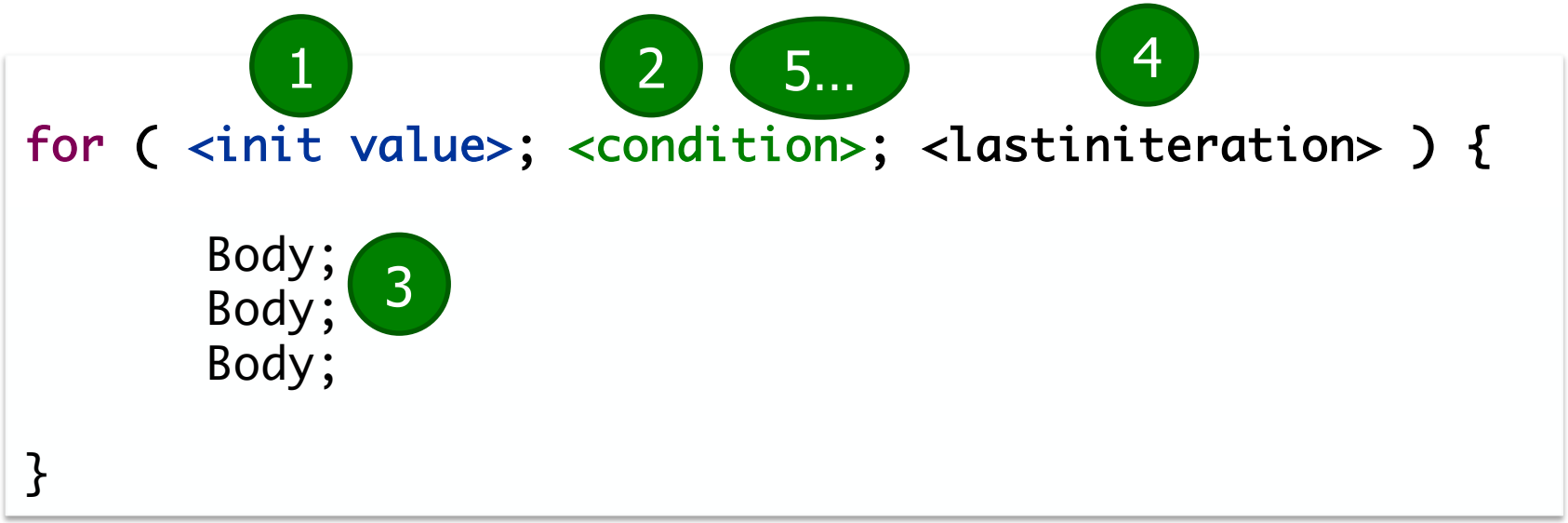
Initialize counter variable; not necessarily declared here

Body should be repeated until this condition isn't true

Executed at end of each iteration of the loop body

Countdown.java

Control Flow: for Loop Order



Control Flow: for Loop Example

```
System.out.println("Counting down…");

for (int count=5; count >= 1; count--) {
    System.out.println(count);
}
System.out.println("Blastoff!");
```

- What is the output?
- How written as a while loop?
- How written in Python?
- You can't print out count with Blastoff. Why not?

for vs while loop

```
System.out.println("Counting down…");

for (int count=5; count >= 1; count--) {
    System.out.println(count);
}
System.out.println("Blastoff!");
```

```
System.out.println("Counting down…");
int count=5;
while (count >= 1) {
    System.out.println(count);
    count--;
}
System.out.println("Blastoff!");
```

Control Flow: for Loop Compare

```
System.out.println("Counting down…");

for (int count=5; count >= 1; count--) {
    System.out.println(count);
}
System.out.println("Blastoff!");
```

In Python:

```
print("Counting down…");

for count in range(5, 0, -1):
    print(count);

print("Blastoff!")
```

More Examples

Counter variable declared before for loop

```
int count;
for (count=5; count >= 1; count--) {
    System.out.println(count);
}
System.out.println("Blastoff!" + count);
```

Empty initialization—not recommended.

Set your counter variable!

```
int count=5;
for (; count >= 1; count--) {
    System.out.println(count);
}
System.out.println("Blastoff!" + count);
```

ARRAYS

Python Lists → Java Arrays

- A Java **array** is like a ***fixed-length*** list
- To ***declare*** an array:
  - `DataType[] myArray;`
  - Example: `int[] arrayOfInts;`
  - Declaration only makes a variable named `arrayOfInts`
  - Does *not* initialize array or allocate memory for the elements

Python Lists → Java Arrays

- A Java **array** is like a ***fixed-length*** list
- To ***declare*** an array:
  - `DataType[] myArray;`
  - Example: `int[] arrayOfInts;`
  - Declaration only makes a variable named `arrayOfInts`
  - Does *not* initialize array or allocate memory for the elements
- To declare *and* ***allocate memory*** for array of integers:

```
int[] arrayOfInts = new int[100];
```

  - Assigned default values for data type
    - But don't rely on defaults

new keyword: allocate memory to a new object

Array Initialization

- Initialize an array at its declaration:
  - `int[] fibNums = {1, 1, 2, 3, 5, 8, 13};`

Value	1	1	2	3	5	8	13
Position/index	0	1	2	3	4	5	6

    - Note that we do not use the new keyword when allocating and initializing an array in this manner
  - `fibNums` has length 7

Array Access

- Access a value in an array as in Python:
  - `fibNums[0] = 1;`
  - …
  - `fibNums[x] = fibNums[x-1] + fibNums[x-2];`
- Unlike in Python, **cannot** use negative numbers to index arrays
- Overstepping an array
  - Attempts to access or write to index < 0 or index >= array.length will generate array index out of bounds exception

Array Length

- All array variables have a ***property*** called `length`
  - Note: no parentheses because it's ***not*** a method

```
int[] array = new int[10];
for (int i = 0; i < array.length; i++) {
        array[i] = i * 2;
}

for (int i = array.length-1; i >= 0; i--) {
        System.out.println(array[i]);
}
```

Command-Line Arguments

- We've seen use of an array (of Strings) since we started programming in Java

Contains the command-line arguments

```
public static void main(String[] args) {
   if( args.length < 1 ) {
        System.out.println("Error: invalid number of arguments");
        System.out.println("Usage: java MyProgram <filename>");
        System.exit(1);
   }
}
```

Example Use:

```
java MyProgram myFile.txt
```

Command-Line Arguments

- Similar to Python's `sys` module

```
# Make sure there are sufficient arguments.
if len(sys.argv) < 2:
    print "Error: invalid number of command-line arguments"
    print "Usage: python", sys.argv[0], "<filename>"
    sys.exit(1)
```

Contains the command-line arguments

```
public static void main(String[] args) {
   if( args.length < 1 ) {
        System.out.println("Error: invalid number of arguments");
        System.out.println("Usage: java MyProgram <filename>");
        System.exit(1);
   }
}
```

Example Use:

```
java MyProgram myFile.txt
```

Command-Line Arguments

- In Python, `sys.argv[0]` represented the name of program
- Not same in Java
  - Command-line arguments do not include the classname

```
# Make sure there are sufficient arguments.
if len(sys.argv) < 2:
    print "Error: invalid number of command-line arguments"
    print "Usage: python", sys.argv[0], "<filename>"
    sys.exit(1)
```

Have to specify program name in Java, e.g.,

```
System.out.println("Usage: java MyProgram <filename>");
```

String Comparison: `equals`

- `boolean equals(Object anObject)`
  - Compares this string to the specified object

```
String string1 = "Hello";
String string2 = "hello";
boolean test;
test = string1.equals(string2);
```

- `test` is false because the Strings contain different values
- `==` is like Python's `is`
  - Compares that the objects are the same (like Python's `is`)

Control Flow: for each Loop

- Sun called “enhanced for” loop
- Iterate over all elements in an array (or Collection)
  - Similar to Python’s `for` loop

```
int[] a;
int result = 0;
. . .
for (int i : a) {
   result += i;
}
```

“in”

for each int element `i` *in* the array `a` , the loop body is executed

https://docs.oracle.com/javase/8/docs/technotes/guides/language/foreach.html

Arrays

- Assigning one array variable to another ➔ both variables refer to the same array
  - Similar to Python

Arrays

- Assigning one array variable to another ➔ both variables refer to the same array
  - Similar to Python
- Draw picture of code:

```
int [] fibNums = {1, 1, 2, 3, 5, 8, 13};
int [] otherFibNums;

otherFibNums = fibNums;
otherFibNums[2] = 99;

System.out.println(otherFibNums[2]);
System.out.println(fibNums[2]);
```

Arrays

- Assigning one array variable to another ➔ both variables refer to the same array
  - Similar to Python
- Draw picture of code:

```
int [] fibNums = {1, 1, 2, 3, 5, 8, 13};
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otherFibNums[2] = 99;

System.out.println(otherFibNums[2]);
System.out.println(fibNums[2]);
```

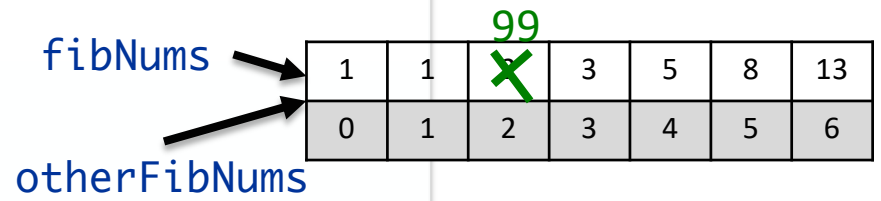

Displays:
99
99

java.util.Arrays

- `Arrays` is a class in `java.util` package
- Methods for sorting, searching, `deepEquals`, filling arrays
- To use class, need `import` statement
  - Goes at top of program, before class definition

```
import java.util.Arrays;
```

- Call methods on the *class* because the methods are static
  - More on this class and the distinction later

`ArraysExample.java`

Looking Ahead

- Assignment 1 due Wednesday