



Competitive Programming





Saarland University — Summer Semester 2022

Markus Bläser, Karl Bringmann, Martin Bromberger, Christoph Weidenbach
Julian Baldus, Yasmine Briefs, Simon Schwarz, Dominic Zimmer

Assignments Week 2

Deadline: **April 28, 2022 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	bordeaux	theanswercount	microbes	knights
Points	3	3	3	3
Difficulty				
Memory Limit	2 GB	2 GB	2 GB	2 GB

Please note:

- 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.

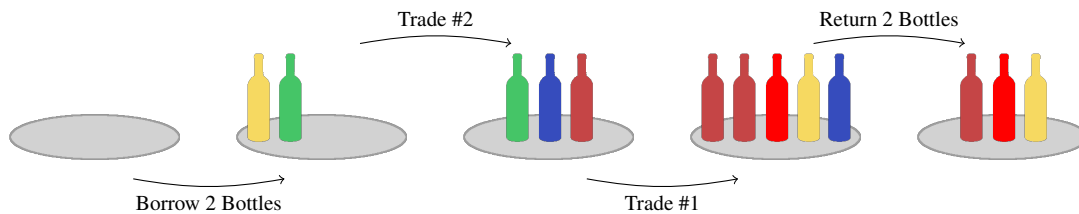
Bordeaux

Problem ID: bordeaux
Time limit: 3 seconds



Dieter's wine tasting was a disaster. That was – he thinks – because there simply wasn't enough wine. Next week, Dieter will be on vacation in France – in Bordeaux – with the same group of friends. On the last evening, there shall be a big wine party. To avoid another flop, he wants to organize as many bottles of wine as possible.

Unfortunately, as a poor student, buying wine is out of the question. Fortunately, a group of viticulturists from France listed exchange offers: Each vintner will take a set number of wine bottles from Dieter and give him a different number of bottles in return.¹ Dieter can use each of these offers at most once and freely choose which offers to take, and in which order.



Depiction of Sample 1: Dieter can gain a maximum of 3 bottles of wine by borrowing 2 bottles from his parents.

Dieter's goal is to maximize the number of bottles of wine he gets, but he probably needs a few bottles of wine to start trading. Fortunately, his parents have a large wine collection in their cellar, so he can borrow some bottles. Because his parents may get suspicious when he borrows too many bottles, he wants to borrow the least amount of wine possible.

What is the minimum number of bottles Dieter has to borrow in order to maximize the number of bottles they will have for their wine party? How many bottles will there be at the party after Dieter returned the borrowed bottles?

Input

The first line of input contains an integer n ($1 \leq n \leq 10^5$), the number of offers made to Dieter.

Each of the following n lines contains one offer. An offer consists of two integers d_i and v_i ($0 \leq d_i, v_i \leq 10^{10}$). They describe that the i -th viticulturist is offering Dieter v_i bottles in return for Dieter's d_i bottles.

Output

Find a selection of offers to take that maximizes the amount of wine for the party.

Print two numbers: The number of bottles Dieter needs to borrow from his parents, and the maximum number of bottles they can have for the party.

Keep in mind that maximizing the amount of wine for the party is most important! How many bottles Dieter has to borrow is secondary.

Sample Input 1

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

Sample Output 1

```
2 3
```

¹They were probably all pretty drunk when they made these offers.

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: theanswercount

Time limit: 12 seconds



Remember last weeks exercise concerning Deep Thought 2.0? As was to be expected, it still didn't find an answer, or, rather, the question to which 42 is the answer. And as if that wasn't bad enough, the Vogons destroyed Deep Thought 2.0 five minutes before it would have found the question.

Deep Thought, the previous version of Deep Thought 2.0, is already building a new computer¹ to find the question. However, mankind cannot wait this long again. They are already wondering *how many solutions* the big question has. This will surely provide much deeper insights in how the universe works and why the Vogons are so stupid. Of course, mankind didn't come up with this question itself. It was Deep Thought 2.0, right before its sudden death, who output the following question:

If you have n integer numbers, how many subsets of them sum up to x ? Please note that x is not always 42.

The Answer to the Ultimate Question of Life, the Universe, and Everything is still 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
```

Sample Output 2

```
1099511627776
```

¹It will be called Deep Thought 3.0.

Microbes

Problem ID: microbes
Time limit: 6 seconds



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 ($1 \leq i \leq n$) 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
Time limit: 5 seconds



*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 shrubberies². 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 at most one shrubbery in each field. The Knights demand that your placement of the shrubberies must satisfy the following rules:

- For each $i = 1, \dots, n$, the i -th shrubbery can be put on any field in the rectangle specified by the coordinates (a_i, b_i) and (c_i, d_i) , where (a_i, b_i) is the upper left corner of the rectangle, and (c_i, d_i) is the lower right corner. Therefore, you may assume $1 \leq a_i \leq c_i \leq n$ and $1 \leq b_i \leq d_i \leq n$. The field in the upper left corner of the garden has coordinates $(1, 1)$, the square in the lower right 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.

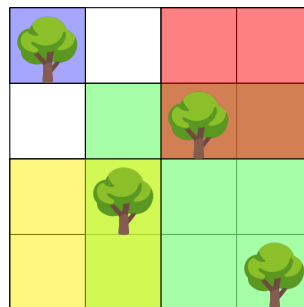


Figure 1: Depiction of Sample 3

Input

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

¹<https://www.youtube.com/watch?v=zIV4poUZAQo>

²That look nice, and not too expensive!

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 of the i -th shrubbery (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

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

Sample Output 1

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

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
```