Maynooth University
National University of Ireland Maynooth

OLLSCOIL NA hÉIREANN MÁ NUAD

THE NATIONAL UNIVERSITY OF IRELAND MAYNOOTH

AUTUMN 2018 EXAMINATION

CS210

Algorithms & Data Structures 1

Dr. S. Flynn, Prof. A. Winstanley, Dr. P. Maguire

Time allowed: 2 hours

Answer all ***four*** questions

All questions carry equal marks

[20 marks]

1 Write a Java program given the following specification and provide comments which explain how your algorithm works.

Problem Statement
The goal is to read in a list of students and their exam scores into an array, sort the class by their exam scores, and output the name of the student with a particular ranking.

Input Format
The first line contains *n*, the number of students. The second line contains *r*, the ranking to output. This is followed by *n* pairs of student names and exam scores, each on a separate line.

Output Format
The name of the student who came in *r*th rank in the class.

Constraints
$0 \leq n \leq 100$

Sample Input
5
2
Eoin
18
Cathy
94
David
34
Dara
69
John
25

Sample Output
Dara

[20 marks]

2 Write a Java program given the following specification and provide comments which explain how your algorithm works.

Problem Statement
If you flip a single coin, you have a 50% chance of getting a single tail. If you flip two coins, you now have a 75% of seeing at least 1 tail. What is the chance you will see at least *T* tails after *N* coin tosses? Use a Monte Carlo simulation and round to the

nearest percent.

Input Format
The first line is an integer *N*, the number of coin tosses. The second line in is an integer *T*, the target number of tails.

Output Format
An integer from 0 to 100 representing the percentage probability that at least *T* tails will be observed given *N* tosses of a fair coin.

Constraints
$0 \leq N \leq 1000$
$0 \leq T \leq 1000$

Sample Input
4
1

Sample Output
94

(if you flip 4 coins, the probability of seeing at least 1 tail is 93.75%)

[20 marks]

3 Write a Java program given the following specification and provide comments which explain how your algorithm works.

Problem Statement
Manipulate a stack according to the given push and pop commands and then output the number that is at the top of the stack. If a pop command is issued for an empty stack then nothing should happen.

Input Format
The first line is a number *N*, which indicates the number of commands to follow. This is followed by *N* lines, each of which consists of the word PUSH or POP. The word PUSH will be followed by an integer *n*.

Output Format
Output the integer that is at the top of the stack following the given commands. If the stack is empty then output "empty".

Constraints
$1 \leq N \leq 10$
$-10000 \leq n \leq 10000$

Sample Input
5
PUSH 4
PUSH 8
POP
POP
PUSH 2

Sample Output
2

[20 marks]

4 a) Identify the output that the following Java code produces and explain your reasoning clearly. [7 marks]

```
public class Recursion{

    public static void main(String[] args){
        System.out.println(compute(100));
    }

    public static int compute(int number){
        if(number<20){
            return number%7;
        }
        System.out.println("Running...");
        return (compute((number*2)%53)+17);
    }
}
```

b) Identify the output that the following Java code produces and explain your reasoning clearly. [7 marks]

```
public class BitManipulation{

    public static void main(String[] args){
        System.out.println((((4|17)|2))>>1);
    }
}
```

c) Show how the following numbers would be sorted by mergesort. State the **Big O complexity** of mergesort and explain why it is more efficient than bubble sort. [6 marks]

33 63 90 68 21 96 38 27