mBIT Rookie Problems

November 2, 2019

These problems are roughly sorted in order of difficulty. However, we suggest you look through and think about as many problems as you can in the time provided. Good luck and happy coding!

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Thanks to Evan Chen for letting us use his style file

The memory limit for all problems is the standard 256 MB.

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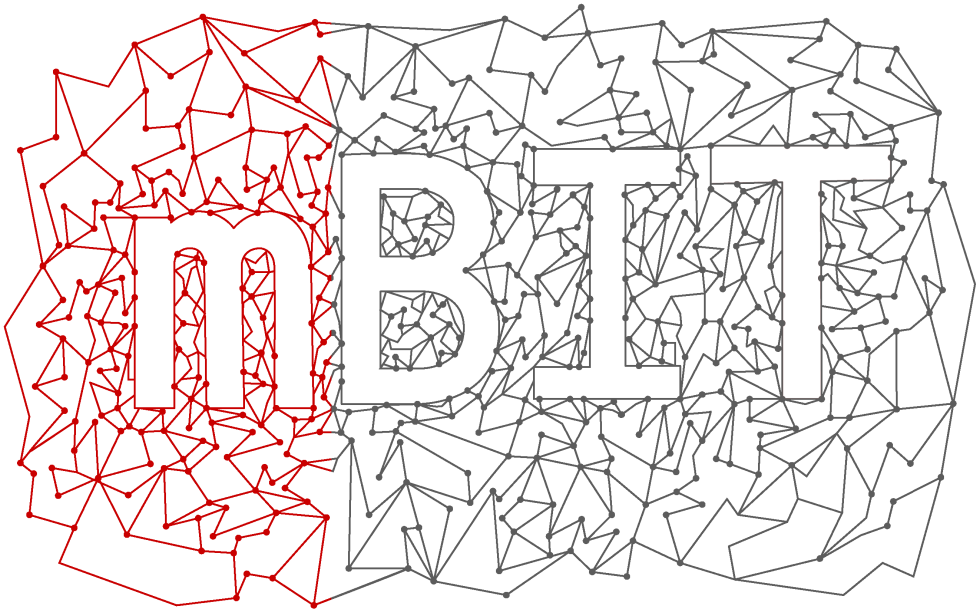


§1 Rating System

Chloe started playing Competitive Candy Crush a few days ago. Since she is very invested in the game, she wants to calculate her rating for each game before it ends . The rating system is structured such that the winner takes 10% of the loser's rating.

Consider a situation where Chloe's rating is 1000 and her opponent's rating is 1200. If Chloe wins, she will gain 120 rating points, which is deducted from the rating of her opponent. If Chloe loses, she will lose 100 rating points.

Given Chloe's rating c, her opponent's rating o, and whether she wins or loses, calculate Chloe's rating after the game. All ratings are divisible by 10.

Input Format:

The first line contains Chloe's rating, c. $(100 \leq c \leq 10^9)$

The next line contains her opponent's rating, o. $(100 \leq o \leq 10^9)$

The third line contains whether she wins (w) or loses (l).

Output Format:

One line with Chloe's rating after the game.

Sample Input:

```
1000
1200
w
```

Sample Output:

```
1120
```

§2 Candy Bowl

To prepare for a big party, Ralph needs to create a candy bowl filled with treats. However, he is very specific in how he wants to fill the bowl. Ralph wants the bowl to either have an even number of treats or a number of treats that is a multiple of 3, but not both. For example, here are some amounts of treats would make Ralph happy:

$$2, 3, 8, 10, 15, 20, 21$$

Here are some amounts of treats that would not satisfy Ralph:

$$1, 5, 6, 12, 13, 18, 25$$

You will be given N positive integers. Output YES or NO for each integer to indicate whether the amount of treats in the bowl would satisfy Ralph.

Input Format:

The first line contains an integer N ($1 \leq N \leq 100$).

The next line contains N positive integers. No numbers will be greater than 1000.

Output Format:

Output N lines. A line should contain YES if Ralph would accept the corresponding number of treats. Otherwise, it should contain NO.

Sample Input:

```
9
7 4 12 9 6 3 1 5 8
```

Sample Output:

```
NO
YES
NO
YES
NO
YES
NO
NO
YES
```

§3 Patisserie

Sophie is at her local patisserie (a French dessert shop) and is studying the words she sees in the recipes around her. While waiting on her macarons, she decides to count vowels in the words using these simplified rules:

> If a letter is an A, E, I, O, or U, then it is a vowel. If a letter is a Y, then it is a vowel only if it is at the end of a word. Otherwise, the letter is not a vowel.

For example, the vowels in this phrase are bolded.

> y**ou**r t**i**n**y** m**a**c**a**r**o**ns

Given a sentence (or phrase) containing only words made of lowercase letters and spaces, output the number of vowels.

Input Format:

The first and only line contains a phrase of lowercase letters and spaces. The length of this phrase is at most 1000.

Output Format:

Output one line containing the number of vowels in the phrase, as defined by the rules above.

Sample Input:

```
mbit twenty nineteen is a very fun event
```

Sample Output:

```
14
```

§4 Sugar Cubes

Sam is using N identical sugar cubes to make a 3D display for his candy shop. He wants to make the display by arranging all N cubes into the shape of a rectangular prism. In how many ways can he do this?

For example, if $N = 12$, then there are 4 possibilities for the rectangular prism:

$$1 \times 1 \times 12$$
$$1 \times 2 \times 6$$
$$1 \times 3 \times 4$$
$$2 \times 2 \times 3$$

Note that two possible displays which are rotations of each other are considered the same shape. ($1 \times 2 \times 6$ is the same as $1 \times 6 \times 2$).

Input Format:

The first line contains N. ($1 \leq N \leq 100$)

Output Format:

Output one line containing the number of ways Sam can create the display.

Sample Input:

```
12
```

Sample Output:

```
4
```

§5 Genotypes

Jean the geneticist is trying to breed sugarcane plants for her cake. Every sugarcane has a genotype composed of N alleles, where each allele is represented by an uppercase or lowercase letter. When two sugarcane plants are bred, the offspring inherits each allele from one of the parents.

For example, if $N = 3$ and aBC is bred with ABc, the offspring could have the genotype of aBc, aBC, ABc, or ABC. You are given the genotypes of two sugarcane plants. How many possible genotypes could the offspring have?

Note that in real life, organisms have two alleles for each trait. For the purposes of the problem, the plants only have one allele for each trait.

Input Format:

The first line contains N. ($1 \leq N \leq 26$)

The next line contains N letters representing the genotype of the first plant.

The third line contains N letters representing the genotype of the second plant.

Output Format:

Output one line containing the number of possible genotypes the offspring could have.

Sample Input:

```
4
WxYZ
wXyZ
```

Sample Output:

```
8
```

The 8 possibilities for the offspring are $wxyZ, wxYZ, wXyZ, wXYZ, WxyZ, WxYZ$, $WXyZ$, and $WXYZ$.

§6 Baking Pan

George wants to bake N cookies, but he lost his baking pan. He wants to get a new one with the smallest area possible. Also, he wants to bake these cookies in a certain aesthetic design. Since George is a really good baker, all of his cookies come out circular. He has planned out his design on a coordinate plane with integer coordinates for the center of each cookie and an integer radius for each cookie. Given this information and the fact that the baking pan's edges must be parallel to the x and y axes of his design, determine the smallest area of a baking pan that contains all of the cookies George wants to bake. Note that the cookies may overlap.

Input Format:

The first line contains the number of cookies George wants to bake, N. $(1 \leq N \leq 10^5)$

The next N lines each contain the center x coordinate, center y coordinate, and radius for a cookie. $(-10^7 \leq x_i, y_i \leq 10^7$ and $1 \leq r_i \leq 10^7)$

Output Format:

Output the area of the smallest possible baking pan George can use. (Beware of integer overflow error if you are using C++ or Java)

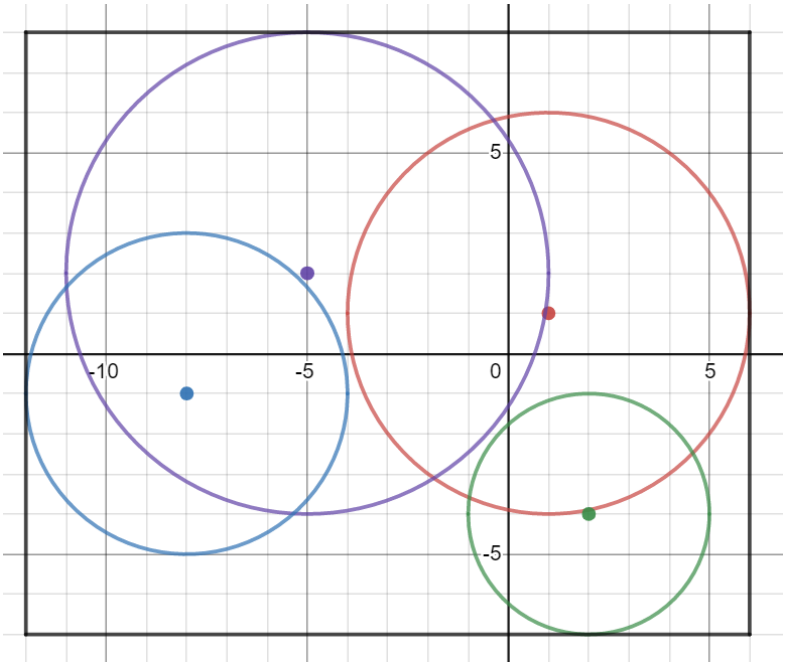
Sample Input:

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

Sample Output:

```
270
```

The smallest possible baking pan has dimensions 18×15.



§7 Number Cookies

Seth has opened a package of number cookies. The package has N cookies, and each one is shaped like a number or an operator. The possible cookie types are:

$$0, 1, 2, 3, 4, 5, 6, 7, 8, 9, +, *, -$$

Seth wants to arrange the cookies in a way that maximizes the final result of the expression. Note that there is no division operator, so the final number must be an integer. Seth *cannot* use the $-$ cookies as a negative sign, only as a minus sign. No two operators can be next to each other, and the expression cannot start or end with an operator. No numbers can start with a zero (besides 0 itself). Follow the order of operations as normal.

Help Seth find the maximum value of the expression. It is guaranteed that there is at least one valid arrangement for a set of cookies.

Input Format:

The first line contains N, the number of cookies in Seth's package. $(1 \leq N \leq 7)$

The second line contains N characters separated by spaces. Each character represents the shape of a cookie in the package.

Output Format:

Output a single number: the maximum value of an expression Seth can make by arranging the cookies. The expression must use all of the cookies provided.

Sample Input:

```
7
4 5 8 2 0 * -
```

Sample Output:

```
4428
```

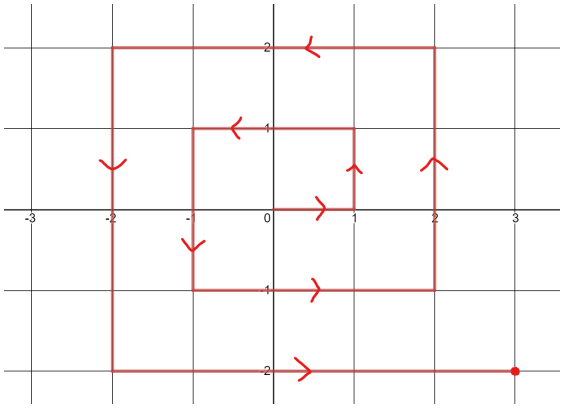
In this case, the expression is maximized when it is $54 * 82 - 0 \implies 4428$

The following expressions would not be valid:

- $4 - 05 * 82$, because there is a leading 0 on 05
- $-824 * 50$, because it starts with a $-$
- $84 - 250*$, because it ends with a $*$
- $548 * 20$, because it does not use all of the provided cookies
- $55 * 84 - 20$, because it uses cookies that were not provided.

§8 Cinnamon Spiral

Cindy the architect is designing the layout of Cinnamon City. She wants it to look like a cinnamon roll, so she is planning on building a spiral road throughout the city. The city is on the coordinate plane (1 unit = 1 city block), with the town hall at the origin (0, 0). Cindy wants the road to start at the town hall, then spiral outwards in a counterclockwise manner until it reaches the candy shop:



The diagram above shows the plan for Cindy's road if the candy shop is at $(3, -2)$. The arrows indicate the direction in which the road spirals outward. In this case, the road is 25 blocks long.

Given the location of the candy shop (X, Y), output the length of the spiral road that starts at $(0, 0)$ and ends at (X, Y).

Input Format:

The first and only line contains X and Y. $(-10^6 \leq X, Y \leq 10^6)$

Output Format:

In a single line, output the length of the spiral road that is required to reach the candy shop.

Sample Input:

```
3 -2
```

Sample Output:

```
25
```

§9 Ice Cream

Phil the photographer is compiling an album of dessert pictures. Unfortunately, in the ice cream section, some of his photos are sideways or upside down. Given an $N \times N$ pixelated image of a cherry ice cream cone, tell Phil which direction it is rotated.

The image consists of three types of pixels: brown (b), pink (p), and white (w). The background of the picture is mostly white, the cherry ice cream is mostly pink, and the cone is mostly brown.

However, it's possible for darker cherries in the ice cream to be brown and for there to be pink ice cream melted on parts of the cone. There may also be dribbles of pink or brown on the background, so you can't count on it being all white. There may even be white marshmallows sprinkled in the ice cream or on the cone. Because of these imperfections, you need to look at the big picture when determining the orientation of the image. Focusing on only a few pixels may produce the wrong answer. The ice cream cone is guaranteed to take up a significant portion of the image.

Hint: This is a soft (serve) problem, which means that there is not necessarily a definite solution. Think of how a human would determine the orientation of the image. The test cases are not intended to trick you.

Input Format:

The first line contains N. ($20 \leq N \leq 200$)

The N lines each contain N letters representing the color of each pixel.

Output Format:

Output the number of degrees clockwise each image has been rotated. It is guarenteed to be a multiple of 90.

- 0 if the ice cream cone is correctly orientated with the cone below the ice cream.
- 90 if the ice cream cone is rotated 90 degrees to the right, with the cone to the left of the ice cream.
- 180 if the ice cream cone is upside down, with the ice cream under the cone.
- 270 if the ice cream cone is rotated 90 degrees to the left, with the cone to the right of the ice cream.

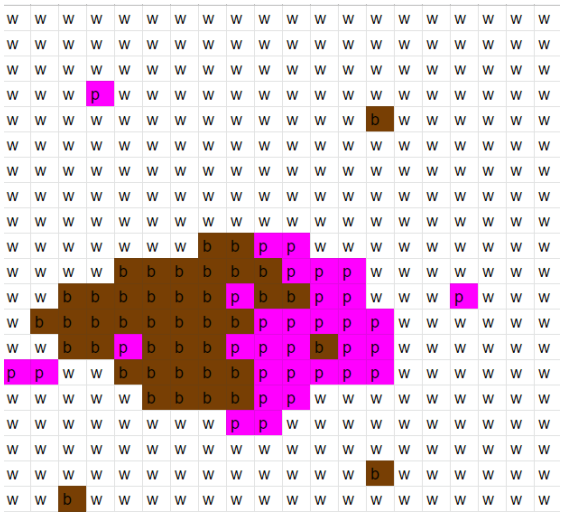
Sample Input:

```
20
wwwwwwwwwwwwwwwwwwww
wwwwwwwwwwwwwwwwwwww
wwwwwwwwwwwwwwwwwwww
wwwpwwwwwwwwwwwwwwww
wwwwwwwwwwwwwbwwwwww
wwwwwwwwwwwwwwwwwwww
wwwwwwwwwwwwwwwwwwww
wwwwwwwwwwwwwwwwwwww
wwwwwwwwwwwwwwwwwwww
wwwwwwwbbppwwwwwwwww
wwwwbbbbbbpppwwwwwww
wwbbbbbbpbbppwwwpwww
wbbbbbbbbpppppwwwwww
wwbbpbbbpppbppwwwwww
ppwwbbbbbpppppwwwwww
wwwwwbbbbppwwwwwwwww
wwwwwwwwppwwwwwwwwww
wwwwwwwwwwwwwwwwwwww
wwwwwwwwwwwwbwwwwww
wwbwwwwwwwwwwwwwwww
```

Sample Output

```
90
```

To make this sample case easier to see, here is a colored representation of the input image:



As you can see, the ice cream cone is rotated 90 degrees clockwise.

§10 Frosting Patterns

Aunt Amy is decorating a cake for her nephew's birthday. She plans on making a pattern with the colors of the frosting dots. Each color is represented with an uppercase letter. For example, one pattern Amy could choose is:

ABBDCABBDCABBDCA...

Here, the block of colors ABBDC is repeated over and over.

Amy has started her pattern, but needs help finishing it. She has already placed down N colors. Can you tell her what the next M colors in the pattern should be? It is guaranteed that the repeated block of colors has already occurred at least twice.

Input Format:

The first line contains N and M. $(1 \leq N, M \leq 1000)$

The next line contains N uppercase letters, representing the colors Amy has already placed.

Output Format:

Output a single line with M uppercase letters representing the next M colors in the pattern

Sample Input:

```
19 4
MBITTIMEMBITTIMEMBI
```

Sample Output:

```
TTIM
```

The repeated sequence of colors in this case is MBITTIME.

§11 Dessert Islands

Eric the Explorer is surveying the famous Chocolate Swamp. He finds that it consists of chocolate lakes and cookie islands. Please help him count the number of distinct islands and lakes there are there are in the swamp.

You will be given Eric's map of the swamp, which can be represented as a grid of letters. There are N rows of M letters each. Each letter is either an L (liquid chocolate) or a S (solid cookie land). It is guaranteed that the borders of the map are all cookie land (no L will be found along the exterior of the grid). An island is defined to be an area of connected cookie land that is not touching the border of the map and is surrounded by liquid chocolate. A lake is defined to be an area of connected liquid chocolate that is surrounded by cookie land. A letter in the map is only in contact with the letters left, right, above, and below it. Two letters that are located "diagonally" do not count as touching.

Note that it is possible to have an island within a lake, and a lake within an island.

Input Format:

The first line contains N and M. $(1 \leq N, M \leq 10^3)$

The next N lines will contain M letters each. Each letter is either an L or a S.

Output Format:

In a single line, print the number of islands followed by the number of lakes.

Sample Input:

```
7 10
SSSSSSSSSS
SLSLSLLLSS
SSLLLLSLSS
SSSLSLSLLS
SSSLLSLSSS
SSLSSLLLSS
SSSSSSSSSS
```

Sample Output:

```
3 4
```

§12 Sugar Sampling

Juan really likes sugar. Fortunately for him, he is at the top left of a grid full of sweets. The grid is of size $N \times N$, and each cell in the grid has a candy in it. There are N types of candy labeled $1, 2, \ldots, N$. Juan is allowed to move from one cell to an adjacent cell by moving right or down. He may not move left or up, and he may not move off the grid. Juan eats the candy in every cell he visits. There is no candy in the top left cell or the bottom right cell. This is denoted by a -1 in the input.

After $2(N-1)$ moves, Juan will be at the bottom right cell. Juan wants to know how many ways there are for him to make these $2(N-1)$ moves, such that he will have eaten a certain type of candy at least once. In other words, output the number of paths connecting the top left and bottom right corners that go through candy i at least once. Answer this for all i from 1 to N.

The answers may grow very large. Please output the numbers mod $10^9 + 7$.

Input Format:

The first line contains N. $(1 \leq N \leq 100)$

The next N lines each contain N space-separated integers representing the types of candies in the grid. The top-left and bottom-right integers will be -1.

Output Format:

Output N lines. The i^{th} line should contain the number i, followed by the number of paths that go through candy type i at least once (mod $10^9 + 7$).

Sample Input:

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

Sample Output:

```
1 20
2 20
3 5
4 13
```

There are 20 paths that include candy 1, 20 paths that include candy 2, 5 paths that include candy 3, and 13 paths that include candy 4.

§13 Magical Calendar

Tommy the dessert wizard is a world-renowned magician famous for his magic tricks involving cakes, candy, and other treats. He gets invited to perform at numerous venues each year, and he needs a complex computer-based calendar to keep track of his schedule.

Your job is to design a calendar capable of adding, removing, and rescheduling events. In addition, Tommy should be able to query for the date of any event at any moment. Finally, after all commands, each of his events should be displayed in chronological order.

Input Format:

The first line contains N ($1 \leq N \leq 10^5$), the number of commands that Tommy will enter into his calendar. The next N lines will contain one of four possible commands:

1. ADD EVENTNAME Month Day - Adds an event of that name on the given date. Does nothing if the event is already on the calendar.
2. DELETE EVENTNAME - Deletes the event of that name. Does nothing if the event is not on the calendar.
3. RESCHEDULE EVENTNAME Month Day - Reschedules the event of that name to the given date. Does nothing if the event is not already on the calendar.
4. PRINT EVENTNAME - Displays the month and date of the event separated by one space. If it is not on the calendar, display the message "NOT SCHEDULED".

Event names will NOT contain spaces. Multiple events of different names can be scheduled on the same day. All events have distinct names and are in capital letters.

Output Format:

Displays the results of any PRINT queries. Each query result is displayed on an individual line. After all queries are processed, display all the events on the calendar in chronological order, space-separated, on one line. If there are two events on the same day, place them in alphabetical order.

Sample Input:

```
10
ADD SAMSBIRTHDAY May 2
ADD TIMSSWEETSIXTEEN January 23
ADD SUPERSECRETMAGICIANGATHERING December 14
PRINT TIMSSWEETSIXTEEN
DELETE TIMSSWEETSIXTEEN
ADD PHONETICALPARTY November 27
RESCHEDULE SAMSBIRTHDAY January 1
ADD PHONETICPARTY November 27
PRINT SAMSBIRTHDAY
PRINT TIMSSWEETSIXTEEN
```

Sample Output:

```
January 23
January 1
NOT SCHEDULED
SAMSBIRTHDAY PHONETICALPARTY PHONETICPARTY SUPERSECRETMAGICIANGATHERING
```

§14 Pie Predicament

Pam the pie baker is attending a pie contest and has prepared N pies with some flavors being repeated. In fact, she only prepared F distinct flavors of pies. She gets to the contest table and places the pies in a row. As other contestants arrive, they become angered by Pam hoarding a lot of space on the table. To appease them, Pam wants to take as many of her pies off the table as possible, but at the same time, she wants to make sure that at least one of each of her F distinct pie flavors are on display. To save time, she wants to sweep off a certain number of pies (possibly 0) from each side to accomplish this. You have been tasked with computing the number of pies to sweep off from each side.

More formally, given an array of size N consisting of pie flavors numbered $1 \dots F$, find the number of pies to remove from the right side and the number to remove from the left side such that there are as few remaining pies as possible, and the remaining pies still contain each of the distinct F flavors.

There may be multiple correct answers that produce the minimum number of remaining pies. Any correct answer will be accepted.

Input Format:

The first line contains N and F. ($1 \leq F \leq N \leq 10^6$)

The next line contains N integers representing the flavors of the each of the pies in the order Pam placed them on the table. It is guaranteed that there is at least one pie of each flavor.

Output Format:

Output two numbers on a single line. The first is the number of pies to remove from the left side and the second is the number of pies to remove from the right side.

Sample Input:

```
15 5
2 4 5 2 3 5 1 3 5 2 1 2 4 5 1
```

Sample Output:

```
7 2
```

If 7 pies are removed from the left side and 2 are removed from the right, the remaining pies will have the flavors: 3, 5, 2, 1, 2, 4. Each flavor from 1 to 5 is represented here, and the number of remaining pies is minimized.

§15 Candle Lighting

Today is Ushio's birthday! Unfortunately, Ushio is feeling a bit under the weather today, so in order to cheer her up, her father buys her a special rectangular cake that is split into $N \times M$ pieces. The cake has N rows and M columns, and each piece contains a single candle that is either lit or unlit. The piece in row i and column j is at the location (i, j). Thus, the location (N, M) represents the bottom right piece of the cake.

Ushio plays around with the cake for a while and notices something very peculiar about the candles: if she blows on a lit candle, the flame is blown out, but if she blows on an unlit candle, the candle gets reignited! Every time she blows on the cake, it affects all of the candles that are in a certain subrectangle of the cake grid. This phenomenon motivates Ushio to ask the following question: after Q blows, each covering certain subrectangle of candles, how many candles will be lit?

A *subrectangle* is a collection of pieces of the cake that forms a rectangle. Formally, a subrectangle is defined by four integers i_1, j_1, i_2, and j_2. A piece at location (a, b) is in the subrectangle if and only if $i_1 \leq a \leq i_2$ and $j_1 \leq b \leq j_2$. Note that (i_1, j_1) represents the the top left corner of the subrectangle and (i_2, j_2) represents the bottom right corner of the subrectangle.

Input Format:

The first line contains N and M ($1 \leq N, M \leq 500$). The next N lines each contain M numbers representing the original state of the cake (0 means unlit, 1 means lit).

The next line contains Q ($1 \leq Q \leq 10^5$), the number of blows Ushio makes.

The final Q lines each contain i_1, j_1, i_2, and j_2, which represents a blow Ushio makes. ($1 \leq i_1 \leq i_2 \leq N$ and $1 \leq j_1 \leq j_2 \leq M$)

Output Format:

Print the number of candles that are lit after Ushio is done blowing on them.

Sample Input:

```
3 4
1 0 0 1
0 1 0 1
0 1 0 0
5
1 1 3 3
1 1 2 2
2 4 3 4
2 3 3 4
1 2 3 3
```

Sample Output:

```
8
```

The final state of the cake is:
1 1 0 1
0 0 1 1
1 1 1 0
This cake has 8 lit candles.