



**Maynooth
University**
National University
of Ireland Maynooth

OLLSCOIL NA hÉIREANN MÁ NUAD
THE NATIONAL UNIVERSITY OF IRELAND
MAYNOOTH

JANUARY 2019 EXAMINATION

CS210

Algorithms & Data Structures 1

Dr. M. Huggard, Dr. J. Timoney, Dr. P. Maguire

Time allowed: 2 hours

Answer ALL four questions

All questions carry equal marks

1

Problem Statement

[25 marks]

[25 marks]

Write a Java program that reads in a list of numbers, and sorts them according to the number of steps they follow in the Collatz sequence before reaching 1 (most steps comes first). A Collatz sequence starts with a given number and follows the operation below until reaching 1:

- If the number is even, divide it by two.
- If the number is odd, triple it and add one.

State the **Big-O complexity** of the algorithm you have written, and explain what this means in your own words.

Sample Input

6
2
8
13
15

Sample Output

15
13
6
8
2

Explanation

15 ...(takes 17 steps to reach 1)
13 ...(takes 9 steps to reach 1)
6 ...(takes 8 steps to reach 1)
8 ...(takes 3 steps to reach 1)
2 ...(takes 1 step to reach 1)

2

Problem Statement

[25 marks]

[25 marks]

Four horses are running a race, with the following probabilities of winning the race:

Horse A: 53%
Horse B: 26%
Horse C: 14%
Horse D: 7%

Write a Monte Carlo simulation which estimates the probability that Horse B will finish third.

[25 marks]
[25 marks]

3 Problem Statement

Manipulate a queue according to the given insert and remove commands and then output the number that is at the front of the queue. If a remove command is issued for an empty queue then nothing should happen. In your answer you should provide the full queue class.

Input Format

A series of lines involving either INSERT or REMOVE commands. The command INSERT is followed by a space and then a number to insert (e.g. INSERT 56).

Output Format

Output the number that is at the front of the queue following the given commands. If the queue is empty then output 0.

Sample Input

INSERT 56
INSERT 33
REMOVE
INSERT 83
REMOVE

Sample Output

83

[25 marks]
[6 marks]

- 4 (a)** Identify the output that the following Java code produces and explain your reasoning clearly.

```
public class Recursion{

    public static void main(String[] args){
        System.out.println(function("Launch"));
    }

    public static String function(String input){
        System.out.println("Evaluating");
        if(input.length()%7==0){
            return "Exit";
        }
        return(function(input+"Return")+"Terminated");
    }
}
```

- (b) Identify the output that the following Java code produces and explain your reasoning clearly. [6 marks]

```
public class BitManipulation{  
  
    public static void main(String[] args){  
        System.out.println((((11&19)|5))<<3);  
    }  
}
```

- (c) Describe in your own words the concept of a linked list, using examples and diagram as appropriate. Explain how you would design an algorithm to delete every third link in a singly linked list. Show the operations that would be required. [8 marks]
- (d) An increasing number of technology companies are investigating the development of blockchain technologies. Explain in your own words what blockchain is, and discuss the novel applications it might support in the future [5 marks]