SOUTH PACIFIC
ANZAC 1

MARCH 27, 2021

Read Me First

- This contest was *supposed* to be a 5 hour contest, but we changed it to be a 3 hour contest!
- This is because Code Jam (a big programming contest run by Google) is also on today.
- We strongly encourage all teams to look at Code Jam in the remaining two hours after this contest finishes.
- It is open to all. It is also an individual contest, however, collaboration is *allowed* in the qualification round.
- See more details at `https://codingcompetitions.withgoogle.com/codejam`

For problems that state "*Your answer should have an absolute or relative error of less than* 10^{-9}", your answer, x, will be compared to the correct answer, y. If $|x - y| < 10^{-9}$ or $\frac{|x-y|}{|y|} < 10^{-9}$, then your answer will be considered correct.

Definition 1

For problems that ask for a result modulo m:
If the correct answer to the problem is the integer b, then you should display the unique value a such that:

- $0 \leq a < m$
  and
- $(a - b)$ is a multiple of m.

Definition 2

A string $s_1 s_2 \cdots s_n$ is lexicographically smaller than $t_1 t_2 \cdots t_\ell$ if

- there exists $k \leq \min(n, \ell)$ such that $s_i = t_i$ for all $1 \leq i < k$ and $s_k < t_k$
  or
- $s_i = t_i$ for all $1 \leq i \leq \min(n, \ell)$ and $n < \ell$.

Definition 3

- Uppercase letters are the uppercase English letters $(A, B, \ldots, Z)$.
- Lowercase letters are the lowercase English letters $(a, b, \ldots, z)$.

Definition 4

Unless otherwise specified, the distance between two points (x_0, y_0) and (x_1, y_1) is defined as its Euclidean distance:

$$\sqrt{(x_0 - x_1)^2 + (y_0 - y_1)^2}.$$

Definition 5

A positive number is a number that is strictly greater than 0, while a negative number is strictly less than 0. This means that zero is neither negative nor positive. A number is nonpositive if it is not positive and a number is nonnegative if it is not negative.

Problem A
Analysis of Advanced Analytics
Time limit: 1 second


Source: Pexels

James is purchasing lecture notebooks for his upcoming course: *Analysis of Advanced Analytics*. James knows exactly how many pages are needed for each day during the semester. On the first day, he starts writing his notes at the beginning of the first notebook. On the second day, he checks if there are enough pages left in the first notebook to write all of the notes for the second day. If there are enough pages left, he will write the notes in the first notebook. If there are not enough pages left, he will start a new notebook and write all of his notes for that lecture in the new notebook. He continues this process, checking every day if there is enough room left in the current notebook to write the notes for that day. If there is enough room, he will continue writing in that notebook and if there is not enough room, he will start a new notebook.

Each notebook contains the same number of pages. Given the lengths of the notes for each day during the entire semester, how many notebooks should James buy to contain all of the notes for the semester?

Input

The input consists of two lines. The first line contains two integers n ($1 \le n \le 1\,000$), which is the number of days in the semester, and k ($1 \le k \le 1\,000$), which is the number of pages in each notebook.

The second line contains n integers $a_1, a_2, \ldots, a_n$ ($1 \le a_i \le k$), where a_i is the number of pages needed for the i^{th} day in the semester.

Output

Display the number of notebooks that James needs for the entire semester.

Sample Input 1	Sample Output 1
`4 100` `60 30 20 60`	`2`

Sample Input 2	Sample Output 2
`3 100` `30 100 10`	`3`

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Problem B
Hamster Ball
Time limit: 10 seconds

The years have been good to the Rock and Roll Hamster Ball company. Starting with a single hamster ball they now produce a popular range of different sizes for hamsters big and small.

Recently they moved manufacturing to a new plant but disaster has happened: The new balls, many of which have been shipped to customers, have a defect. The two halves of the ball do not lock together properly and hamsters are escaping.

The immediate solution is simple. We will send out special hamster ball tape to each customer, they put the hamster in the ball and tape it shut. Problem solved.

Unfortunately you only have a certain amount of tape and you're not sure it will seal all of the balls that have been shipped. Given the length of tape, the number and radius of hamster balls, what is the largest number of balls you can tape shut?

Input

- one line containing the integer t ($1 \leq t \leq 10000$), the length of the tape in centimetres.
- one line containing the integer b ($1 \leq b \leq 100$), the number of different sizes of balls.
- b lines each with integers d ($1 \leq d \leq 100$), the radius of a ball in centimeters and s ($1 \leq s \leq 10000$) the number of balls of that size sold

Output

A single line with the integer number of the largest number of balls you can tape shut. If you cannot tape shut any balls, output 0.

Sample Input 1

```
1000
2
2 30
3 20
```

Sample Output 1

```
5
```

Sample Input 2

```
2000
4
20 30
1 20
1 15
20 25
```

Sample Output 2

```
13
```

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Problem C
Analogue Cluster
Time limit: 10 seconds

For his thesis in distributed systems, Drew is focusing on an underserved market ripe for disruption: the player piano, a genus of analogue device which, given a piece of paper of appropriate style and width, can play whatever song is copied onto it.

Drew is going to network these devices; they will communicate using their native medium of long pieces of paper.

He hit a snag immediately: pianos can only communicate directly if they take the same width of paper, and not all of the pianos in the computer science department take the same width of paper. Some will need to be retrofitted if his plans are to succeed.

Time is valuable and, in particular, the time of the expensive technician Drew has hired to carry out the work is eye-wateringly valuable. What is the smallest number of pianos he can get away with modifying to make his project work?

Input

- One line containing the number of pianos, n ($1 \leq n \leq 1000$), followed by the number of connections between pianos, c ($1 \leq c \leq 10^5$).
- One line containing the n integer widths of each piano's paper intake in centimetres, in order, w_1 to w_n ($1 \leq w \leq 10^6$).
- Each of the following e lines are all distinct, and each contains two integers a and b ($1 \leq a < b \leq n$) indicating that pianos a and b need to become compatible.

Output

Output the minimum number of pianos that can be modified in order for all of the connections to become possible.

Sample Input 1	Sample Output 1
4 2 40 20 40 2 2 3 1 3	1

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Problem D
Kings
Time limit: 10 seconds

A heated game of "chess-tidying" starts with a messy board containing several king pieces strewn across the cells. The player's job is to put all of the pieces into a line along the primary diagonal of the board, which runs along black squares.

In each move, unlike in normal chess, one king may be moved one place either horizontally or vertically (but not both) to another unoccupied cell.

Given an instance of the game, find how many moves you will need in order to finish it.

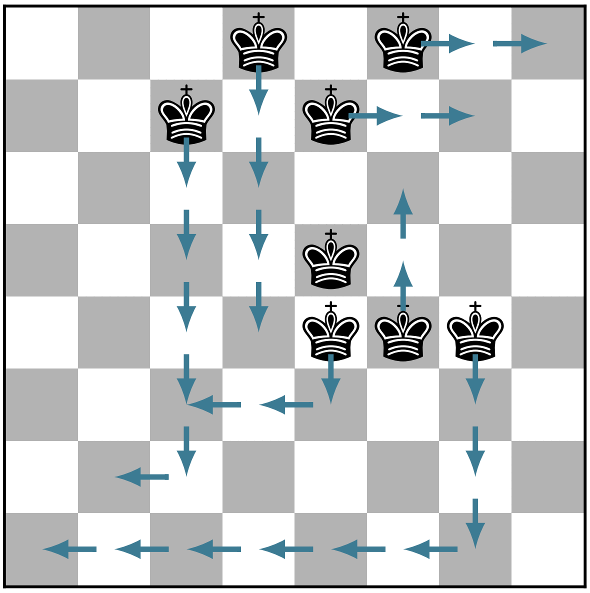

Figure D.1: Illustration of Sample Input 2. In this case, the minimum number of moves necessary to put all of the kings along the black diagonal is 28 as pictured.

Input

- One line with the number of rows and columns, n ($1 \leq n \leq 500$).
- Each of the following n lines contains the two-dimensional integer coordinates c and r ($1 \leq c, r \leq n$), the position of one of the kings.

Each of the kings starts at a unique position.

Output

Output the minimum number of moves necessary to cover the main diagonal ($r = c$) with kings.

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

Sample Input 2	Sample Output 2
8 6 4 6 8 5 5 5 4 4 8 5 7 7 4 3 7	28

Problem E
Dome Construction
Time limit: 10 seconds

The world's largest indoor water park is built inside a hemispherical dome that was once used as an aircraft hangar. The park attracts more than $10\,000$ visitors per day and is big enough that it even has its own tropical micro-climate with clouds forming inside.

Management would like to expand business operations by opening another branch in the dome of your local cathedral. The micro-climate is a key selling point, so to really capitalise on the cathedral they asked you to expand the dome's radius so that it contains at least a given number of clouds. A cloud is contained if its centre is on or inside the boundary of the dome.

You are a cloud engineer by trade, and hence a competent meteorologist. You already identified several potential clouds close by and plotted them in three dimensions relative to the centre of the current structure. In order to capture enough of them, how large do you need to make the radius of the dome?

Input

- The first line contains the number of clouds you found, n, and the number that must be contained, k, respectively ($1 \le k \le n \le 10^5$).
- The next n lines each contain three real numbers x_i, y_i, z_i, the coordinates of the ith cloud relative to the centre of the dome ($0 \le |x_i|, |y_i|, |z_i| \le 10^6$). Every cloud has a non-negative y-coordinate.

Output

Output the minimum radius of the dome required to enclose at least k points. Your answer must be accurate to an absolute or relative error of 10^{-6}.

Sample Input 1	Sample Output 1
5 3 -4 2 1 2.1 3 5 1.2 1 -1 -2.2 3 2 1 0 2.1	4.22374242

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Problem F
Last Word
Time limit: 10 seconds

The `substring()` function is a commonly-used operation available in most programming languages that operates on strings. A start offset and a length are provided and used to construct a new string containing only the characters in a sequence of that length beginning from the offset.

One particular string has had this called a large number of times in sequence: we repeatedly used the standard library function `substring(s, start, length)` to chop it up until now a potentially much shorter string remains.

Find the value of the string produced by all of these operations.

Input

- The first line of input contains the string s ($1 \leq |s| \leq 10^6$).
- The second line of input contains the number of operations, n ($1 \leq n \leq 10^6$).
- Each of the following n lines contains the two integers $\texttt{start}_i$ and $\texttt{length}_i$ ($0 \leq \texttt{start}_i < \texttt{length}_{i-1}; 1 \leq \texttt{start}_i + \texttt{length}_i \leq \texttt{length}_{i-1}$).

Output

Output the string after all of the successive substring() operations.

Sample Input 1

```
helloworld
2
1 9
0 5
```

Sample Output 1

```
ellow
```

Sample Input 2

```
abcdefghijklmnopqrstuvwxyz
8
1 24
1 22
1 20
1 18
1 16
1 14
1 12
1 10
```

Sample Output 2

```
ijklmnopqr
```

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Problem G
Ballpark Estimate

Giving the right level of detail is an important skill for efficient communication. Sometimes, only the high-level message matters.

For example, whenever a person asks for a number, often they just want an estimate. If the value is in the millions, they do not need to know the precise number of hundreds and tens. Likewise, if the value is in the billions, they do not necessarily care about little things like millions.

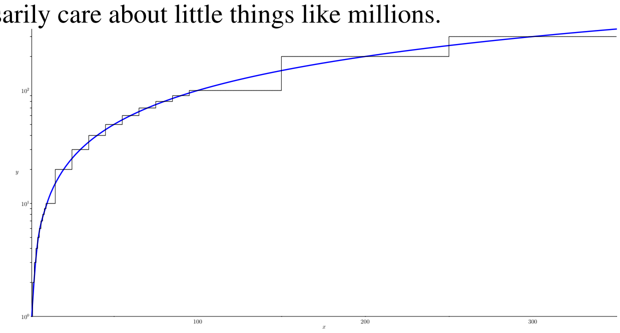

Figure G.1: Illustration of ballpark figures versus actual figures, as a log chart.

Given a (possibly very large) number, print its numerically closest representation that has only one digit other than trailing zeroes.

The closeness of the representation r of a number n is defined by $\text{abs}(r - n)$.

Input

The input consists of:

- one line with the positive integer n ($1 \leq n \leq 10^{18}$).

Output

Output the closest number to n with exactly one significant (non-zero) figure. If there are two equally-close answers, print the larger one.

Sample Input 1	Sample Output 1
`150`	`200`

Sample Input 2	Sample Output 2
`4`	`4`

Sample Input 3	Sample Output 3
`33471234512345`	`30000000000000`

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Problem H
Fabulous Photos
Time limit: 6 seconds

Erica has a collection of bowling balls numbered 1 to n. Each of her bowling balls is a certain colour and its number is written on the ball. Note that multiple bowling balls may be the same colour.

Erica transports her bowling balls in bags which match the colour of the balls they contain. For example, red bowling balls must go in red bags, green bowling balls must go in green bags, and so on.

Each coloured bag is designed to hold exactly some (possibly empty) subset of the balls of that colour. The bag must hold exactly the subset of balls it is designed to hold when it is used. No two bags of the same colour can hold the same subset of bowling balls.

Erica decided to get her bowling ball collection professionally photographed. For each picture, Erica picked exactly one bag of each colour. She then brought those bags and the bowling balls they hold to the photo studio. The photographer then took all the bowling balls Erica brought out of the bags and lined them up for a picture.

Because Erica is really proud of her bowling ball collection, she went to the studio once for every possible valid combination of bags she could bring.

For example, assume Erica has 5 bowling balls in her collection numbered from 1 to 5. Bowling balls 1, 2, and 5 are red while bowling balls 3 and 4 are green. Also assume that Erica has two red bags: the first of which can hold balls 1 and 2 and the second can hold balls 2 and 5. Erica also has three green bags: the first of which can hold balls 3 and 4, the second of which can hold only ball 3, and the third which is green but can hold no bowling balls. Therefore, Erica can pick either of the two red bags and one of the three green bags. This gives the following six combinations that she will have photographs of: [1, 2, 3, 4], [2, 3, 4, 5], [1, 2, 3], [2, 3, 5], [1, 2], and [2, 5].

Sadly, after Erica got the pictures back from the professional photographer, she realized that the pictures were taken in black and white! This means that each picture only shows the numbers on the balls in the picture and not what colour each ball is.

Given Erica's photographs, can you figure out which bowling balls in her collection are definitely the same colour?

For example, assume Erica had two pictures: the first of which shows balls 1 and 2 and the second of which shows balls 1 and 3. There are two possibilities:

- All bowling balls are the same colour with bags holding $\{1, 2\}$ and $\{1, 3\}$.
- Bowling balls 2 and 3 are the same colour but different from ball 1, with bags holding $\{1\}$, $\{2\}$, and $\{3\}$.

In both cases, bowling balls 2 and 3 are the same colour, while bowling ball 1 may be a different colour.

Input

The first line contains two integers n ($1 \le n \le 60$), which is the number of bowling balls Erica has, and m ($1 \le m \le 10\,000$), which is the number of pictures Erica took.

The next m lines describe Erica's pictures. Each picture is encoded as a string of n `0`s and `1`s describing the balls from 1 to n in order. A `0` means that the ball was not present in the picture and a `1` means that the ball was included in the picture.

Output

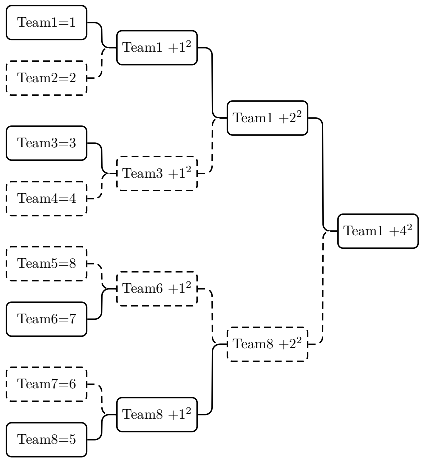
For each bowling ball in Erica's collection, in order, display the smallest numbered bowling ball that is definitely the same colour as this bowling ball.

Sample Input 1	Sample Output 1
3 2 110 101	1 2 2

Sample Input 2	Sample Output 2
6 6 110101 110011 100011 011101 011011 001011	1 2 1 2 2 6

Problem I
Low Effort League
Time limit: 10 seconds

The teams in your local rugby league aren't particularly good, but they make up for it in enthusiasm. We are going to organise a single-elimination knockout tournament between them, where the 2^n teams play n rounds. In each round, the $2i+1$th remaining team pairs up with the $2i+2$th team and one or the other team is eliminated.



Each team has a scalar skill level. In the normal course of things, a team with higher skill level will always beat a team with lower skill level. However, training plays a part too: if one team studies another, learns its techniques, and trains against them, it can win.

The number of hours a team with skill a must train to beat a team with skill b (where $a \leq b$) is $|b-a|^2$. This training only affects that one game (it does not transfer to other teams).

You would quite like your favourite team to win the tournament. If you take complete control over how every team trains, you can always make this happen. What is the minimum number of hours needed, in total across all teams, in order for your team (team 1) to win?

Input

The input consists of:

- one line containing the integer r ($1 \leq r \leq 14$), the number of rounds in the tournament.
- one line with 2^{r} integers $s_1 \ldots s_{2^{\mathrm{s}}}$ ($0 \leq s_i \leq 10^6$ for each i), where s_i is the skill level of the ith team.

Output

Output the smallest number of hours needed for team 1 to win the tournament.

Sample Input 1	Sample Output 1
1 50 40	0

Sample Input 2	Sample Output 2
3 1 2 3 4 8 7 6 5	28

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