Procedural Java

Requisite ‘Hello World’ in Java

```java
public class HelloWorld {
    public static void main(String[] args) {
        System.out.println("Hello World");
    }
}
```

Now what?

- How to compile?
  - Must specify the file(s)
- How to execute?
  - Must specify the class (without .class)
- Does the filename matter?
  - Must have ‘.java’ suffix
  - Must be named the same as class

Primitives

- 8 types (9 including void)
  - `boolean` - one bit (but size undefined)
    - `true` or `false`
  - `byte` - signed 8 bits
    - (-128, 127)
  - `short` - signed 16 bits
    - (-32,768, 32,767)
  - `char` - unsigned 16 bits. Unicode character
    - from '\u0000' to '\uFFFF' or (0, 65,535)
  - `int` - signed 32 bits
    - $(-2^{31}, 2^{31}-1)$
  - `long` - signed 64 bits
    - $(-2^{63}, 2^{63}-1)$
  - `float` - single-precision 32-bit IEEE 754 floating point
    - 1.40129846432481707e-45 to 3.40282346638528860e+38
  - `double` - double-precision 64-bit IEEE 754 floating point
    - 4.94065645841246544e-324d to 1.79769313486231570e+308d

Where'd unsigned go?

Removed for simplicity.

What's this C code print?

```
1  #include<stdio.h>
2
3  int oldEnough(unsigned int age) {
4    return (age >= 18);
5  }
6
7  int main() {
8    int age = -1;
9    if (oldEnough(age)) {
10     printf("Old enough!\n");
11   } else {
12     printf("Not old enough\n");
13   }
14 }
```

Default Primitive Types / Specifying

```
1  // int and double are default integer / real number primitives
2  /* int */ foo = 10;
3  /* double */ bar = 10.0;
4
5  // to specify long or float use 'L' and 'f' respectively
6  /* long */ fool = 10L;
7  /* float */ barf = 10.0f;
8
9  // can also explicitly initialize with 'd' (or 'D')
10 // useful to force as a real number instead of integer
11 /* double */ food = 10d;
12
13 // nothing analogous for byte / short
14 /* short */ foos = (short) 10;
15 /* byte */ barb = (byte) 10;
```

Fun with Primitives

```
1  double nan = Double.NaN;
2  if (nan == Double.NaN) {
3      System.out.println("What I thought!");
4  } else {
5      System.out.println("WAT?!?");
6  }
```

Fun with Primitives (cont)

```
1  int truthy = 1;
2  if (truthy) {
3      System.out.println("truthy");
4  } else {
5      System.out.println("falsy");
6  }
```

Variables

- Declaration
  - Define a variable with a name.
  - Multiple on a single line
- Initialization
  - Can be inline with declaration
  - Can be after declaration
  - Cannot reference a variable until initialized
- Naming
  - camelCase
  - only ‘static final’ use UPPER_SNAKE_CASE
  - Be descriptive with naming (don’t use aBox as a name)

Fun with Variables

```
1  int foo, bar = 1;
2  if (System.currentTimeMillis() > 0L) {
3      foo = bar;
4  }
5  if (true) {
6      System.out.printf("%d%n", foo);
7  }
```

Fun with Variables (cont)

```
1  int bar = 1, foo = bar;
2  if (System.currentTimeMillis() > 0L) {
3      foo = bar;
4  }
5  if (true) {
6      System.out.printf("%d%n", foo);
7  }
```

Descriptive Variable Names

```
1  private static final double KILOMETER_TO_MILE = 0.621371d;
2
3  private static double convertKilometerToMile(double kilometers) {
4      double miles = kilometers * KILOMETER_TO_MILE;
5      return miles;
6  }
```

Descriptive Variable Names (cont)

DO NOT DO - COUNTEREXAMPLE

```
1  public static final double radius = 6378.137d;
2
3  public double compute(double[] a, double[] b) {
4      double diff1 = b[0] - a[0];
5      double diff2 = b[1] - a[1];
6
7      double tmp1 = Math.sin(diff1 / 2);
8      double tmp2 = Math.sin(diff2 / 2);
9      double aa = (tmp1 * tmp1) + (tmp2 * tmp2 * Math.cos(a[0]) * Math.cos(b[1]));
10     double c = 2 * Math.atan2(Math.sqrt(aa), Math.sqrt(1 - aa));
11     return (radius * c);
12 }
```

Descriptive Variable Names (cont)

```java
public static final double EARTH_RADIUS_KM = 6378.137d;

/**
 * Use the Haversine (i.e., as crow flies) formula to calculate distance between two points.
 *
 * @param fromLat from-point's latitude in radians
 * @param fromLng from-point's longitude in radians
 * @param toLat to-point's latitude in radians
 * @param toLng to-point's longitude in radians
 * @return the Haversine distance between from and to points in kilometers.
 */
public double haversineDistance(double fromLat, double fromLng, double toLat, double toLng) {
    double deltaLat = toLat - fromLat;
    double deltaLng = toLng - fromLng;

    double deltaLatSin = Math.sin(deltaLat / 2);
    double deltaLngSin = Math.sin(deltaLng / 2);

    double squareHalfChordLength = (deltaLatSin * deltaLatSin) +
                                   (deltaLngSin * deltaLngSin * Math.cos(fromLat) * Math.cos(toLat));
    double angularDistance = 2 * Math.atan2(Math.sqrt(squareHalfChordLength),
                                            Math.sqrt(1 - squareHalfChordLength));
    return (EARTH_RADIUS_KM * angularDistance);
}
```

Operators

```
1  int foo = 10, bar = 2;
2
3  // PLUS
4  int result = foo + bar; // result = 12
5  // MINUS
6  result = foo - bar; // result = 8
7  // MULTIPLICATION
8  result = foo * bar; // result = 20
9  // DIVISION
10 result = foo / bar; // result = 5
11 // MODULOS
12 result = foo % bar; // result = 0
13
14 // CAVEAT on divide by 0
15 double food = 10d, bard = 0d;
16 bar = 0;
17 double resultd = food / bard; // result = NaN/Infinity
18 result = foo / bar; // Exception -> "java.lang.ArithmeticException: / by zero"
```

The rarest of keywords...`strictfp`

```
1   private static double getX(double a, double b, double c) {
2       return a * b / c;
3   }
4
5   private static strictfp double getY(double a, double b, double c) {
6       return a * b / c;
7   }
8
9   double a = 1.11d, b = 2.22d, c = 3.33d;
10
11  // what's the difference between x and y?
12  double x = getX(a, b, c);
13  double y = getY(a, b, c);
```

Increment / Decrement Operators

- Postfix increment / decrement operator
  - a++; a--;
- Prefix increment / decrement operator
  - ++a; --a;

```
1  int a = 0, b = 0;
2  boolean equals = (a++ == ++b);
3  System.out.printf("%d and %d are equals? %s%n", a, b, equals);
```

Relational Operators

```java
int a = 0, b = 1;

// equality
boolean equals = a == a;
// inverse equality - a not-equals b?
boolean notEquals = a != b;
// less than
boolean lessThan = a < b;
// greater than
boolean greaterThan = b > a;
// less than or equals
boolean lessThanOrEquals = a <= a;
// greater than or equals
boolean greaterThanOrEquals = b >= b;
// conditionals - and
boolean and = (a == a) && (a < b);
// conditionals - or
boolean or = (b < a) || (b > a);
```

Short Circuit

```
1  private boolean evaluateViaLookup(int id1, int id2) {
2    int id1Result = loadFromDB(id1);
3    int id2Result = loadFromDB(id2);
4    return (id1Result > id2Result);
5  }
6
7  int id1 = 1, id2 = 1;
8
9  // method `evaluateViaLookup` never called - saved a DB lookup
10 boolean equals = (id1 == id2) || evaluateViaLookup(id1, id2);
```

Ternary

```
1  private int maximum(int a, int b) {
2      if (a > b) {
3          return a;
4      } else {
5          return b;
6      }
7  }
```

Bitwise Operators

```
1  int foo = 1, bar = 2, foobar = 3;
2  // bitwise 'and'
3  int result = foo & bar; // result = 0
4  // bitwise 'or'
5  result = foo | bar; // result = 3
6  // bitwise 'exclusive or'
7  result = bar ^ foobar; // result = 1
8  // bitwise 'not'
9  result = ~foo; // result = -2
```

Bitwise Shift Operators

```
1   int a = 1, b = 2, c = -2;
2   // bit shift to the right (arithmetic)
3   int result = b >> 1; // result = 1
4   // bit shift to the right (arithmetic)
5   result = c >> 1; // result = -1
6   // bit shift to the left
7   result = a << 1; // result = 2
8
9   // logical right shift (there is no logical left shift)
10  result = b >>> 1; // result = 1
11  result = c >>> 1; // result = 2147483647;
```

Conversions

- Memorize diagram on page **59** of **Core Java Vol 1**

```
1  12 + 14.1; // 12 is converted to double
2  10f - 17; // 17 is converted to float
3  50L + 10; // 10 is converted to long
4
5  short foo = (short) 10;
6  10 + foo; // foo is converted to int
```

Casts

- May be necessary to explicitly cast to other types
  - Have already seen in needing to get to short type
- Careful as down-casting results in loss of precision

```
1  // downcast from double to short
2  double foo = 99999.99999d;
3  short bar = (short) foo;
4  // what is bar?
```

Order of Operations

- Memorize diagram on page **64** of **Core Java Vol 1**

```
1  int a = -1, b = -1, c = 3;
2  c += b *= a;
3  // what's c?
```

Strings!

- First, not primitives!
  - They're Objects (next lecture)
- Any Unicode character, surround in quotation marks
  - "This is a string in Java"
  - Escape Unicode - "This is the snowman character \u2603"
- Unlike other objects they're literals do not need 'new' and they have an overloaded '+' operator

```
1  String brianLangel = "Brian Langel";
2  String snowman = "\u2603";
3  // can concatenation with '+' however prefer `String.format`
4  String brianLangelAndSnowman = brianLangel + snowman;
5  // concatenation via String.format
6  String combined = String.format("%s %s", brianLangel, snowman);
```

String.format

- Similar to C style `printf`

```
1  String.format("%d int | %.f float | %.2f float", 10, 10.121212, 10.121212);
2  String.format("0x%x - hexidecimal!", 10);
3  String.format("%s %s %s concatenated", "this", "and", "that");
```

StringBuilder / StringBuffer

- Prefer `StringBuilder` as you should never be needing to build strings shared across threads.

```
1  int lineLimit = 10;
2  StringBuilder buffer = new StringBuilder();
3  for (int i = 0; i < characters.size(); i++) {
4      char character = characters;
5      buffer.append(character);
6      if ((i != 0) && ((i % lineLimit) == 0)) {
7          buffer.append('\n');
8      }
9  }
10 String text = buffer.toString();
```

Control Flow - Blocks

- Surrounded by braces {} they define a logical scope for variables.
- Methods, if statements, loops, try/catch are all examples of blocks.
- Can define arbitrary blocks yourself

```
1  private void blockOne() {
2      int value = 1;
3      if (true) { // block two
4          int scoped = 0;
5          value++;
6          scoped++;
7      }
8      for (int i = 0; i < 1; i++) { // block three
9          int scoped = 0;
10         value++;
11         scoped++;
12     }
13     try { // block four
14         int scoped = 0;
15         value++;
16         scoped++;
17         throw new RuntimeException();
18     } catch (Exception e) { // block five
19         int scoped = 0;
20         value++;
21         scoped++;
22     }
23     // custom block, block six
24     {
25         int scoped = 0;
26         value++;
27         scoped++;
28     }
29     System.out.printf("Scoped is not accessible, value = %d%n", value);
30 }
```

Control Flow - If Statements

- The `else` is optional
- Although allowed for single lined statements, ALWAYS surround with braces

```
1  int foo = 1, bar = 1;
2  if ((foo == bar) && (bar != 2)) {
3      System.out.printf("Foo & Bar not equal to 2%n");
4  }
5  if ((foo != bar) && (foo == 2)) {
6      System.out.printf("Bar not equal to 2%n");
7  } else {
8      System.out.printf("Bar may equal 2%n");
9  }
10 if ((foo == bar) && (foo == 2)) {
11     System.out.printf("Foo & Bar equal to 2%n");
12 } else if (foo == 2) {
13     System.out.printf("Bar not equal to 2%n");
14 } else {
15     System.out.printf("Bar may equal 2%n");
16 }
```

Control Flow - Loops

```
1  String[] array = new String[] { "foo", "bar" };
2  // for loop
3  for (int i = 0; i < array.length; i++) {
4      // do something
5  }
6  // while loop
7  int i = 0;
8  while (i < array.length) {
9      // do something
10     i++;
11 }
12 // do-while loop
13 i = 0;
14 do {
15     // do something
16 } while (i < array.length);
17 // for-each loop
18 for (String entry : array) {
19     // do something
20 }
```

Control Flow - Switch Statement

- Available for primitive types and `String` (as of Java 7)
- Careful not to “fall through”

```
1  String value = "foo";
2  switch (value) {
3      case "foo":
4      case "bar":
5          // do something
6          break;
7      default:
8          // do something
9  }
```

Arrays

- Zero based
- Protected at runtime with bounds checking
  - Will throw an ArrayIndexOutOfBounds exception
- Cannot use pointer arithmetic (as you can in C++) to increment
- Always initialize with array brackets associated with type

```
1  int[] array = new int[100];
2  // can also initialize with known values
3  int[] values = new int[] { 1, 2, 3, 4, 5 };
4  // has length member
5  int size = values.length; // equals 5
6  // access and assign with common syntax
7  int firstValue = values[0];
8  values[0] = firstValue + 1;
```

Multidimensional Arrays

```
1  // initialize with first dimension
2  int[][] multi = new int[100][];
3  // initialize second in loop
4  for (int i = 0; i < multi.length; i++) {
5      multi[0] = new int[100];
6  }
7  // can also inline initialize
8  multi = new int[][] { { 1, 2, 3 },
9                        { 4, 5, 6 } };
```

Arrays Object

- Contains helper methods
  - Use these methods whenever necessary
  - Popular ones are `fill` and `sort`

```
1  int a[] = new int[10];
2  Arrays.fill(a, 2);
3  Random random = new Random();
4  a[random.nextInt(10)] = random.nextInt();
5  Arrays.sort(a);
```

Read Chapter 4

All sections will be covered in next lecture

Homework 2

https://github.com/NYU-CS9053/Fall-2016/homework/week2