Maynooth University
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OLLSCOIL NA hÉIREANN MÁ NUAD

THE NATIONAL UNIVERSITY OF IRELAND MAYNOOTH

AUTUMN 2019 EXAMINATION

CS210

Algorithms & Data Structures 1

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Time allowed: 2 hours

Answer ALL four questions

All questions carry equal marks

[25 marks]

1 (a) **Problem Statement** [25 marks]

The goal is to read in a number and output the distance to the nearest prime, either before it or after it. If the number itself happens to be prime, then output 0.

Sample Input
10

Sample Output
1

[25 marks]

2 (a) **Problem Statement** [25 marks]

The goal is to read in a list of integers into an array and output the one which is the median, that is, the one which if you put them all in order would be in the middle. If there are two in the middle then take the average of those two. For example the median of 4, 8, 2, 3 and 5 is 4, because if you put them all in order 4 would be the middle value. The median of 2, 7, 4, and 9 is 5.5 because 5.5 is the average of 4 and 7.
State the **Big O complexity** of your algorithm, and explain your reasoning clearly.

Sample Input
7
15 18 3 2 -5 6 2

Sample Output
3.0

[25 marks]

3 (a) **Problem Statement** [25 marks]

You are given a set of instructions to get from a home location to a destination location. You have to give the instructions which begin at the destination location and return to the home location. In other words, you need to reverse the directions. The possible set of directions is "Go North", "Go South", "Go East" and "Go West". Another possible instruction is "Go Back" which means to undo the latest step. The instruction "Arrived" means the sequence of directions is complete.
The way to solve this problem is to push all the instructions onto the stack, pop when you get "Go Back", and then pop them all off at the end (flipping North <-> South and East <-> West) to have a reversed set of instructions to get you home.

You should provide a full stack class as part of your answer.

Sample Input
Go North
Go North
Go West
Go Back
Arrived

Sample Output
Go South
Go South

[25 marks]

4 (a) Identify the output that the following Java code produces and explain your reasoning clearly. [8 marks]

```
public class Recursion{

 public static void main(String[] args){
    System.out.println(function(83));
 }

 public static int function(int input){
     input++;
     if(input%13==2){
         return 8;
     }
     return (function(input+2)-3);
 }
}
```

(b) Identify the output that the following Java code produces and explain your reasoning clearly. [8 marks]

```
public class BitManipulation{

   public static void main(String[] args){
      System.out.println(((5|7|16|11)&167)>>1);
   }
}
```

(c) Show how the following numbers would be sorted by the following algorithms, and identify the Big O complexity of each [9 marks]

i) Mergesort
ii) Insertion sort
iii) Selection sort

69 24 10 72 96 22 18 38