Problem A
Bird Rescue
Problem ID: warmup/birdrescue


CC0 Public Domain, Mystic Art Design via Pixabay

Polly the Parrot is sitting at the top of her favorite tree in Manhattan. In Manhattan, the roads are either avenues; going north to south, or streets; going east to west. The avenues are numbered 0, 1, 2, and so on, from east to west, with avenue 0 being the easternmost one. The streets are numbered 0, 1, 2, etc, from south to north, with street 0 being the southernmost one. Polly thinks that the New Yorkers were not very creative in naming their roads, but at least this naming convention makes for a convenient coordinate system.

Polly has n friends that live in different parts of the city. Friend i is known to never leave the neighborhood between avenue x_1^i and x_2^i, and between the streets y_1^i and y_2^i. Every now and then, Polly hears a call for help from one of her friends. Based on how loud the call is, Polly is able to precisely determine that the manhattan distance from her tree to the friend who is calling (in Manhattan the buildings are so tall that even sound travels along the streets and avenues). Polly doesn't care enough to actually go help, but she is interested in how many different friends the call could be coming from. This is what she is asking you to help her with. That, and a cracker.

Input

The first input line contains two positive integers n and q: the number of friends Polly has, and the number of calls for help she heard. The second line contains two values x_a and y_a: the position of the tree where she is sitting.

Then follow n lines that describe the neighborhoods her friends frequent. The i'th line describes the neighborhood of friend i by specifying x_1^i, y_1^i, x_2^i and y_2^i. Finally there are q lines that describe the calls for help. Each line j contains a single non-negative integer $x_j \geq 0$, how far from Polly in Manhattan distance the call originated from.

Constraints

We always have $1 \leq n, q \leq 10^5$. Further, all coordinates are integers and between 0 and 10^6, and all distances are integers between 0 and $2 \cdot 10^6$. For subcases, the inputs have these further restrictions:

Group 1: 30 points $n \leq 10$

Group 2: 30 points $q \leq 10$

Group 3: 40 points No further restrictions.

Output

For each call for help, output the number of friends the call for help could be coming from.

Sample Input 1	Sample Output 1
6 13 1 4 0 7 1 6 3 5 0 3 0 1 3 2 4 6 5 3 8 7 7 4 8 0 7 2 0 1 2 3 4 5 6 7 8 9 10 11 12	1 1 3 4 3 2 2 1 2 2 2 1 0

Problem B
Pong Tournament
Problem ID: warmup/pongtournament

CC0 Public Domain. "The Mozart of table tennis," Jan-Ove Waldner (SWE). Photo by djimenezhdez via Pixabay

The Swedes wanted to arrange a ping pong tournament among the n high school students in the nation. Since Sweden is the fairest country on earth, they wanted to ensure that the ranking of all the players is perfectly fair. Therfore, they decided that every high school student in the nation should play against every other high school student. Sadly, when all the matches were done, it turned out that ranking the players in a fair manner was hard, or even impossible; sometimes it was the case that a player a had beat some other player b, player b had beat some player c and player c had beat player a. Regardless of which ranking the Swedish experts suggested, someone was treated unfairly in the sense that they were ranked below someone they had beaten. The Swedish king thus decided to disqualify some players, so that there would be no ambiguity in the ranking among the remaining players. His experts then came up with a set S of k players to disqualify. Unfortunately, you are one of these disqualified players.

Together with the other disqualified players, you plead with the king to make him undo his decision. While he remains firm in the belief that his approach will yield a fair ranking, he has offered your group a deal: If you can find a set S' containing strictly less than k players to disqualify instead of your own group, then the king will disqualify this group instead. The group S of disqualified players has now bestowed upon you the responsibility of finding that different group S'. They require that none of the originally disqualified players are in S', and that the group you suggest is as small as possible.

Input

The first line contains two positive integers, n the number of high school students, and k the number of disqualified players. Then follows n lines, each containing n integers. The j-th integer on the i-th line is 1 if player i beat player j, and 0 otherwise (i.e. there is also a 0 at the i-th entry of the i-th line, even though player i didn't lose to himself). Finally, there is a line with k integers indicating the set S, the players who were disqualified. Each player is identified by a number between 0 and $n-1$. You may assume that, when the disqualified players S are removed, there exists a fair ranking of the remaining players. A *fair* ranking is one such that nobody is ranked below someone they beat. We remark that even though the Swedish experts couldn't find a fair ordering of all the players, there might still be one. **Note:** The input may be quite large.

Constraints

We always have $2 \leq k \leq n \leq 2\,000$. For subcases, the inputs have these further restrictions:

Group 1: 20 points $n \leq 30$

Group 2: 30 points $k \leq 8$, $n \leq 100$

Group 3: 50 points No further restrictions.

Output

Output a single integer, the size k' of the smallest set S' of players needed to be disqualified to make a fair ranking. Recall that none of the originally disqualified players of S can be in S', and k' must be strictly less than k. If no such solution exists, print "impossible".

Sample Input 1

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

Sample Output 1

```
1
```

Sample Input 2

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

Sample Output 2

```
impossible
```

Sample Input 3

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

Sample Output 3

```
2
```

Problem C
Toast
Problem ID: warmup/toast

N people are sitting evenly spaced around a circular table. All of them are infinitesimally small, indeed they can be modeled as points, except that they all have pretty long arms - D cm long arms, to be exact. Amer pronounces a toast, and everyone cheers! Well, everyone clinks their glass with everyone that they can reach. In other words, two people will clink glasses if their arms can reach each other across the table. In total, you hear T "*clink!*" sounds as the milk glasses touch. What is the radius of the table?

Input

A single line containing three integers, N, D, and T.

Constraints

We always have $2 \leq N \leq 10^4$, $100 \leq D \leq 10^9$ and $1 \leq T \leq 10^8$. For subcases, the inputs have these further restrictions:

Group 1: 29 points $D = 100$ and $T \leq 45$.

Group 2: 71 points No further restrictions.

Output

Output should contain two numbers ℓ and h, the lowest and highest possible radius of the table. Your answers may be off by at most 10^{-4}. There will always be a possible radius for the table.

Sample Input 1	Sample Output 1
`4 1000 4`	`1000 1414.21356`

This page is intentionally left blank.

Problem D
Political Development
Problem ID: day1/politicaldevelopment

CC0 Public Domain. Federal Open Market Committee, Federal Reserve Bank of Philadelphia via Wikimedia Commons

A certain political party with N members wants to develop some brand new politics. In order to do so, the party plans to make a committee for new political development. Clearly, the best politics is developed when all committee members disagree with each other, and when the committee is as large as possible.

In order to figure out which pairs of politicians disagree and which don't, the party then arranged for every possible pair of politicians to discuss a randomly selected topic. Whenever two politicians couldn't agree on their assigned topic, this was recorded in the party's *Book of Great Achievements*.

Armed with this book, you have now been assigned the task of finding the largest comittee where everyone disagrees. However, finding a large comittee can prove challenging; careful analysis have revealed that for *any* non-empty group of party members, there is always at least one member of the group who disagrees with (strictly) less than K of the other group members. Obviously, then, the committee can not have more than K members. But is there a choice of committee of this size? Find the size of a largest possible committe such that nobody in that committee agrees.

Input

The first line contains two integers, N the number of members in the party, and K as described above. Each member is indicated by an integer i between 0 and $N-1$. After the first line follow N lines, one for each politician i, starting with $i = 0$. The line for politician i begins with an integer D_i, and is followed by D_i integers indicating with which other party members the i-th politician disagrees according to the *Book of Great Achievements*.

Constraints We always have $0 \leq D_i < N \leq 50\,000$, and $1 \leq K \leq 10$. For subcases, the inputs have these further restrictions:

Group 1: 4 points $K \leq 2$, $N \leq 5\,000$

Group 2: 12 points $K \leq 3$, $N \leq 5\,000$

Group 3: 23 points Each party member disagrees with at most 10 other members.

Group 4: 38 points $N \leq 5000$

Group 5: 23 points $K \leq 5$

Output

Output a single integer, the size of the largest possible comittee.

Sample Input 1	Sample Output 1
5 3 2 1 2 3 0 2 3 3 0 1 4 2 1 4 2 2 3	3

Sample Input 2	Sample Output 2
5 3 3 1 2 4 1 0 1 0 0 1 0	2

Problem E
Toll
Problem ID: day1/toll

A trucking company wants to optimize its internal processes—which mainly means saving money. The company serves a region where a toll must be paid for every single street. Each street connects two places (cities, villages etc.) directly. The company serves a set of orders; each order tells them to carry goods from one place to another. When serving an order, the company wants to pay the minimum overall toll. As the region's street network can be modeled by a graph where each edge has a specific cost (the toll for the respective street), the company actually wants to know (the cost of) the cheapest path between two nodes in this graph.

However, the region's street network graph has an interesting property: it is directed (i.e. all streets are oneway), and there can only be an edge from a to b if $\lfloor b/K \rfloor = 1 + \lfloor a/K \rfloor$ (for some constant K).

Write a program that for each of a given list of orders outputs the minimum toll the company has to pay to serve the respective order.

Input

The first line contains four integers: K (with the meaning described above), N (the number of places), M (the number of streets), and O (the number of orders).

Each of the next M lines contains three integers a, b, t ($0 \leq a, b < N$). This means that there is a (oneway) street from a to b with toll t. You are guaranteed that $\lfloor b/K \rfloor = 1 + \lfloor a/K \rfloor$ is satisfied, and that no two locations are connected by more than one street.

Finally O lines follow, each containing two integers a, b: this means that there is an order to carry goods from place a to place b.

Constraints

We always have $1 \leq N \leq 50\,000$, $1 \leq O \leq 10\,000$ and $K \leq 5$. Moreover, we have $0 \leq a < b < N$ for all orders a, b and $1 \leq t \leq 10\,000$ for all tolls t. For subcases, the inputs have these further restrictions:

Group 1: 7 points $K = 1$

Group 2: 10 points All orders have $a = 0$.

Group 3: 8 points $O \leq 100$

Group 4: 31 points $O \leq 3\,000$

Group 5: 44 points No further restrictions.

Output

Your output should consist of O lines, each with one integer. The i-th line should contain the toll on a cheapest path between the two places in order i. If no such path exists, output -1 in this line.

Sample Input 1	Sample Output 1
5 14 5 5 0 5 9 5 12 10 0 7 7 7 12 8 4 7 10 0 12 0 5 0 7 7 12 0 13	15 9 7 8 -1

Problem F
Railway
Problem ID: day1/railway

A couple of years ago the Bergen Ministry of Infrastructure prepared a plan for a new light railway network. This network was supposed to connect all n neighbourhoods in the city with $n-1$ railway tracks in such a way, that there would be a path from every neighbourhood to every other neighbourhood. The planned tracks are identified by numbers from 1 to $n-1$.

Years passed, new elections are approaching, and the railway network still exists only on paper. Therefore the Minister of Infrastructure (representing a party holding disagreement in high regard) decided to construct at least some part of the plan. He asked each of his m deputy ministers to choose which neighbourhoods *they* thought should be connected. That will result in a list of necessary tracks for each deputy minister. If a deputy minister thinks that the neighbourhoods $a_1, \ldots, a_s$ need to be connected, then according to him or her, the necessary tracks are all those which lie on planned paths from a_i to a_j for some $1 \le i < j \le s$.

The minister just received all lists from the deputy ministers. He decided to construct in the first place the tracks which are requested by at least k deputy ministers. Your task is to prepare a list of these tracks.

Input

In the first line of the input there are three integers n, m and k. The next $n-1$ lines contain the plan; in the i-th of these lines there are two integers a_i and b_i ($1 \le a_i, b_i \le n, a_i \ne b_i$), specifying that the i-th track on the plan is between neighbourhoods a_i and b_i.

In the next m lines there are neighbourhoods chosen by deputy ministers; the i-th of these lines begins with an integer s_i which specify the number of neighbourhoods chosen by the i-th deputy minister. After it there are s_i integers specifying these neighbourhoods. The total length of all lists of deputy ministers is at most S, i.e. $\sum_{i=1}^{m} s_i \le S$.

Constraints

We always have $2 \le s_i \le n \le 100\,000$, $S \le 100\,000$, and $1 \le k \le m \le 50\,000$. For subcases, the inputs have these further restrictions:

Group 1: 8 points $n \le 10\,000$, $S \le 2000$,

Group 2: 15 points $n \le 10\,000$, $m \le 2\,000$,

Group 3: 7 points Every neighbourhood is the endpoint of at most 2 planned tracks.

Group 4: 29 points $k = m$, $s_i = 2$,

Group 5: 16 points $k = m$,

Group 6: 25 points No further restrictions.

Output

In the first line of the output you should write one integer r, specifying the number of tracks which are requested by at least k deputy ministers. In the second line you should write r identifiers of these tracks in ascending order.

Explanation of sample

The first deputy minister thinks that tracks 1–3, 2–3, 3–4 and 4–5 are necessary. The second deputy minister considers tracks 3–4 and 4–6, and the third one only track 2–3. Tracks 2–3 and 3–4 are necessary according to at least two deputy ministers.

Sample Input 1	Sample Output 1
6 3 2 1 3 2 3 3 4 6 4 4 5 4 1 3 2 5 2 6 3 2 3 2	2 2 3

Problem G
Friends
Problem ID: day2/friends

CC BY-NC-SA 2.0, Dolores Umbridge by Julio Oliveiraa via Flickr

High school is all about being in the coolest group of friends. Headmistress Umbridge knows this, and she also knows that knowledge is power. She has collected data on all of the n students at the school, asking each of them who they are friends with. Now she has a list of responses, but she is suspicious that some of the students might not have been entirely truthful during the questioning.

From anonymous (but highly reliable) sources, Headmistress Umbridge knows that the friendships at her school satisfy the following properties:

- If a is friends with b then b is also friends with a.
- The set of students can be partitioned into groups, such that every student participates in exactly one group, where
  - each group has at least one and at most p students, and
  - for each group there are at most q pairs of friends with the first one in the group, and the second one outside of it.

Note that two students in the same group do not have to be friends.

Umbridge has hired you to figure out whether it is possible that all students are telling the truth, or whether she can be sure that at least one student is lying, and that she therefore should put everyone in detention. Is this morally questionable? Probably.

(In case the students may be telling the truth, you are worried that her suspicion might fall on you instead; thus you will also want to provide evidence of a valid partition if there is one.)

Input

First a single line with three non-negative integers n, p and q as described above. Next follow n lines, one for each student, starting with student $i = 0$. Each such line starts with an integer m_i, denoting the number of friends student number i claims that she has. Then follow m_i distinct integers between 0 and $n - 1$, indicating who those friends are (the students are numbered from 0 to $n - 1$).

Constraints

We always have $1 \leq n \leq 2\,500$, and $p + q \leq 15$. Furthermore, it is guaranteed that $m_0 + m_1 + \ldots + m_{n-1} \leq 30\,000$. A student never lists herself as one of her friends. For subcases, the inputs have these further restrictions:

- **Group 1: 20 points** $n \leq 16$
- **Group 2: 37 points** $n \leq 250$ and $q \leq 2$
- **Group 3: 12 points** $q \leq 2$
- **Group 4: 31 points** No further restrictions.

Output

If Dolores can be certain someone did't tell the truth, output "detention". Otherwise, output "home". If you output home on the first line, then you should prove your claim by outputting a partition of the students into groups such that the requirements above hold (if there are several, any one will do): The second line should then contain a positive integer G, the number of groups. The following G lines should each begin with a positive integer g_i, the number of students in the i-th group. Then on the same line, g_i integers indicating the students in this group.

Sample Input 1	Sample Output 1
4 2 1 1 1 2 0 2 2 1 3 1 2	home 2 2 0 1 2 2 3

Sample Input 2	Sample Output 2
5 2 1 1 1 2 0 2 2 1 3 2 2 4 1 3	detention

Sample Input 3	Sample Output 3
3 3 3 2 1 2 2 0 2 1 0	detention

Problem H
Plus Minus
Problem ID: day2/plusminus

Matthew the physicist studies the quantum electro-dynamics of a silicon-based rectangular microchip. The microchip consists of a very large $N \times M$ grid of electrons. Each electron has either positive (up) or negative (down) spin, denoted by $+$ and $-$ respectively.

Matthew does not know the spin of all the electrons, but he has done K measurements. In the i-th measurement, he discovered that the electron at position (y_i, x_i) has a given spin s_i. He also knows that in each 2×2 subgrid, there are equally many electrons with positive and negative spin. He wants to know whether he can recover the state of every electron based on his measurements. If not, he would like to know how many possible states are consistent with his measurements. For classified reasons, he wants the answer modulo $10^9 + 7$.

Input

The first line contain three numbers N, M and K: the height of the grid, the width of the grid and the number of measurements. The next K lines contain a spin s_i where s_i is either $+$ or $-$, and two numbers $1 \leq y_i \leq N$ and $1 \leq x_i \leq M$ – the coordinates of the electron. Matthew never did two measurments at the exact same location.

Constraints

We always have $1 \leq N, M \leq 10^9$ and $0 \leq K \leq 100\,000$. For subcases, the inputs have these further restrictions:

- **Group 1: 12 points** $N, M \leq 5$
- **Group 2: 42 points** $N, M \leq 1\,000$
- **Group 3: 46 points** No further restrictions.

Output

Output the total number of valid states consistent with Matthew' measurements modulo $10^9 + 7$.

Explanation of sample 1

The only two valid grids are
+-+-
+-+-
and
+-+-
-+-+

Sample Input 1	Sample Output 1
2 4 4 + 1 1 - 1 2 + 1 3 - 1 4	2

Sample Input 2	Sample Output 2
3 3 3 - 2 1 + 2 3 + 3 3	0

Problem I
Cat in a tree
Problem ID: day2/catinatree

A cat lives in a tree that has N nodes. She will demarcate her territory by "marking" some of the tree nodes. Marked nodes may not be closer to each other than distance D. Find the maximum number of nodes that the cat can mark.

CC BY-2.0, Just a kitten in a tree by Zoe Shuttleworth via Flickr

Input

First line has two integers, N and D. The 0'th node is the root node of the tree. Then follows $N-1$ lines, the i-th of which contain a single integer x_i with $0 \leq x_i < i$ (starting with $i = 1$). This means that node x_i is connected to node i.

Constraints We always have $1 \leq N, D \leq 2 \cdot 10^5$. For subcases, the inputs have these further restrictions:

- **Group 1: 11 points** $N \leq 18$
- **Group 2: 40 points** $N \leq 1\,500$
- **Group 3: 49 points** No further restrictions.

Output

Output should contain one integer: the maximum number of nodes that can be marked.

Sample Input 1	Sample Output 1
4 3 0 0 1	2

Sample Input 2	Sample Output 2
3 1000 0 0	1

This page is intentionally left blank.

Problem J
Parity Game
Problem ID: extra/paritygame

Consider the following two-player game. Some positive integer is given at the start of the game. Two players move alternately, and the first player moves first.

When a player moves, he selects any digit in the present number and deletes it. Remaining digits close up so, that the number does not contain a hole. The obtained number is added to the "accumulator." At the beginning, the accumulator contains 0.

The game is over when all digits are deleted. The first player wins if the accumulator contains an even number at the end of the game, the second player wins otherwise.

Consider this sample game, with starting number = 2017. The first player deletes the second digit. Remaining number = 217. Accumulator = 217. The second player deletes the last digit. Remaining number = 21. Accumulator = 238. The first player deletes the last digit. Remaining number = 2. Accumulator = 240. The second player deletes the only digit. Accumulator final value = 240 is even, so the first player wins.

Note: Leading zeros may appear if the first digit of the number is deleted. These zeros will continue to participate in the game. Thus, the number of digits is reduced by exactly one each round.

Your job is to find a winning strategy, and list all possible winning first moves for the first player.

Input

A single non-negative integer n given by k digits. Note that n will have leading zeros if $k > \lceil log_{10}(n) \rceil$.

Constraints (tentative)

In all subtasks we have $0 \le n < 10^{100\,001}$. For testsets worth 30 points, $n \le 10^8$.

Output

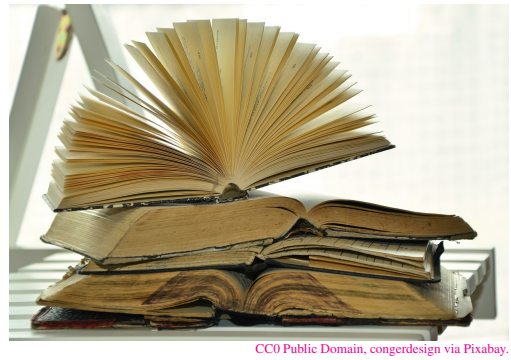
Output a single line containing k letters - one symbol for each digit of n. Each symbol must be either W or L. If the removal of i-th digit by the first player at the first move allows him to win (assuming that both players play in the best possible way), then in the i-th position there should be symbol W, otherwise - symbol L.

Sample Input 1	Sample Output 1
2017	LLLL

Sample Input 2	Sample Output 2
012345	LLLLLW

This page is intentionally left blank.

Problem K
Citations
Problem ID: extra/citations


CC0 Public Domain, congerdesign via Pixabay.

Grace is going to read a certain scientific book. However, she is very careful about always reading the sources that books refer to, and also the sources of the sources, and so on. It usually ends up being the case that she reads quite a lot more books than just the one she originally intended to read. The librarians are constantly complaining about Grace's excessive borrowing of books, and so she now wants to find an order in which to read the books that minimizes the total borrow time.

There are N books that she eventually will need to read. The books are numbered from 1 to N, and book i takes K_i minutes to read. Book i additionally has a citation list containing F_i books. First, Grace borrows all N books, and then she reads book 1.

When Grace reads a book she does the following:

- First she opens the book and reads the citation list, which takes a minute,
- then she reads all the books that are in the list, in some order of her own choosing,
- thereafter she reads the actual book and returns it to the library, which takes K_i minutes.

You now want to compute the minimum total borrow time for all books, given that Grace reads the books in an optimal order. Books may contain empty citation lists, and every book except book 1 *will occur in exactly one citation list*. There will be no cycles of citations.

Input

The first line contains the integer N, $1 \leq N \leq 100\,000$. Then follows N lines, one for each book 1 to N. On each such row there will be a number $1 \leq K_i \leq 1\,000$, the number of minutes the book takes to read. Then follows a number $0 \leq F_i < N$, followed by F_i numbers, the indices of the books that book i refers to.

Constraints

- **20 points** $N \leq 10$,
- **30 points** $N \leq 50$, $K_i \leq 10$, $F_i \leq 5$,
- **20 points** $F_i \leq 5$,
- **30 points** No further restrictions.

Output

One positive integer, the minimum sum of borrow times for all books.

Explanation of sample

time 1: open book 1
time 2: open book 2
time 3: open book 4
time 4: close book 4 (borrow time 4 minutes)
time 14: close book 2 (borrow time 14 minutes)
time 15: open book 3

time 16: open book 5
time 17: close book 5 (borrow time 17 minutes)
time 37: close book 3 (borrow time 37 minutes)
time 38: close book 1 (borrow time 38 minutes)

Sample Input 1	Sample Output 1
5 1 2 2 3 10 1 4 20 1 5 1 0 1 0	110