INTRODUCTION TO COMPUTER SCIENCE II - CS 112
Final Exam Review

In Lab23 you compared time taken to MergeSort 50k elements to time taken to BubbleSort 50k elements. We know BubbleSort is an $O(N^2)$ sort while MergeSort is an O(Nlog(N)) sort. BubbleSort took about 170x longer than MergeSort. $50000^2/(50000*\log2(50000))$ is 3000. Explain what might cause this discrepancy in a few sentences.

The big-O analysis gives a rough estimate of the complexity of an algorithm, not the exact details. In this case, bubbleSort does N^2 operations and mergeSort does $N\log_2(N)$ operations almost exactly. But the mergeSort operation is much more expensive than the bubbleSort operation: it is a full merge of two lists, with recursive function calls. The bubbleSort operation is just a compare and possibly a swap of two numbers.

Write a method that calculates Fibonacci numbers without using recursion

```
int fib(int N) {
        if (N < 2) { return 1; }
        int[] data = new int[N];
        data[0] = 1;
        data[1] = 1;
        for(int j = 2; j < N; j++) {
                data[j] = data[j-1] + data[j-2];
        }
        return data[N-1];
}
```

Write a method that adds a Node 'n' to the end of a LinkedList.

```
void addToEnd(Node n) {
        Node ptr = headOfList;
        if (ptr == null) { headOfList = n; }
        while (ptr.next != null) {
                ptr = ptr.next;
        }
        ptr.next = n;
}
```

Answer whether each of the following errors is a syntax error, run-time error, or logic error:

```
int value = 64.0; syntax
System.out.println("Can't wait for Wednesday!); syntax
int[] array = new int[10]; System.out.println("Last value is " +
array[10]); runtime
int[] array = new int[10]; System.out.println("First value is " +
array[1]); logic
```

Which of the following code snippets could cause a runtime, but *not* a compile time error? More than one might be correct. Assume the necessary import statements are present.

a) `Scanner scan = new Scanner(System.in); int num = scan.nextLine();` syntax, not this one

b) `int num = Integer.parseInt(args[0]);` runtime

c) `String[] arr = new String[4];` legal code, not this one

d) `int[] arr = new int[2]; arr[2] = 100;` runtime

e) `ArrayList<string> ls = new ArrayList<string>();` syntax, not this one

Write a class for a `Circle`. A `Circle` is described only by a `radius`, which should be a `double`. The constructor should allow a user to create a `Circle` of any desired size. The `Circle` class should only have two methods besides the constructor: `perimeter()`, which should return the value of the perimeter; and `area()`, which should return the value of the area. (Recall that the formula for perimeter is 2*p*r, the formula for area is p*(r*r), and the approximate value of p is 3.14.) Throw an exception if the given radius is < 0.

```
class Circle {
        private double radius;
        Circle(double r ) throws Exception {
                if (r < 0) { throw new Exception("negative radius not allowed"); }
                radius = r;
        }
        double perimeter() { return 2*3.14*radius; }
        double area() { return 3.14*radius*radius; }
}
```

Use the modulus operator '%' to complete the following method:

```
// Input is a number of seconds.  Print a number of hours, minutes, and seconds
void PrintTime(int time) {
        int hours = time/3600;
        int minutes = (time/60) % 60;
        int seconds = time % 60;
        System.out.println(hours + ":" + minutes + ":" + seconds);
```

What is printed by the following code?

`String blastOff = "Three, two, one, go!";`
`System.out.println(blastOff.length());` 20

1. If a method does not have a return statement, then
    a. it will produce a syntax error when compiled
    b. it must be a void method
    c. it cannot be called from outside the class that defined the method
    d. it must be defined to be a public method
    e. it must be an int, double, float, or String method

6. Which is the correct syntax to declare a Scanner object?

```
a. Scanner objectName = Scanner();
b. Scanner objectName = new Scanner();
c. Scanner objectName = Scanner(System.in);
d. Scanner objectName = new Scanner(System.in);
```

Problems #1 and #2 use the following code:

```
class Animal { }
class Cat extends Animal { }
```

1. The following code is legal: `Cat tom = new Animal();` false

2. The following code is legal: `Animal garfield = new Cat();` true

3. To determine the type that a polymorphic variable refers to, the decision is made
    a) by the programmer at the time the program is written
    b) by the compiler at compile time
    c) by the operating system when the program is loaded into memory
    d) by the Java run-time environment at run time
    e) by the object this answer is ok also

True or False (1 point each)

The following statement will display the value 127.

```
System.out.println("123" + 4);
```

ANS: _____ F

A method defined in a class can access the class's instance variables without needing to pass them into the method as parameters or declare them as local variables.

ANS: _____ T

While multiple objects of the same class type can exist, in a given program there can only be one version of each class.
ANS: _____ T

Multiple Choice (1 point each)

What is the value of `total` if the value of `count` is 15 before the following statement is executed:

```
total = count++;
```

a) 16
b) 17
c) 18
d) 14
e) 15

What is the value of z after the following assignment statement is executed?

```
float z = 5/10;
```

a) 0.0
b) 0.5
c) 5.0
d) 0.05
e) None of these; a run-time error will occur because z is a float and 5/10 is an int.

Short answer (2 points each)

What is the difference between "volatile memory" and "nonvolatile memory" in your computer?

volatile memory loses its values when the computer loses power. Nonvolatile memory does not

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What is the value of myVar?

```
int myVar =  1 + 5 / 3;
```

2_____

What is the value of the variable `c` ?

```
int a = 1;
int b = a++;
int c = a++ + b++;
```

3

What type of error is in the following code? How could you fix this error in the creation of nearPi?

```
final double PI = 3.14159265;
int nearPi = PI;
```

syntax error. Use a cast or change type of nearPi

Given `class DoMath`, what gets printed when the constructor is called? Is there an error?

```
class DoMath {
	void mathFunc(int a, int b) { System.out.println("int, int"); }
	void mathFunc(double c, double d) {
		System.out.println("double, double");
	}
	DoMath() {
		mathFunc(1.1, 2*3);
	}
}
```

double, double

No error

How would you create an object named `myObject` of type `DoMath`, from the previous question?

DoMath myObject = new DoMath();

What is the type of each of the following constants?

`'4'` char

`4.0` double

`4` int

`"4"` String

What gets printed when the constructor is called? Is there an error?

```
class StringQuestion {
      StringQuestion () {
            String a = "I am";
            String b = "I am string b";
            a += " string b";
            System.out.println(a == b);
      }
}
```

false. No error

What is the value of x?

```
int a = 9;
int b = 12;
double x = (double) a / b;
```

0.75

What gets printed when the constructor is called? Is there an error?

```
class PBJ {
      void change(String var) {
            var += " and jelly";
      }
      PBJ() {
            String s = "peanut butter";
            change(s);
            System.out.println(s);
      }
}
```

peanut butter

If the following program is compiled, and then run with the command lines given below, what is printed in each case? Is there an error? What type?

```
class MyFeelings {
      static public void main(String[] args) {
            System.out.println(args[2].charAt(3));
      }
}
```

- java MyFeelings I cannot wait until this test is over

  t_____

- java MyFeelings I think I can finish in time

  runtime error_____

- java MyFeelings "I think I can finish in time"

  runtime error_____

You have a job writing software for the campus library. Your first task is to design a Java class to represent a library book. Please list three member variables you might put in your class, and three methods you might include. Just give good names for the methods, do not implement them.

String title, void SetTitle(String);
boolean isCheckedOut, void checkoutBook();
int lengthInPages, int getLength();

What is printed by the following code?

```
int index = 0;
int max = 10;
while (index < max) {
      System.out.print(index);
      max -= 2;
}
System.out.println();
```

00000

List 4 different sort methods and say whether each is $O(N^2)$ or O(NlogN)

bubble O(N2), insertion O(N2), selection O(N2), merge O(NlogN), quick O(NlogN), heap O(NlogN)

List two key characteristics of OOP, as distinguished from Procedural Programming.

encapsulation: protection of variables and methods from improper use
inheritance: reuse of base classes to create new more-specialized classes
polymorphism: use of a variety of different child classes thru a polymorphic reference variable

What are the two basic Java graphics classes used in almost every graphics program? What is the role of each?
JFrame – manages an entire scene of visual objects, but not visible itself
JPanel – a basic object visible on a graphics screen

List two types of events that may be handled in a Java graphics program
ActionEvents, MouseEvents, KeyboardEvents, WindowEvents, ??

Coding (10 points each)

Write the code for a constructor that prints out the cubes of the integers, starting with 1 and increasing. Your code should stop before it prints any number >= 2000.

```
class Cubes {
      Cubes() {
            int x = 1;
            while (x*x*x < 2000) {
                  System.out.println(x*x*x);
                  x ++;
            }
      }
}
```

Write code for the main() method that reads a string with one word from the command line and prints it out with alternating lowercase and uppercase, e.g.
`wAsHiNgToN`

```
class FunnyCaps {
     static public void main(String[] args) {
          if (args.length < 1) {
               throw new Exception("need an arg");
          }
          String inp = args[0];
          for(int n = 0; n < inp.length; n++) {
               char c = inp.charAt(n);
               char c = Character.toLowerCase(c);
               if (n % 2) { // index is odd number
                    c = Character.toUpperCase(c);
               }
               System.out.print(c);
          }
          System.out.println();
     }
}
```

The following `class Node` is used to build a binary tree:

```
class Node {
     String value;
     Node left, right;
}
```

Write a method to check a tree to see if the `String name` is contained in it.

```
Boolean foundString(Node top, String s) {
     if (top == null) { return false; }
     if (top.value.equals(s)) { return true; }
     if (foundString(top.left, s)) { return true; }
     return foundString(top.right, s);
}
```

The following `class Node` is used to build a non-binary tree:

```
class Node {
     int value;
     ArrayList<Node> children;
}
```

Write a method to return the sum of all values in the tree.

```
int sum(Node n) {
	if (n == null) { return 0; }
	int total = n.value;
	for(Node child : n.children) { // for-each loop over all n's children
		total += sum(child);
	}
	return total;
}
```

Write a base class and 2 child classes. Show an example of polymorphism with suitable member functions in your classes.

```
abstract class FlyingThing {
	abstract String sound();
}
class Plane extends FlyingThing {
	String sound() { return "vroom!"; }
}
class Bird extends FlyingThing {
	String sound() { return "cheep cheep cheep"; }
}
```

Write a checker for a sort method that takes as input an array of doubles and that raises an Exception if the input is not sorted.

```
void checker(double[] data) throws Exception {
	for(int m = 1; m < data.length; m++) {
		if (data[m] < data[m-1]) {
			throw new Exception("data not sorted properly");
		}
	}
}
```