Maynooth University
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OLLSCOIL NA hÉIREANN MÁ NUAD

THE NATIONAL UNIVERSITY OF IRELAND MAYNOOTH

JANUARY 2017 EXAMINATION

CS210

Algorithms & Data Structures 1

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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. Estimate the **Big O complexity** of your program and explain your reasoning clearly.

Problem Statement
The goal is to read in a list of integers into an array and output the one which is closest to the average. For example, the average of 4, 8, 2, 3 and 5 is 4.25, and 4 is the closest to this. If there are two values equally close then choose the one which was earliest in the list.

Input Format
The first line contains *N*, the number of inputs. The second line contains *N* integers separated by a space.

Output Format
A number that represents the value that is closest to the average.

Constraints
$1 \leq N \leq 1000$
$-1000 \leq A[i] \leq 1000$

Sample Input
5
36
73
26
85
83

Sample Output
73

[20 marks]

2 Write a Java program given the following specification and provide comments which explain how your algorithm works. Estimate the **Big O complexity** of your program and explain your reasoning clearly.

Problem Statement
The goal is to read in the quantity of numbers used in a lottery, the quantity of numbers removed in each draw, and output the probability that the numbers will be drawn in ascending order (e.g. 4, 18, 24, 25, 42).

Input Format
The first line contains *N*, the quantity of numbers used in the lottery (e.g. the EuroMillions lottery uses 50 numbers). The second line contains *D*, the quantity of numbers drawn in a lottery draw (e.g. 5 random numbers are drawn in each EuroMillions draw).

Output Format
An integer from 0 to 100 representing the percentage probability that the numbers will be drawn in ascending order.

Constraints
$0 \leq N \leq 1000$
$0 \leq D \leq 100$

Sample Input
100
2

Sample Output
50

[20 marks]

3 Write a Java program given the following specification and provide comments which explain how your algorithm works. Estimate the **Big O complexity** of your program and explain your reasoning clearly.

Problem Statement
The goal is to sort a list of words by the character in each word that comes earliest in the alphabet (e.g. all words containing an ‘a’, then all words containing a ‘b’ but no ‘a’, then all words containing a ‘c’ but no ‘a’ or ‘b’ etc.). To separate words with the same earliest character, defer to the second earliest character and then the third etc. (e.g. both ‘ant’ and ‘apple’ have an ‘a’, but ‘apple’ should come before ‘ant’ because its second earliest character is an ‘e’, whereas that of ‘ant’ is an ‘n’). If two words use all the same characters (e.g. ‘babble’ and ‘able’) then use alphabetical ordering to separate them.

Input Format
The first line contains *N* (number of words) followed by *N* lines. Each line contains a String.

Output Format
A line consisting of the words sorted in alphabetical order, each

separated by a space.

Constraints
1≤*N*≤100

Sample Input
4
one
two
three
four

Sample Output
three one four two

[20 marks]

4 Complete the Java method given the following specification and provide comments which explain how your algorithm works. Estimate the **Big O complexity** of your method and explain your reasoning clearly.

Problem Statement
A loop in a linked list occurs when following the linked list chain brings you back where you started. For example, link 1 points to link 2 which points to link 3 which points to link 1, to link 2, to link 3, to link 1...and you go round in an infinite loop. Each test case here involves a single-ended singly-linked list with a potential loop. Output the size of the loop, or 0 if there is no loop. In the above example, the loop is of size 3 (e.g. link 1, link 2, link 3...repeating forever).

Input Format
The linked list is created automatically by the stub code.

Output Format
Complete the findLoopLength() method below. Output an integer, either 0 if the linked list is empty or has no loop, or else >0 corresponding to the length of the loop in the linked list.

Constraints
0≤#(links)≤100

Stub Code
```
import java.util.*;

public class Solution {
    public static void main(String args[] ){
        Scanner myscanner = new Scanner(System.in);
```

```
        int num = Integer.parseInt(myscanner.nextLine());
        Link[] array = new Link[num];
        for(int i=0;i<num;i++){
            array[i]=new Link(myscanner.nextLine());
        }
        while(myscanner.hasNext()){
            int select=myscanner.nextInt();
            int next=myscanner.nextInt();
            if(next!=-1){
                array[select].next=array[next];
            }
        }
        LinkedList mylist = new LinkedList();
        if(num>0){
            mylist.first=array[0];
        }
        System.out.println(findLoopLength(mylist));
    }

    public static int findLoopLength(LinkedList mylist){
/*return 0 if empty or no loop, otherwise length of loop
in mylist*/
        return 0;
    }
}

class Link{
    public String data;
    public Link next;

    public Link(String input){
        data=input;
        next=null;
    }
}

class LinkedList {
    public Link first;

    public LinkedList( ){
            first=null;
    }

    public boolean isEmpty( ){
            return (first==null);
    }

    public void insertHead(Link insert){
        if(isEmpty()){
            first=insert;
        }else{
            insert.next=first;
            first=insert;
        }
    }
}
```