All-Ireland Programming Olympiads 2020

Preliminary Round

January 16, 2020

AIPO
All Ireland Programming Olympiad

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

1 OK boomer!

Time had come to write some nasty tweets! Spreading fake news about Brexit or commenting on intergenerational conflicts? Good stuff! Only problem is; you forgot to turn your caps lock on. Capitalizing letters is essential to express how much you are offended by it.

Write a program that takes a text as input, capitalizes all the letters and replaces the full stops (.) with three exclamation marks (!!!).

Input The first line will consist in a single integer N. The second is a single line of text of size N, $1 \leq s \leq 256$ composed of lowercases letters, full stops, spaces and numbers. The text does **NOT** contain any special character (@, *, %, etc).

Output The expected output is the input text with all letters dully capitalized and all full stops (.) with three exclamation marks (!!!).

Sample Input 1

```
60
my generation grew up reciting
this every morning in school.
```

Sample Output 1

```
MY GENERATION GREW UP RECITING
THIS EVERY MORNING IN SCHOOL!!!
```

Sample Input 2

```
16
i dont think so.
```

Sample Output 2

```
I DONT THINK SO!!!
```

2 Schedule

You are given a start and end time of a booking and need to determine, for N arrivals, which ones were early, on time or late, and which ones missed the booking. The rules are as follows:

- A person is early if they arrived at most an hour before the start time, or at exactly the start time itself.
- A person is on time if they arrive within the first 10 minutes of the booking.
- A person missed the booking if they arrived after it ended, or if they arrived earlier than an hour before than its start time.
- In all other cases the person is considered as being late.

Input The first two lines of the input contains two dates and 24-hour times of the format year-month-day hour:minute. These represent the start time and end time respectively. It is guaranteed that every booking is at least 11 minutes long. A booking can last multiple days or months.

The second line contains a single integer N $(1 \leq N \leq 100000)$ the number of arrival times to check.

The following N lines each contain a single date and time (year-month-day hour:minute) to be checked.

Output The output should consist of N lines containing one of either *On time*, *Early*, *Late* or *Missed*.

Sample Input 1

```
2020-1-10 11:05
2020-1-10 13:47
6
2020-1-10 11:04
2020-1-10 10:04
2020-1-10 11:15
2020-1-10 11:30
2020-1-10 13:50
2020-1-10 11:05
```

Sample output 1

```
Early
Missed
On time
Late
Missed
Early
```

Sample input 2

```
2020-11-30 23:59
2020-12-1 5:00
5
2020-12-1 0:00
2020-12-1 1:00
2020-11-30 23:30
2020-11-30 10:00
2020-11-30 22:00
```

Sample output 2

```
On time
Late
Early
Missed
Missed
```

3 Minimal Subsequence

We are given a sequence of N numbers (all ≥ 0) and we want to select a subsequence of K numbers from them, under certain conditions.
We want the sum of all the numbers to be minimal.
We want the difference between each of the K consecutive numbers to be ≤ 5

Input The first line will consist of two space separated integers N $(1 \leq N \leq 100000)$ and K $(1 \leq K \leq N)$
The next line will consist of N space separated integers.

Output The output will consist of a single integer, corresponding to the sum of the K integers. If no valid subsequence exists, you should output -1.

Sample Input 1

```
8 3
1 2 5 1 3 4 6 7
```

Sample Output

```
4
```

Sample Input 2

```
10 4
22 30 35 40 12 100 43 10 15 31
```

Sample Output

```
136
```

Explanation of Sample Input

Sample Input 1

There are numerous possible sub-lists of length K from the original list, e.g.
(1,3,1), (2,3,5), (5,7,4), (1,4,6), (5,6,2), (3,7,1), etc.

We can only consider those where the difference between consecutive numbers is ≤ 5, however, so (1,7,1), (1,7,3), etc. are not valid solutions.

Also, we cannot select any number from the list more times than it appears there. So while (1,1,2) is valid, (1,1,1) and (1,2,2) are not.

Of all the possible valid solutions, (1,1,2) has the minimal sum of 4.

4 Caoimhe's Queens

Caoimhe's favourite board game is chess. She came up with a puzzle involving her favourite chess piece, the queen, however she is having some difficulty solving it. Can you help her solve her own puzzle?

While a normal chess board has 8 rows and 8 columns, Caoimhe's chessboard can be much bigger. We are given an integer N, the number of rows and columns in Caoimhe's chessboard. Every square on the chessboard can be represented by a pair of numbers (R, C) where R is the row of the square and C is the column. The top-left corner square is at position $(1, 1)$ and the bottom-right corner square is at (N, N).

Caoimhe's chessboard contains Q queen pieces, each numbered from 1 to Q. We are given the positions (R, C) of each queen. We need to help Caoimhe list all pairs of queens which are able to attack each other in a single move. A queen's move consists of moving up, down, left, right or diagonally for any number of squares up until it hits another piece or it reaches the edge of the chessboard.

Input The first line contains two integers N $(1 \leq N \leq 10^9)$ denoting the size of Caoimhe's chessboard, and Q $(1 \leq Q \leq min(N^2, 3 * 10^5))$ denoting the number of queens.

The following Q lines each contains two integers R and C $(1 \leq R, C \leq N)$ the positions of each queen piece. Each queen is labelled with a number from 1 to Q. It is guaranteed every queen occupies a unique square of the chessboard.

Output The first line should contain a single integer P, the number of pairs of queens which can attack each other in a single move.

The following P lines should each contain two numbers, the labels of a pair of queens which can attack each other. The first element of the pair has to be smaller than the second. The pairs have to appear in increasing order of the first element. If two (or more) pairs have the same first element the pairs should appear in increasing order of the second one.

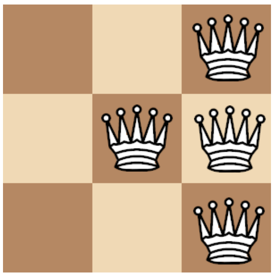
Sample Input 1

```
3 4
2 2
1 3
2 3
3 3
```

Sample Output 1

```
5
1 2
1 3
1 4
2 3
3 4
```

Diagram 1



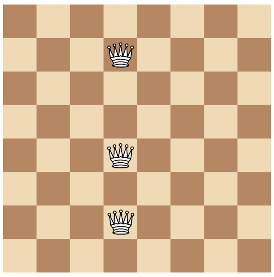
Sample Input 2

```
8 3
2 4
5 4
7 4
```

Sample Output 2

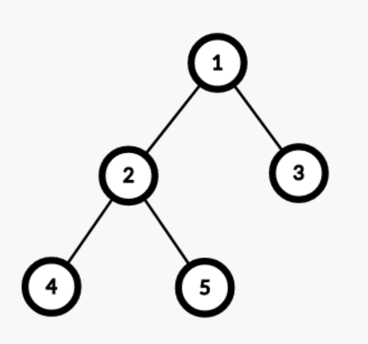
```
2
1 2
2 3
```

Diagram 2



5 Timber

In computer science, a tree consists of nodes and edges. Typically nodes are assigned labels and edges join two nodes together. In a tree, it is possible to reach every node from every other node. There are also no cycles in a tree, meaning there is a unique path between any two nodes. In a rooted tree, every node has a parent except for one node, called the root. The following figure is an example of a tree. In this example node 1 is the root.



The height of a rooted tree is the number of edges on the longest path from the root to any other node. Given a tree with nodes labelled from 1 to N, your task is to find its height.

Input

The first line contains a single integer N $(1 \leq N \leq 10^6)$, the number of nodes in the tree.

The next N lines will each contain a single integer. The i^{th} line $(1 \leq i \leq N)$ give the parent of node i. If node i is the root then -1 will be given.

Output

You should output a single integer, the height of the given tree.

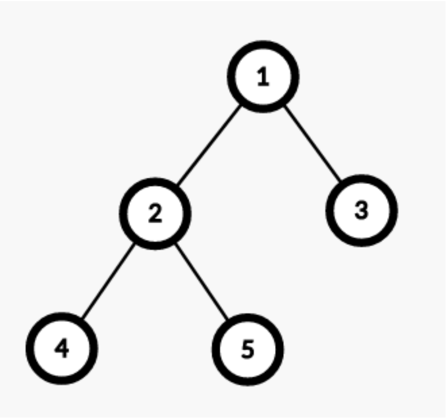
Sample Input 1

```
5
-1
1
1
2
2
```

Sample Output 1

```
2
```

Diagram 1



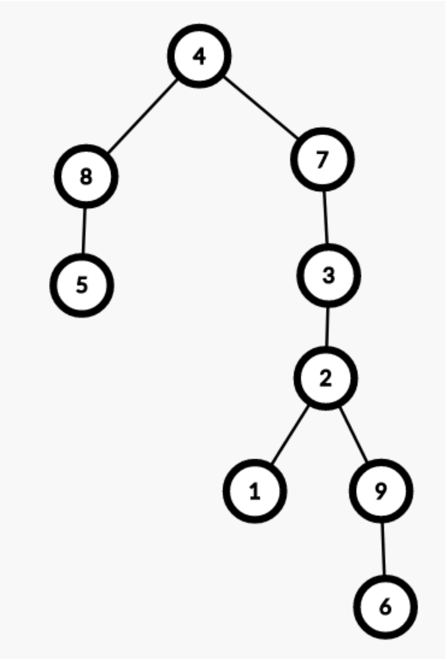
Sample Input 2

```
9
2
3
7
-1
8
9
4
4
2
```

Sample Output 2

```
5
```

Diagram 2



6 Rainbow patchwork

In Arrakis, a planet in Alpha Centauri, every morning a wonderful rainbow shines in the sky. This rainbow is particular, the same color can appear multiple times and with wider bands.

The rainbow is also the flag of the planet, and it changes every day. Leto, a local artist, has to prepare it every morning. To to so he can sew or glue together fabric stripes. Because of a very limited budget, Leto has to produce flags made out of the minimum number of stripes.

You need to help Leto to compute the minimum amount of stripes needed to prepare the flag.

For example, if the rainbow is composed by 3 bands of 2 alternated colors, Leto can prepare the flag with just 2 stripes. One larger and a different one shorter and glued in the center of the previous one.

Input The first line contains N the number of bands in the rainbow, $5 \leq N \leq 150$. In the second row there are N integer numbers $C_1, \ldots C_N$ each representing the color of that band. Multiple consecutive bands can have the same color.

Output The output must contains the minimum number of stripes to prepare the flag.

Sample Input 1

```
3
1 2 1
```

Sample Output 1

```
2
```

Sample Input 2

```
7
1 1 2 3 1 2 1
```

Sample Output 2

```
4
```