Objectives

- More Java fundamentals
  - Math class
  - String class
  - Arrays
  - Control Structures

Review: Assign 0

- How did it go?
  - How long did it take?

Review

- What are some of the primitive data types of Java?
- What is a benefit of static typing?
- What is the syntax for declaring a variable in Java?
- What is the keyword for a constant value?

`java.lang.Math` class

- Similar to Python's `math` module
- Part of the Java class libraries
- Included by default in every Java program
- Contains useful mathematical functions (methods) and constants (fields):
- Look at `java.lang.Math` API online
  - http://java.sun.com/javase/6/docs/api/

`java.lang.Math` class

- Example Uses:

method

constant

```
double y = Math.pow(x, a);
double z = Math.sin(y);
double d = Math.exp(4.59) * Math.PI;
```

Use `Classname.methodname()` to call Math's methods because they're `static`

Java API Documentation

- API: Application Programming Interface
  - What the class can do for YOU!
- Complete documentation of every class included with the JDK
  - Every method and variable contained in class

http://java.sun.com/javase/6/docs/api/

- Bookmark it!
  - Too many classes, methods to remember them all
  - Refer to it often

STRINGS

Another Class: String

- Similar to Python
- Java class libraries include a String class in java.lang.String
  - All java.lang classes are *automatically* included in Java programs

Strings

- Strings are represented by **double** quotes: ""
  - Single quotes represent chars
- Examples:

```
String emptyString = "";
String niceGreeting = "Hello there.";
String badGreeting = "What do you want?";
```


String Concatenation

- Use + operator to concatenate Strings

```
String niceGreeting = "Hello";
String firstName = "Clark";
String lastName = "Kent";
String blankSpace = " ";

String greeting = niceGreeting + "," +
     blankSpace + firstName +
     blankSpace + lastName;

System.out.println(greeting);
```

Prints "Hello, Clark Kent"

String Concatenation

- If a string is concatenated with something that is not a string, the other variable is converted to a string.

```
int totalPoints = 110;
int earnedPoints = 87;
float testScore = (float) earnedPoints/totalPoints;

System.out.println("Your score is " + testScore);
```

Converted to a String

StringBuffers vs Strings

- Strings are "read-only" or immutable
- Use StringBuffer to manipulate a String
- Instead of creating a new String using
  - String str = prevStr + " more!";
- Use

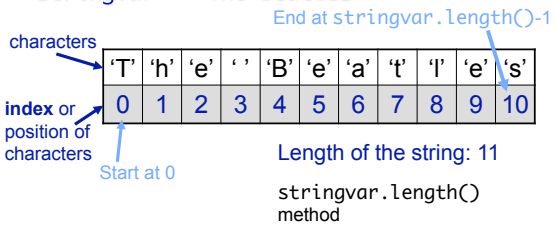
```
StringBuffer str = new StringBuffer( prevStr );
str.append(" more!");
```

- Many StringBuffer methods, including toString() to get the resultant string back

Strings

- A character at each position of string
  - Example:

`stringvar = "The Beatles"`



String methods: substring

- Like slicing in Python
- `String substring(int beginIndex)`
  - Returns a new String that is a substring of this string, from `beginIndex` to end of this string
- `String substring(int beginIndex, int endIndex)`
  - Returns a new String that is a substring of this string, from `beginIndex` to `endIndex`

```
String greeting = "Hello, Clark Kent!";
String subStr = greeting.substring(7);
String subStr2 = greeting.substring(7, 11);
```


String methods: substring

- Can't use negative numbers for indices as in Python

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

String Comparisons: Python Gotcha

- `string1 == string2` will **not** yield the same result as `string1.equals(string2)`
  - == tests if the *objects* are the same
    - **not** if the *contents* of the objects are the same
  - Similar to `is` operator in Python

String methods: equalsIgnoreCase

- Does what it's named!

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

- `test` is true!

String methods: charAt

- A String is a collection of chars

```
String testString1 = "Demonstrate Strings";

char character1;
char character2 = testString1.charAt(3);
character1 = testString1.charAt(2);
```


String methods: and many more!

- `boolean endsWith(String suffix)`
- `boolean startsWith(String prefix)`
- `int length()`
- `String toLowerCase()`
- `String trim()` : remove trailing and leading white space
- …
- See `java.lang.String` API for all

CONTROL STRUCTURES

Logical Operators

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

Control Flow: Conditional Statements

- `if` statement
  - **Condition** must be surrounded by ()
  - Condition must evaluate to a boolean
  - Body is enclosed by {} if multiple statements

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

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

Control Flow: Conditional Statements

- `if` statement

Condition

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

Block of code

Blocks of Code

- Everything between { } is a block of code
  - Has an associated scope

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

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

Out of scope

Fixed

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

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

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


Control Flow: `else if`

- 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 put do we get if x is 9, 13, and 6?

Control Flow: `switch` statement

- Like a big `if/elseif` statement
- Works with variables with datatypes `byte`, `short`, `char`, and `int`

```
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");
}
```

Grades.java

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 < 10) {
     System.out.println(counter);
     counter++;
}
System.out.println("Done: " + counter);
```

Changing control flow: break

- Exits the current loop
- In general, I do **not** recommend using break
  - But, you should know it for reading other people's code

```
while ( <readingdata> ) {
   …
   if( data == null ) { // shouldn't happen
      break;
   }
}
```


Control Flow: for Loop

- Very different syntax from Python
- Syntax:

```
for (<init>; <condition>; <execution_expr>)
```

Loop's counter variable, Usually used in condition

Executed at end of each iteration. Typically increments or decrements counter

Control Flow: for Loop Example

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

for (int count=10; count >= 1; count--) {
    System.out.println(count);
}
System.out.println("Blastoff!");
```

shortcut

- What is the counter variable?
- What is the condition?
- What is the output?
- How written in Python?

ARRAYS

Python Lists → Java Arrays

- A Java **array** is like a *fixed-length* list
- To declare an array of integers:

```
int[] arrayOfInts;
```

  - Declaration only makes a variable named arrayOfInts
  - Does not initialize array or allocate memory for the elements
- To declare *and initialize* array of integers:
  - `int[] arrayOfInts = new int[100];`

Array Initialization

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

1	1	2	3	5	8	13
0	1	2	3	4	5	6

Position/index

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

Array Access

- Access a value in a array as in Python:
  - `fibNums[0]`
  - `fibNums[x] = fibNums[x-1] + fibNums[x-2]`
- Unlike in Python, cannot use -1 (or negative numbers) to index last item

Array Length

- All array variables have a *field* called `length`
  - Note: no parentheses because 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]);
}
```


Overstepping Array Length

- Java safeguards against overstepping length of array
  - Runtime Exception: "Array index out of bounds"
  - More on exceptions later…
- Example

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

  - Attempts to access or write to index < 0 or index >= array.length (100) will generate exception

Arrays

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

```
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]);
```

fibNums[2] and otherFibNums[2] are both equal to 99.

Array Copying

- Copy an array (element-by-element) using the `arraycopy` method in the System class

```
System.arraycopy(from, fromIndex, to, toIndex, count);
```

- For example:

```
int [] fibNums = {1, 1, 2, 3, 5, 8, 13};
int [] otherFibNums = new int[fibNums.length];
System.arraycopy(fibNums,0,otherFibNums,0,fibNums.length);
otherFibNums[2] = 99;
System.out.println(otherFibNums[2]);
System.out.println(fibNums[2]);
```

fibNums[2] = 2,
otherFibNums[2]= 99

java.util.Arrays

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

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

ArraysExample.java

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.exit(1);
   }
}
```

Command-Line Arguments

- Name of Python program was sys.argv[0]
  - 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)
```


Control Flow: foreach Loop

- Introduced in Java 1.5
  - Sun calls "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;
}
```

for each int element `i` in the array `a`

The loop body is visited once for each element of `a`.

Python Dictionaries ➔ Java HashMaps

- We'll discuss later

Python to Java Gotchas

- Every variable needs to be declared before it is used
- Every variable needs a statically-declared data type
- Scope of variables
- Syntax
  - Semicolons at the end of **statements**
  - Braces around blocks of code
  - Keywords

Assignment

- Part 1: Fixing compiler and logic errors from program
- Part 2: Writing a program to compute a gymnastics score at the Olympics
- Part 3: Reverse a string