1 Our First Java Program

Below is our first Java program of the semester. Next to each line, write out what you think the code will do when run.

Comments are above the line they describe

```java
1/* Declare a variable of type String and assign it the value "no". In 
Java, all variables must be declared before they are used. */
2String disagree = "no";
3
4/* Declare a variable of type int and assign it the value 7. */
5int x = 7;
6
7/* Declare a variable of type Singer and initialize it using the Singer 
constructor with the argument "Queen" */
8Singer queen = new Singer("Queen");
9
10/* Checks if x is greater than 0; if so, subtract 1 from x, then call 
queen's sing method with argument "no", then go back to the beginning 
of the loop. queen object sings "no" 7 times. */
11while (x > 0) {
12    x -= 1;
13    queen.sing(disagree);
14}
15
16/* Declares a variable of type String array and initializes it to hold 
three Strings. */
17String[] phrases = {"Oh", "mamma mia", "let me go");
18
19/* Prints "Oh" to standard output */
20System.out.print(phrases[0]);
21
22/* Declares variable i and initialize to 0 and checks if it is less than 
3. If so, print "mamma mia", then add one to i, then go back to the 
beginning of the loop and re-check that i < 3. "mamma mia" is printed 
out 3 times. */
23for (int i = 0; i < 3; i += 1) {
24    System.out.print(" " + phrases[1]);
25}
26
27/* Prints "let me go" to standard output. */
28System.out.print(" " + phrases[2]);
```

2 Writing Your First Program

```java
/** fib(N) returns the Nth Fibonacci number, for N ≥ 0. 
* The Fibonacci sequence is 0, 1, 1, 2, 3, 5, 8, 13, 21, ... */
```
public static int fib(int N) {
    if (N <= 1) {
        return N;
    } else {
        return fib(N - 1) + fib(N - 2);
    }
}

We can also write this iteratively:

```java
/** fib(N) returns the Nth Fibonacci number, for N ≥ 0.
 * The Fibonacci sequence is 0, 1, 1, 2, 3, 5, 8, 13, 21, ...
 */
public static int fib(int N) {
    int f0 = 0;
    int f1 = 1;
    while (N > 0) {
        int temp = f1;
        f1 = f0 + f1;
        f0 = temp;
        N -= 1;
    }
    return f0
}
```

Extra for experts: Complete fib2 in 5 lines or less. Your answer must be efficient.

```java
public static int fib2(int n, int k, int f0, int f1) {
    if (n == k) {
        return f0;
    } else {
        return fib2(n, k + 1, f1, f0 + f1);
    }
}
```

To compute the Nth fibonacci number using fib2, call fib2(N, 0, 0, 1).

3 Mystery

```java
/** This is a function (a.k.a. method). It takes an array
 * of integers as an argument, and returns an integer. */
public static int mystery(int[] inputArray, int k) {
    int x = inputArray[k];
    int answer = k;
    int index = k + 1;
    while (index < inputArray.length) {
        if (inputArray[index] < x) {
            x = inputArray[index];
            answer = index;
        }
        index = index + 1;
    }
    return answer;
}
```

```java
/** Extra for experts. This is another function. It takes an
 * argument...
 */
```
array of integers and returns nothing at all. */

public static void mystery2(int[] inputArray) {
    int index = 0;
    while (index < inputArray.length) {
        int targetIndex = mystery(inputArray, index);
        int temp = inputArray[targetIndex];
        inputArray[targetIndex] = inputArray[index];
        inputArray[index] = temp;
        index = index + 1;
    }
}

• What does mystery return if inputArray is the array 3, 0, 4, 6, 3, and k is 2?
  It returns 4.

• Describe, in English, what mystery returns.
  It returns the index of the smallest element that occurs at or after index \( k \) in the array. If \( k \) is
greater than or equal to the length of the array or less than 0, an ArrayIndexOutOfBoundsException
will be thrown, though this exception is not something you’d know without running the pro-
gram.

  The variable \( x \) keeps track of the smallest element found so far and the variable answer
keeps track of the index of this element. The variable index keeps track of the current
position in the array. The while loop steps through the elements of the array starting from
index \( k + 1 \) and if the current element is less than \( x \), \( x \) and answer are updated.

• Extra for experts: What does mystery2 do if inputArray is the array 3, 0, 4, 6, 3?
Describe, in English, what mystery2 does to the array.

  If mystery2 is called on the array 3, 0, 4, 6, 3 then after the method runs, the array will
be 0, 3, 3, 4, 6. Given any array, the method mystery2 sorts the elements of the array in
increasing order.

  At the beginning of each iteration of the while loop, the first index elements of the array
are in sorted order. Then the method mystery is called to find the index of the smallest
element of the array occurring at or after index. The element at the index returned by
mystery is then swapped with the element at position index so that the first index + 1
elements of the array are in sorted order.