Croatian Olympiad in Informatics

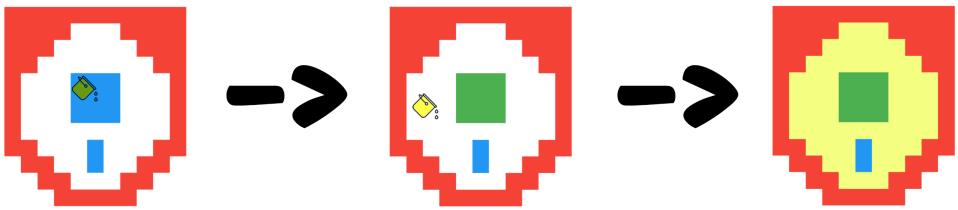
October 3rd 2020

Tasks

Task	Time Limit	Memory Limit	Score
Paint	3 seconds	512 MiB	100
Pastiri	1 second	512 MiB	100
Semafor	4 seconds	512 MiB	100
Zagrade	3 sekunde	512 MiB	100
Total			400

Task Paint

We will represent the drawing area of *MS Paint* as a rectangular grid of unit squares divided into R rows and S columns. Each square of the grid represents a single pixel that can be colored in one of the 10^5 different colors. When the user applies the so called *bucket tool* with color A on a pixel (r, s) which is colored in the color B, then all pixels in the *monochrome neighborhood* of pixel (r, s) change their color to A. Monochrome neighborhood of a pixel (r, s) is a set of pixels that are reachable by *walking* from (r, s) in the four general directions (up, down, left and right) without changing the color of the pixel along the way. Note that the pixel (r, s) is itself a part of its monochrome neighborhood.



You are given a starting image drawn in *MS Paint* along with Q instructions that should be executed in the given order. Each instruction tells you on which pixel should you apply the bucket tool and with what color. Your task is to how the image looks like after all instructions are executed.

Input

The first line contains integers R and S from the task description.

Each of the next R lines contains S non-negative integers less than 100 000 that represent the starting image drawn in *MS Paint*. More precisely, the j-th number in the i-th row of the image represents the color of the pixel (i, j).

The next line contains an integer Q from the task description.

The i-th of the next Q lines contains integers r_i, s_i and c_i ($1 \leq r_i \leq R, 1 \leq s_i \leq S, 0 \leq c_i < 100\,000$), which represent the i-th instruction that tells you to use the bucket tool with color c_i on the pixel (r_i, s_i).

Output

You should output the final state of the image in the same format as it was given in the input.

Scoring

Subtask	Score	Constraint
1	8	$1 \leq R \cdot S \leq 10\,000$, $1 \leq Q \leq 10\,000$
2	9	$R = 1$, $1 \leq S \leq 200\,000$, $1 \leq Q \leq 100\,000$
3	31	$1 \leq R \cdot S \leq 200\,000$, $1 \leq Q \leq 100\,000$ Each pixel will in every moment be colored either in color 0 or color 1.
4	52	$1 \leq R \cdot S \leq 200\,000$, $1 \leq Q \leq 100\,000$

Examples

input

```
12 11
1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 0 0 0 1 1 1 1
1 1 1 0 0 0 0 0 1 1 1
1 1 0 0 0 0 0 0 0 1 1
1 0 0 0 2 2 2 0 0 0 1
1 0 0 0 2 2 2 0 0 0 1
1 0 0 0 2 2 2 0 0 0 1
1 0 0 0 0 0 0 0 0 0 1
1 1 0 0 0 2 0 0 0 1 1
0 1 1 0 0 2 0 0 1 1 0
0 0 1 1 0 0 0 1 1 0 0
0 0 0 1 1 1 1 1 0 0 0
2
5 5 3
6 2 4
```

output

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

input

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

output

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

input

```
6 6
1 2 1 2 2 2
3 1 2 1 3 1
3 3 2 3 2 2
2 3 1 3 3 2
3 3 3 3 3 3
2 3 2 2 2 1
4
6 2 2
3 5 2
3 2 3
1 2 3
```

output

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

Clarification of the first example: The figure from the task description corresponds to the input of the first example. White color corresponds to number 0, red color corresponds to number 1, blue color corresponds to number 2, green color corresponds to number 3 and yellow color corresponds to number 4.

Task Pastiri

„*I never felt so full that I couldn't eat one more lamb.*" – Mr. Malnar

A flock of K sheep lives in a tree, a simple connected graph without a cycle. The tree contains N nodes denoted with integers from 1 to N. Each node of a tree is a home to at most one sheep. A wise shepherd realized that, sooner or later, wolves will learn how to climb trees.

In order to protect the sheep, we need to place shepherds into some nodes such that each sheep is protected by at least one shepherd. It is known that **each shepherd protects all sheep that are closest to him**, and only them. The distance between some sheep and some shepherd is equal to the number of nodes on a unique path between the node containing the sheep and the node containing the shepherd (inclusive). Additionally, the shepherd can share a node with a sheep. Of course, in that case he protects only that sheep.

Determine **the minimal number of shepherds** that need to placed in the nodes of a tree such that **each sheep is protected by at least** one shepherd. Additionally, determine one such arrangement of shepherds.

Input

The first line contains integers N i K ($1 \leq K \leq N$) from the task description.

Each of the next $N-1$ lines contains two integers a_i and b_i ($1 \leq a_i, b_i \leq N$) which indicate that there is an undirected edge between nodes a_i and b_i.

The next line contains K different integers o_i ($1 \leq o_i \leq N$) that represent nodes which containing a sheep.

Output

In the first line you should output a number X which represents the minimal number of shepherds from the task description.

In the second line you should output X space-separated integers which represent the nodes containing shepherds.

If there are multiple correct solutions, you may output any of them.

Scoring

Subtask	Score	Constraint
1	8	$1 \leq N \leq 500\,000$, every node $x = 1, \ldots, n-1$ is connected with node $x+1$
2	18	$1 \leq K \leq 15$, $1 \leq N \leq 500\,000$
3	23	$1 \leq N \leq 2\,000$
4	51	$1 \leq N \leq 500\,000$

Examples

input

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

output

```
2
1 3
```

input

```
9 5
1 2
2 3
3 4
3 5
1 6
1 7
7 8
8 9
2 5 6 7 9
```

output

```
3
1 4 9
```

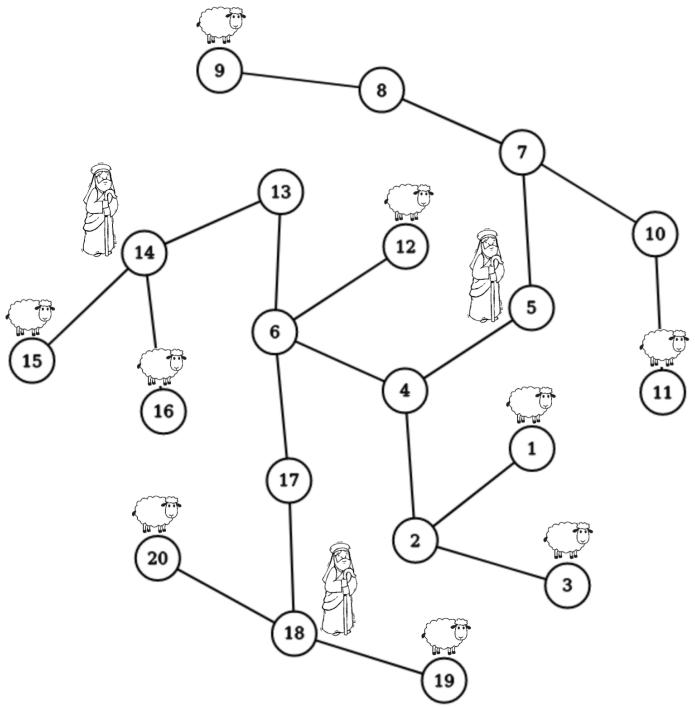
input

```
20 9
1 2
2 3
2 4
4 5
4 6
5 7
7 8
8 9
7 10
10 11
6 12
6 13
6 17
13 14
14 15
14 16
17 18
18 19
18 20
1 3 9 11 12 15 16 19 20
```

output

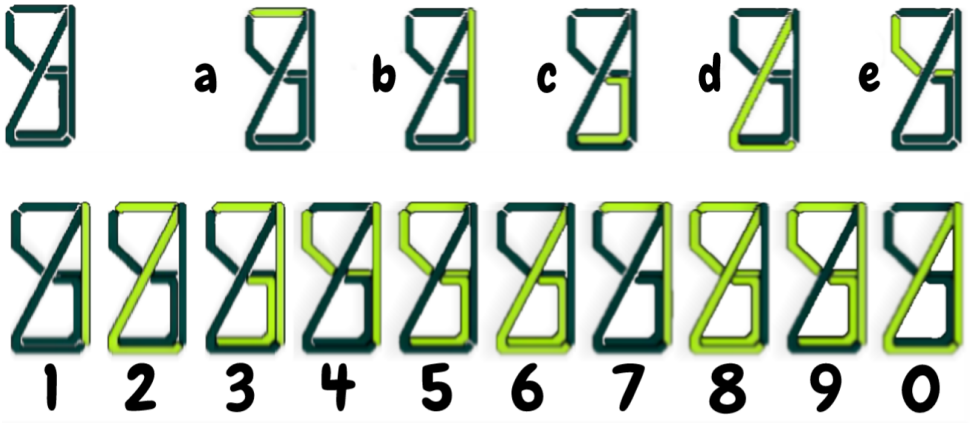
```
3
5 14 18
```

Clarification of the third example:



Task Semafor

You are most likely familiar with a so-called *7-segment* display which is widely used to depict digits on various digital devices, such as watches or calculators. Due to its simplicity, intuitiveness and aestheticism, this design has been accepted across the globe. Still, young Matej argues against the 7-segment design and claims that the same functionality can be obtained more efficiently, using only 5 segments.



5-segment display design – segments are labeled using with letters from `a` to `e`.

Matej decided to make his first entrepreneurial steps in the most prosperous branch of Croatian economy, football. His revolutionary design will be used on a substitution board during the games of 1. HNL.[1] He is currently making a presentation for the board of directors at the Croatian Football Association.

The substitution board consists of M 5-segment displays which, from left to right, represent the digits of a jersey number worn by the player that is about to leave the pitch. At the beginning of Matej's presentation, the substitution board represents the number X, and Matej will make one of the following moves each second:

- Turn on one segment that is currently turned off.
- Turn off one segment that is currently turned on.

Also, Matej will make sure that after each K-th move, the board shows a valid number. The number is valid if each of its digits is correctly shown on the corresponding display (i.e. segments that are turned on show a valid digit). Also, numbers having less than M digits are validly shown if they contain the appropriate number of leading zeros.

For each final state (integer between 0 and $10^M - 1$), Matej is interested in how many different ways could he make his moves during the presentation such that this final state is reached at the end. Of course, he needs to adhere to all limitations presented in the previous chapters. We consider two sequences of moves different if, imagining they are executed on two different boards at the same time, there is a moment at which the two boards represent a different state.

Since the number of different ways can be quite large, you are asked to compute it modulo $10^9 + 7$.

[1] The elite tier of Croatian professional football.

Input

The first line contains integers M, N, K ($1 \leq K \leq N$) and X ($0 \leq X < 10^M$) from the task description.

Output

In the i-th line you should output the number of different ways for the substitution board to show the number $i-1$ at the end of Matej's presentations. The numbers should be printed modulo 10^9+7.

Scoring

Subtask	Score	Constraints
1	6	$M = 1$, $1 \leq N \leq 12$
2	15	$M = 1$, $1 \leq N \leq 10^{15}$
3	12	$M = 2$, $1 \leq N \leq 1\,500$, $K = N$
4	12	$M = 2$, $1 \leq N \leq 10^{15}$, $1 \leq K \leq 15$
5	15	$M = 2$, $1 \leq N \leq 10^{15}$, $1 \leq K \leq 1\,500$
6	40	$M = 2$, $1 \leq N \leq 10^{15}$

Examples

input

```
1 2 1 5
```

output

```
0
0
0
1
0
2
0
0
0
0
```

input

```
1 3 3 8
```

output

```
0
0
0
6
0
13
0
0
0
0
```

input

```
1 4 2 4
```

output

```
24
0
8
0
37
0
4
28
4
24
```

Clarification of the first example: At the beginning of the presentation the (single-digit) substitution board shows the number 5. After each move (due to $K = 1$), the board must show a valid number. Matej is going to make a total of $N = 2$ moves. Therefore, at the end of the presentation, the board can show either number 3 or number 5. Number 3 can be obtained using one way ($5 - 9 - 3$) and number 5 can be obtained using two ways ($5 - 9 - 5$ and $5 - 8 - 5$).

Task Zagrade

Središnja obavještajna agencija (engl. *Central Intelligence Agency, CIA*) je obavještajna služba Sjedinjenih Američkih Država. U njenoj se nadležnosti primarno nalazi prikupljanje i analiza podataka o stranim vladama, korporacijama i pojedincima. Nedvojbeno je da CIA prikuplja i analizira ogromne količine računalnih lozinki domaćih i stranih građana te razvija alate kojima je moguće kompromitirati još veći broj korporacija i pojedinaca.

Vaš je zadatak jednostavan, kompromitirajte sigurnost središnje obavještajne agencije. Sretno!

Naravno, budući da su im poznati tipični obrasci izrade računalnih lozinki, pokušaji poput `123456`, `password`, `1q2w3e4r` ili `welcome` neće uroditi plodom. Srećom, tajnim smo kanalima ipak otkrili neke informacije koje bi vam mogle pomoći.

Naime, njihova se glavna lozinka sastoji od N znakova, pri čemu je N paran te je točno polovina znakova jednaka otvorenoj zagradi (`'('`), dok je druga polovina znakova jednaka zatvorenoj zagradi (`')'`). Također, umjesto uobičajene "*zaboravili ste lozinku?*" funkcionalnosti, inženjeri su odlučili zaboravljivom administratoru dopustiti da najviše Q puta postavi pitanje oblika: „*je li interval lozinke koji započinje a-tim, a završava b-tim znakom matematički validan?*".

Matematičku validnost niza zagrada definiramo induktivno na sljedeći način:

- `()` je matematički validan niz zagrada.
- Ako je A matematički validan niz zagrada, tada je i `(`A`)` matematički validan niz zagrada.
- Ako su A i B matematički validni nizovi zagrada, tada je i AB matematički validan niz zagrada.

Interakcija

Ovo je interaktivni zadatak. Vaš program treba uspostaviti dijalog sa programom izrađenim od strane organizatora koji simulira funkcionalnost **fiktivnog** nesigurnog poslužitelja središnje obavještajne agencije iz teksta zadatka.

Prije interakcije vaš program treba sa standardnog ulaza pročitati paran prirodan broj N koji predstavlja duljinu tajne lozinke te prirodan broj Q koji predstavlja broj upita koje vaš program smije poslati.

Nakon toga, vaš program može slati upite pisanjem na standardni izlaz. Svaki upit treba biti ispisan u zaseban redak te poprimati oblik "`?` a b" gdje vrijedi $1 \leq a \leq b \leq N$. Nakon svakog ispisanog upita, vaš program treba napraviti *flush* izlaza te sa standardnog ulaza pročitati *odgovor* na upit – broj 1 ako je interval lozinke koji započinje a-tim, a završava b-tim znakom matematički validan, odnosno 0 ako to nije. Vaš program smije poslati najviše Q ovakvih upita.

Kada je vaš program odgonetnuo tajnu lozinku, treba na standardni izlaz ispisati redak oblika "`!` $x_1x_2\ldots x_N$" gdje znakovi x_1, x_2, $\ldots$, x_N predstavljaju znakove tajne lozinke. Nakon toga, vaš program ponovno treba napraviti *flush* izlaza i završiti izvođenje.

Napomena: Putem sustava za evaluaciju možete preuzeti primjere izvornih kodova koji na ispravan način obavljaju interakciju, uključujući *flush* izlaza.

Bodovanje

Podzadatak	Broj bodova	Ograničenja
1	14	$1 \leq N \leq 1\,000$, $Q = \frac{N^2}{4}$, cijela lozinka je matematički validan niz.
2	7	$1 \leq N \leq 1\,000$, $Q = \frac{N^2}{4}$
3	57	$1 \leq N \leq 100\,000$, $Q = N - 1$, cijela lozinka je matematički validan niz.
4	22	$1 \leq N \leq 100\,000$, $Q = N - 1$

Primjer interakcije

Izlaz	Ulaz	Napomena
	6 9	Tajna lozinka je `((()))`, duljine 6, a program smije postaviti najviše 9 upita.
`? 1 6`	1	Cijela lozinka je matematički validan niz zagrada.
`? 1 2`	0	`((` nije matematički validan niz zagrada.
`? 2 4`	0	`()` nije matematički validan niz zagrada.
`? 2 5`	1	`(())` je matematički validan niz zagrada.
`? 3 4`	1	`()` je matematički validan niz zagrada.
`! ((()))`		Lozinka je uspješno odgonetnuta i CIA je kompromitirana.