CISC 7024X

Sample Final Exam

Question 1

Does each of the following programs compile and run? If no, explain the reason. If yes, give the output.

1.
```
public class P1 {
    public static void main(String[] args) {
        f(6);
    }

    public static void f(int length) {
        while (length > 1) {
            f(length - 1);
            System.out.print((length - 1) + " ");
        }
    }
}
```

2.
```
class P2 {
    public static void main(String[] args) {
        for (int i = 0; i < 2; i++) {
            System.out.print(i + " ");
            try {
                System.out.println(1.0 / 0);
            }
            catch (Exception ex) {
              System.out.println("divided by zero");
            }
        }
    }
}
```

3.
```java
import java.util.*;
class P3 {
    ArrayList<Integer> lst = new ArrayList<Integer>();

    public void add(Integer obj){
        if (!lst.contains(obj))
            lst.add(obj);
    }

    public static void main(String[] args){
        P3 d = new P3();
        d.add(1); d.add(2); d.add(1); d.add(2); d.add(3);
        System.out.println(d.lst);
    }
}
```

4.
```java
public class P4 {
    public static Object max(Object o1, Object o2) {
        if (((Comparable)o1).compareTo(o2) >= 0) {
            return o1;
        } else {
            return o2;
        }
    }
    public static void main(String[] args){
        System.out.println(max(1,2));
    }
}
```

5.
```
class A {
    public A(){
        System.out.println("A’ constructor");
    }

    public void m(){
        System.out.println("A’s m");
    }
}

public class P5 extends A {
    public P5(){
        System.out.println("P5’s constructor");
    }
    public void m(){
        System.out.println("P5’s m");
    }

    public static void main(String[] args){
        A o = new P5();
        o.m();
    }
}
```

Question 2

1. Design a class named `Candidate` for holding a candidate in an election. Assume that only two attributes of a candidate, namely, the name and the number of votes, are of interest here. The class contains a constructor that initializes the member variables to the given values, and a get method for each of the member variables. The class implements the `Comparable` interface, and compares two candidates based on their numbers of votes.

2. Designing a class named `VotingMachine` that contains a collection of candidates and the following methods:

   - `addCandidate(String name)`: Add a candidate of a given name to the collection of candidates. This method throws an exception if a candidate of the given name already exists in the collection.
   - `castVote(String name)`: Cast a vote to the candidate of the given the name. This method throws an exception if there is no candidate of the name in the collection.

Question 3

Implement a class named `MyArrayList` that extends the `java.util.ArrayList`. The class `MyArrayList` overrides the `toString` method in the following way: it returns a string representation of the elements in the collection in the format $(a_0, a_1, \ldots, a_{n-1})$, where a_i (i=0,..,n-1) is the string representation of the element at index i.

Question 4

Consider the BTNode class:

```
class BTNode<T> {
    T data;
    BTNode<T> left, right;

    public BTNode(T data){
        this.data = data;
        left = null;
        right = null;
    }

    public BTNode(T data, BTNode<T> left, BTNode<T> right){
        this.data = data;
        this.left = left;
        this.right = right;
    }
}
```

Write each of the following functions on a binary tree with a given root of the type BTNode.

1. `leaves(tree)`: This function returns a list of leave values in `tree` from left to right.

2. `deepest(tree)`: This function returns the values in a deepest node in `tree`. If there are multiple such values, then the functions returns the left-most one.

3. `min_max(tree)`: This function returns a pair `(min, max)`, where `min` is the minimum element, and `max` is the maximum element in `tree`. Note that the tree may not be a binary search tree.

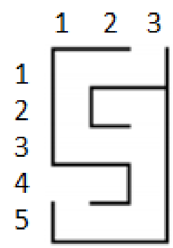
Question 5

The following function `f` takes exponential time to compute. Re-write the function using top-down dynamic programming (memoization) to improve the efficiency. Assume that the initial call is `count(0,0,n)` for some positive integer `n`. What is the running time of your program?

```
long count(long r, long c, long n) {
  if (r == n) return 1;
  if (c == n) return 1;
  return count(r+1,c,n) + count(r,c+1,n);
}
```

Question 6

The function `solve_maze(Maze,R0,C0,R,C)` takes a maze, the position of a starting square (R0,C0), and the position of a target square (R,C), and returns a path from the starting square to the target square. The maze is given as a matrix, where each entry is a four-bit binary integer `(B3,B2,B1,B0)` that indicates how the corresponding square is connected to its neighboring squares: `B0` is 1 if the square is connected to the left; `B1` indicates if the square is connected to the right; `B2` indicates if the square is connected to the above; `B3` indicates if the square is connected to the below. For example, in the following maze, the square at (1,1) is represented by the binary number 1010 (i.e., the decimal number 10), meaning that the square is connected to the right and the blow.



A path is a list of visited square positions. Implement the function `solve_maze` in C++ or Java.