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informatik

Competitive Programming

Saarland University — Summer Semester 2020

Julian Baldus, Markus Bläser, Karl Bringmann, Marian Dietz, Simon Schwarz,
Christoph Weidenbach, Dominic Zimmer

Assignments Week 3

Deadline: **May 26, 2020 at 16:00 sharp**

Please submit solutions to the problems in our judge system, available at
`https://compro.mpi-inf.mpg.de/`.
You can find your credentials on your personal status page in our CMS.

Problem	`stonks`	`theanswer2`	`microbes`	`knights`
Points	3	3	3	3
Difficulty				
Time Limit	1s	5s	5s	1s
Memory Limit	2 GB	2 GB	2 GB	2 GB

Please note:

- *Later, we will reopen the judge for the problems of the last weeks. However, you won't get any points for submissions of these problems.*
- *In the judge you can switch between the exercises of different weeks in the top-right corner.*
- Your solution will be judged immediately after submitting. This may take some time, depending on the current server load.
- You can submit as many times as you want. However, don't abuse the server or try to extract the secret test cases.
- If your solution is **accepted**, you will receive the points specified in the table above.
- If you get **another verdict**, you will receive 0 points.

Stonks

Problem ID: stonks

Dieter Schlau accepted a job as a broker. He has frequently made profit from trading shares with other shareholders and used to own a great fortune. However, due to a recent speculation mishap, his bank account balance is currently at 0 and the bank will not lend him money anymore. He needs every Euro he can get.

Today, a shady person approached Dieter and made him an offer that he couldn't refuse: Dieter is given a collection of trades, where each trade i requires an investment of c_i Euros and pays out a_i Euros. Each trade first costs the investment money c_i and pays a_i back immediately after execution (e.g. before any other trade can be executed). Dieter can freely choose which trades to take, and in which order.

Dieter already suspects that the person will expect something in return, but decided to worry about that later. For now, he is just thinking about how to maximize his profit. Of course he will have to borrow money from someone to start trading.

What is minimal amount of initial money Dieter needs to borrow to get the maximal profit out of the trades? And how much profit can he make?

Input

The first line of input contains an integer n ($1 \leq n \leq 10^5$), the number of trades Dieter can perform.

Each of the following n lines contains two integers c_i and a_i ($0 \leq c_i, a_i \leq 10^{10}$). c_i is the investment neccessary to commit to the i-th trade and a_i is the payout resulting from it.

Output

Find a selection of trades that results in maximal profit.

Print two numbers: The amount of money Dieter needs to borrow before trading for maximal profits, and the maximal profit.

Keep in mind that maximizing the profit is most important! How much money Dieter has to borrow is secondary.

Explanation of Sample Input 1

There are three trades that Dieter can do: He can invest 3 Euro to get 5 Euros back, invest 1 Euro to get 2 Euros back and invest 4 Euros to get 2 Euros back. He will have a maximal profit of 3 if he does only the first two trades; the third trade is a loss. If he initially has 2 Euros, he can achieve a maximal profit by first executing the second trade and then the first trade.

Sample Input 1

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

Sample Output 1

```
2 3
```

Sample Input 2

```
3
2 1
5 5
12 2
```

Sample Output 2

```
0 0
```

Sample Input 3

```
4
5 10
3 7
10 7
1 3
```

Sample Output 3

```
1 11
```

How many answers to everything?

Problem ID: theanswer2

After finding out the definitive answer to everything, mankind decided that only knowing the solution is not enough. Instead, they figured out that knowing *how many solutions* the big question has would provide much deeper insights in how the universe works.

Therefore, one of the big questions now remaining is: If you have n integer numbers, how many subsets of them sum up to x? *Please note that x is not always* 42.

Input

The first line of input contains two integers n and x such that $1 \leq n \leq 40$, $0 \leq x \leq 10^9$.

The next line contains n integers between -10^9 and 10^9, separated by spaces.

Output

Print the number of subsets of the given integers that sum up to x.

Sample Input 1

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

Sample Output 1

```
4
```

Sample Input 2

```
40 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

Sample Output 2

```
1099511627776
```

Microbes

Problem ID: microbes

A team of microbiologists researches a new type of microbe. Umar takes care of a line of n petri dishes, each with a colony of the new microbe.

In order to categorize the behaviour of each colony, Umar assigns each colony a numeric behaviour id. Behaviours that are described by numbers ending in either a 1, 3, 5, 7 or 9 are categorized as "wild" colonies. All other colonies are considered "tame".

Umar observes the microbes carefully every day and notices changes in behaviour immediately. His research partner Quinton conducts behavioural studies on the colonies. Several times a day, he will call Umar and ask about the behaviour of the colonies in some of the petri dishes.

Input

The first line of input contains integers n and q such that $1 \leq n \leq 10^6$, $1 \leq q \leq 200\,000$.

The next line contains n integers b_i ($1 \leq b_i \leq 10^6$), separated by spaces. Each number b_i represents the behaviour id of the i-th colony.

The following q lines contain the observations and communication of Quinton and Umar in the following formats:

- `U i b`: Umar observes that the i-th colony changed its behaviour to b ($1 \leq b \leq 10^6$).
- `Q i j`: Quinton calls Umar and requests the number of wild colonies between the i-th and j-th (inclusive) petri dish ($1 \leq i \leq j \leq n$).

Output

For each of Quinton's calls, print a line containing the number of wild colonies reported by Umar.

Sample Input 1

```
10 5
11 4 7 6 3 3 1 2 6 4
Q 1 10
Q 7 10
U 9 1
Q 9 9
Q 1 10
```

Sample Output 1

```
5
1
1
6
```

Sample Input 2

```
9 10
38 80 96 19 74 78 60 60 16
U 2 10
U 5 87
U 6 15
Q 1 6
U 9 73
Q 2 9
U 2 100
U 6 31
Q 1 5
U 1 30
```

Sample Output 2

```
3
4
2
```

Knights of Ni

Problem ID: knights

Ni!
Ni! Ni! Ni! Ni! Ni!

Who are you?

We are the Knights Who Say 'Ni' and we demand a sacrifice.

Well, what is it you want? We want... a shrubbery![1]

On his path to the holy grail, King Arthur encountered the dreaded Knights who Say 'Ni'! Since his mission of finding the holy grail is of uttermost importance, he must pass the forest alive and give the sacrifice the Knights demand. The Knights of Ni demand Arthur to deliver exactly n shrubberies[2]. Furthermore, you should also place the brought shrubberies in the allotment garden of the Knights.

The allotment garden of the knights consists of $n \times n$ rectangular fields arranged in a chess-board like fashion. You can fit exactly one shrubbery in one field. The Knights demand that your placement of the shrubberies must satisfy the following rules:

- For each $i = 1, \ldots, n$, the i-th shrubbery can be put on any field in the rectangle specified by two pairs of coordinates: (a_i, b_i) (c_i, d_i) where (a_i, b_i) are coordinates of the square in the left upper corner of the rectangle (row, column), (c_i, d_i) are coordinates of the square in the right lower corner of the rectangle, $1 \leq a_i \leq c_i \leq n$ and $1 \leq n_i \leq d_i \leq n$. The field in the left upper square has coordinates $(1, 1)$, the square in the right lower corner has coordinates (n, n).
- No two shrubberies can be placed in the same row or column

If it is possible to satisfy the Knights of Ni, please print a valid combination as specified in the output section. If it is impossible to place the shrubberies so that all constraints are fulfilled, print `NI` in a single line.

Input

The first line of input contains an integer n ($1 \leq n \leq 10^5$), the number of shrubberies as well as the field size.

Each of the following n lines contain four integers a_i, b_i, c_i, d_i specifying the rectangle where the i-th shrubbery may be placed.

Output

If you can't place the shrubberies, your output should consist of the single word `NI`

Otherwise, there should be n lines containing two integers x_i and y_i each, where the i-th line describes the position where the i-th shrubbery can be put (in column x_i and row y_i). Keep in mind that (x_i, y_i) must lie within the rectangle specified for the i-th shrubbery: $a_i \leq x_i \leq c_i$ and $b_i \leq y_i \leq d_i$.

Sample Input 1	Sample Output 1
3 1 1 2 2 2 2 3 3 1 3 2 3	2 1 3 2 1 3

[1] https://www.youtube.com/watch?v=zIV4poUZAQo

[2] That look nice and that are not too expensive

Sample Input 2

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

Sample Output 2

```
NI
```

Sample Input 3

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

Sample Output 3

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