ICPC Northern Round 2025

University of Engineering and Technology

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GIFT

0.5s | 128 MB

Khanh Dan's birthday is approaching, and Scratch decided to make a handmade item to give as a gift. Specifically, Scratch personally made a large wooden block of size p×q×r (assembled from pqr unit blocks). However, due to Scratch's lack of experience, some of the unit blocks in the big block were peculiar (cracked, hollow inside, etc.). Scratch cannot directly give such a gift.

Therefore, Scratch plans to carve a sub-block a×a×b from the big block (requiring that the rectangular block to be carved must have two adjacent sides equal). Naturally, this sub-block must not contain any error unit blocks.

To maximize the number of samples the block can contain, Scratch wants to choose the solution with the largest possible value of 4ab from all possible alternatives. But just checking to see which part of the block has the problem exhausted Scratch. As Scratch's good friend, can you help him?

INPUT

The first line contains three positive integers separated by spaces: p, q, r ($1 \le p, q, r \le 150$).

Each line in the following line pq contains r characters, where each character is 'P' (Peculiar) or 'N' (Normal), indicating whether the corresponding unit block is peculiar or intact. Specifically, the zth character in the $(1 + (yp + x - p))$ row describes the condition of the block at coordinates (x, y, z). ($1 \le x \le p$, $1 \le y \le q$, $1 \le z \le r$)

OUTPUT

Print an integer representing the optimal 4ab value.

Sample Input	Sample Output
4 3 5 NNNNP NPNPN PNPPN NNNNN NNNNN NNNNN NNNNP NNPPN NNPPN PNNNN NNNNN NNPNN	24

EXPLANATION

Ước gì được như ngài!!

MOVIE

0.5s

During a rare holiday, Sunflower''s class organized a group movie trip. However, due to the large number of people during the holiday season, buying tickets for the whole class to watch the same screening is very difficult. Finally, the class found a movie theater hidden in a deserted alley. This cinema has a unique seating allocation system, described as follows:

1. The theater has K seats numbered from 1... K. After purchasing tickets, each person is randomly assigned a seat. Specifically, a positive integer L is chosen with equal probability from 1…K.
2. If $L \leq K$ and seat L is available, that seat will be assigned to that person. Otherwise, L is increased by one and the process repeats.
3. If there are no L seats available in the second step, the person must stand to watch the movie — also known as a standing ticket.

Sunflower's class has N students (including Sunflower). As a math enthusiast, Sunflower wanted to know the probability that every student in the class could get a seat.

INPUT

The first line contains the number of tests T ($T \leq 50$).

Each of the next T lines contain two positive integers N and K ($N, K \leq 200$).

OUTPUT

For each test, print on online two numbers A and B, indicating that the answer is A/B. The answer must be expressed as a reduced fraction.

Sample Input	Sample Output
40	1 1
1 6	1 1
1 7	1 1
1 8	1 1
1 9	1 1
1 10	35 36
2 6	48 49
2 7	63 64
2 8	80 81
2 9	99 100
2 10	49 54
3 6	320 343
3 7	243 256
3 8	700 729
3 9	121 125
3 10	343 432
4 6	2048 2401
4 7	3645 4096
4 8	2000 2187
4 9	9317 10000
4 10	2401 3888
5 6	12288 16807
5 7	6561 8192

5 8 5 9 5 10 6 6 6 7 6 8 6 9 6 10 7 7 7 8 7 9 7 10 8 8 8 9 8 10 9 9 9 10 10 10	50000 59049 43923 50000 16807 46656 65536 117649 177147 262144 400000 531441 161051 200000 262144 823543 531441 1048576 1000000 1594323 1771561 2500000 4782969 16777216 20000000 43046721 58461513 100000000 100000000 387420489 214358881 500000000 2357947691 10000000000

EXPERIENCE

1s

Little Potato Mine was working in a biology lab and encountered big trouble. His compartmentalized laboratory dish is a cube with dimensions a × b × c. For experimental convenience, it is divided into a × b × c 1 × 1 × 1 unit cube and (i, j, k) is used to define a unit cube.

The dish is not used for a long time. Now, Potato Mine is asked to clean several areas of the cube (each area can be cleaned multiple times). Little Potato Mine will use a specific bleach for cleaning. This bleach is especially strange: every time a rectangular cubic area of size x × y × z (including x × y × z cubic units) is cleaned, the amount of units of bleach required is min(x, y, z). The price of the bleach is not cheap, which makes Potato Mine feel uncomfortable.

Help him determine the minimum number of units of bleach needed.

INPUT

The first line contains the number of tests T ($T \leq 3$).

In each test: the first line contains 3 positive integers X, Y, Z describing the dimensions of the experimental dish ($X*Y*Z \leq 5000$).

Following that, there will be X 01 matrices with Y rows and Z columns describing the status of each unit block (0 means that the corresponding unit block does not require cleaning, and 1 means that the corresponding unit block needs to be cleaned): the number in the i-th row, j-th column of the k-th matrix describes the status of the unit block (i, j, k).

OUTPUT

For each test, print on one line the minimum number of units of bleach needed.

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

EXPLANATION

Cleaning the area (1,1,3) - (2,2,4) and (1, 1,1) - (4,4,1), costs 2 units and 1 unit of bleach.

STOCK

0.5s

Recently, when Crazy Dave was learning how to buy stocks, he received inside information: Company V's shares would skyrocket. The daily price of a stock is known to be a positive integer and, for objective reasons, can only have a maximum price of N. During the K spike days, Dave observed: the stock price of each day except the first day is higher than the previous day, and the difference (that is, the difference between the current day's stock price and the previous day's stock price) will not exceed M, with M being a positive integer. And these parameters satisfy $M(K-1) < N$.

Crazy Dave forgot the specific stock price of K on these days, and now he wants to know how many configurations there are for the stock price on these K days. Two configurations are considered different if on some day, the stock price according to them are different.

INPUT

A single line contains 4 numbers N, K, M, P ($N \leq 10^{18}$; M, K, $P \leq 10^9$). P is not necessarily a prime number.

OUTPUT

Print a single integer representing the answer.

Sample Input	Sample Output
7 3 2 1024	16
3001 400 6 9901	8669

EXPLANATION

In the first sample, all possible price configurations are {1,2,3},{1,2,4},{1,3,4},{1,3,5}, {2,3,4}, {2,3,5},{2,4,5}, {2,4,6} ,{3,4,5},{3,4,6},{3,5,6},{3,5,7},{4,5,6},{4,5,7},{4,6,7},{5,6,7}. There are 16 of them in total.

GRAPH

1s

Consider an undirected connected graph with n vertices and m edges. The vertices are numbered from 1 to n and the edges are numbered from 1 to m. Baby Peashooter performs a random walk on the graph. Initially, Peashooter is at vertex 1. At each step, Peashooter randomly chooses an edge of the current vertex with equal probability, and walks along this edge to the next vertex, obtaining a point that is the index number of this edge. The walk ends when Peashooter reaches vertex n, and the total score is the sum of all points obtained.

Find the minimal expected value of Peashooter total score across all possible numberings of the m edges.

INPUT

The first line contains two integers representing the number of vertices n and edges m of the graph (2 <= n <= 500).

Each of the next m lines contains two integers u, v, indicating that there is an edge between two vertices u and v (1 <= u, v <= n).

It is guaranteed that the graph is connected and contains no self-loops or multi-edges.

OUTPUT

Print a single real number representing the answer, with exactly three decimal places.

Sample Input	Sample Output
3 3 2 3 1 2 1 3	3.333

EXPLANATION

Edge (1,2) is numbered 1, edge (1,3) is numbered 2, edge (2,3) is numbered 3.

GATO

After a lot of effort, Thanh had a rectangular piece of cake. Thanh planned to cut the cake in two pieces. For aesthetic reasons, Thanh wants the cutting surface to be as smooth and harmonious as possible.

For simplicity, we consider the pie as a cubic grid of length P, width Q and height R. Point (x, y, z) at row x, column y in layer z, has a non-negative dissonance value v(x, y, z). A valid cut meets the following two conditions:

- There is one and only one intersection with each vertical axis (total $P \times Q$). That is, the tangent is a function f (x, y); for all (x, y) ($x \in [1, P]$, $y \in [1, Q]$), we need to specify an intersection point f (x, y) ($1 \le f(x, y) \le R$).
- The cutting surface needs to meet certain smoothness requirements, meaning that cutting points on adjacent longitudinal axes cannot be too far apart. That is, for all $1 \le x, x' \le P$ and $1 \le y, y' \le Q$, if $|x - x'| + |y - y'| = 1$, then $|f(x, y) - f(x', y')| \le D$, where D is a given non-negative integer.

There can be many cutting functions f that satisfy the above conditions, and Thanh wants to find one with the smallest total dissonance value.

INPUT

The first line records 3 positive integers P, Q, R which are the length, width and height of the cake respectively ($1 <= P, Q, R \le 40$).

The second line records the smoothness D, followed by R*P*Q lines describing R matrices of size P x Q; located at column x, row y of matrix z is v(x, y, z) ($1 \le x \le P$, $1 \le y \le Q$, $1 \le z \le R$, $0 \le v(x, y, z) \le 1000$).

OUTPUT

Print out a single integer representing the minimum total dissonance value possible.

Sample Input	Sample Output
2 2 2 1 6 1 6 1 2 6 2 6	6

EXPLANATION

One optimal cut is f(1,1) = f (2,1) = 2, f(1,2) = f(2,2) = 1.

LINES

1s

Thanh has divided the Oxy plane into n + 1 different vertical media with refractive indices a_0, a_1, a_2, …, a_n (not necessarily unique). The first medium is normal air ($a_0 = 1$).

The media are separated by n vertical boundaries h_1 to h_n ($-\infty = h_0 < h_1 < h_2 < \ldots < h_n < h_{n+1} = \infty$). Thus, the i-th medium is the part between two lines $x = h_i$ and $x = h_{i+1}$.

Thanh now casts q laser beams from q points (x_i, y_i), which lie in the first medium, aiming at (z_i, t_i) ($1 \le i \le q$). Now Thanh needs to find the total length each ray has travelled from the starting point until it reaches the n-th medium for the first time. It is guaranteed that the ray will eventually reach the n-th medium.

Every laser beam follows the Snell's law of refraction. In short,

$n_1 \sin\theta_1 = n_2 \sin\theta_2$,

where θ_i is the angle between the ray and the normal (the x-axis), and n_1, n_2 are the refractive indices of the two media.

INPUT

The first line contains two positive integers n and q ($1 \le n, q \le 10^5$).

For the next n lines, line i contains two integers h_i and a_i ($0 \le h_i \le 10^9$, $1 \le a_i \le$ 10^9).

For the last q lines, line i contains four integers x_i, y_i, z_i, t_i ($0 \le x_i < z_i$, $x_i < h_1$, $-1000 \le x_i, y_i, z_i, t_i \le 1000$).

OUTPUT

For each query, output one number per line. The answer is considered correct if the absolute error or the relative error does not exceed 10^{-4}.

Sample Input	Sample Output
3 1 3 6 6 3 9 9 1 1 2 2	8.936454547

EXPRESSIONS

1s | 512MB

Given a list of n distinct number, Jack want to create expressions using only the numbers in the list with ***addition, multiplication*** and ***parenthesis***. Jack defines the relationship "~" between two expressions as follows:

- $a \sim (a)$
- $a + b \sim b + a$ and $a \times b \sim b \times a$
- $a + (b + c) \sim (a + b) + c \sim a + b + c$ and $a \times (b \times c) \sim (a \times b) \times c \sim a \times b \times c$
- $1 \times a \sim a$
- If $a \sim b$ and $b \sim c$ then $a \sim c$

Two expressions a and b are considered the same if and only if $a \sim b$.

Find the number of **distinct expressions** that evaluated to m.

INPUT

First line of input is T ($T \geq 1$) the number of tests. Each test will have the following format

The first line of each test is two number n, m ($1 \leq n \leq m \leq 5 \times 10^5$)

The second line of each test is n number $1 \leq a_1 < a_2 < \ldots < a_n \leq m$, the numbers on the list

It is guaranteed that the sum of m over all test cases does not exceed 5×10^5

OUTPUT

For each test output the answer on a single line, since the answer can be big, print it in modulo 998244353

Sample Input	Sample Output
5 1 1 1 1 99 2 5 5 1 2 3 4 5 1 10 1 8 5000 2 3 5 7 11 13 17 19	1 0 10 10 299891645

In the third test, 5 can be represented as

1+1+1+1+1

1+1+1+2

1 + 2 + 2

1+1+3

1 + 4

1 + 2.2

1 + (1+1).2

1 + (1+1).(1+1)

2 + 3

5

In the forth test, 10 can be represented as

1+1+1+1+1+1+1+1+1+1

1+1+1+1+1+1+(1+1).(1+1)

1+1+1+1+(1+1+1).(1+1)

1+1 + (1+1).(1+1+1+1)

1+1+ (1+1).(1+1).(1+1)

1+1+ (1+1).(1+1) + (1+1).(1+1)

1 + (1+1+1).(1+1+1)

(1+1).(1+1+1+1+1)

(1+1).(1+(1+1).(1+1))

(1+1).(1+1) + (1+1).(1+1+1)

CyberFFT

1s

Misdeed is thinking of jumping. Jumping down the stairs.

His staircase has n ($n \le 10^{18}$) steps, and he's starting at step n. He's thinking of jumping k ($1 \le k \le 60$) times in total, each time he can jump an unlimited amount of steps or none at all, as long as he doesn't reach past the end of the staircase – as in, he does not land lower than step 0. Count for Misdeed how many ways can he jump successfully. *Thanks*.

That's the problem statement, at first. However, Misdeed is ugly and prickly.

Call the sequence of jumps $a_1, a_2, \ldots, a_k$. Now, on turn i, Misdeed will jump $a_i * i$ steps, instead. Thus, $a_1 * 1 + a_2 * 2 + \ldots + a_k * k \le n$. Plus, now, $(a_1 \& a_2 \& a_3 \& \ldots \& a_k) = x$ ($x \le 10^{18}$); or else, Misdeed would slip and crack his skull on the edge of a step.

And die.

Count for Misdeed how many jump sequence fits his demands so that he can survive this. *Thanks*.

INPUT

Three numbers n, k, x ($n, x \le 10^{18}$, $1 \le k \le 60$), describing the number of steps on Misdeed's staircase, the number of jumps, and the AND condition of his jumps.

OUTPUT

The number of jumping sequences that fits Misdeed's demand modulo $10^9 + 7$. *Thanks.*

Sample Input	Sample Output
11 3 1	4

EXPLANATION

The sequences are: [1, 1, 1], [3, 1, 1], [1, 3, 1], [5, 1, 1]

WALTZ

5s

As great dancers, Katharina and you are invited for the opening waltz at the annual ball event of Infamously Clumsy People's Community. After hours of training, both of you are confident in your skill. However, as the name suggests, other dancers might be clumsy and mistake someone else's partner as their own, especially on a chaotic dance floor.

This year, the opening waltz is performed as follow: first, all n dancers stand in a line. Each dancer is given an ID number so that spectators can follow.

Then, at some point, the dancers with indices from l to r perform a circular dance of k steps. This means if before the dance, the ID's of n dancers form an array of n integers $b_1, \ldots, b_n$, at the end of the dance, their ID's are now

$b_1, \ldots, b_{l-1}, b_{r-k+1}, b_{r-k+2}, \ldots, b_{r-1}, b_r, b_l, b_{l+1}, \ldots, b_{r-k}, b_{r+1}, \ldots, b_n$.

As everyone dances, you do not want to lose sight of your precious partner (or else, she will be very mad at you afterwards). But there are three problems:

• You are clumsy, so you cannot keep track of her whilst dancing;

• Other dancers are clumsy, so whilst to the spectators' eyes, the ID numbers might look consistent, somehow a dancer might not end up with someone else's ID number (hence the need for ID numbers in the first place). Thus, even Katharina's ID number might change.

• The organiser is also clumsy, so there might be multiple dancers with the same ID number;

Knowing this, from time to time, Katharina will ask you to identify her. She will gives you three numbers, l, r, and k, meaning that her ID number is the k-th smallest number amongst those of dancers with indices from l to r in the line.

In other words, if the ID's of n dancers form an array of n integers $b_1, \ldots, b_n$, then her ID is the k-th smallest number amongst $b_l, \ldots, b_r$.

INPUT

The input consists of:

• One line with two integers n and q ($1 \le n, q \le 10^5$), the size of array and the number of queries.

• One line with n integers $a_1, \ldots, a_n$ ($1 \le a_i \le 10^9$ for each i), where ai denotes the i th of the initial array.

• q lines, the i th of which contains four integers t_i, l_i, r_i, k_i. Assume that before this dance, the heights of the dancers in their order are $b_1, b_2, \ldots, b_{n-1}, b_n$.

– If $t_i = 1$, it means the dancers with indices from l to r perform a circular dance of k steps. In other words, then at the end of the dance, the heights of dancers are now $b_1, \ldots, b_{l-1}, b_{r-k+1}, b_{r-k+2}, \ldots, b_{r-1}, b_r, b_l, b_{l+1}, \ldots, b_{r-k}, b_{r+1}, \ldots, b_n$.

– If $t_i = 2$, then Katharina wants you to identify her. Her ID number is the k-th smallest amongst all dancers with indices from l_i to r_i, meaning with ID's $b_l, \ldots, b_r$.

OUTPUT

For each query of type 2, output Katharina's ID number.

Sample Input	Sample Output
10 10 10 5 7 5 1 9 8 1 10 1 1 6 10 1 2 1 4 2 2 3 7 3 1 9 10 1	5 5 1 5 1 5

2 5 8 2 2 2 4 1 1 4 10 4 2 6 8 1 1 1 10 9 2 1 3 1	

TRAVEL

1s

In a far away country, there is a tourist named Thanh, who hopes to travel across the country on his bicycle. In this country, each city has an index, and there are n cities, numbered from 1 to n. A city either has no scenic spots that Thanh wants to visit, or has exactly 1 scenic spot that Thanh wants to visit.

Thanh has arranged a route going through all the attractions he wanted to visit: the 1st destination city is a_1, the i-th destination city is a_i, and finally, arriving at city a_n ends the trip. Thanh hopes to complete the trip exactly in month m (m < n), so he needs to plan his travel properly.

When Thanh arrives in a city, if the city has a tourist attraction that he wants to visit, he will receive 1 happy point, else Thanh will receive 1 sad point. A month is enough time for him to visit as many cities as he wants, but he also wants to rest a bit. Thanh always rests at the last city he visits that month (but if there is an attraction in this city, Thanh will always visit it before resting). Of course, Thanh hopes to have a certain travel plan every month, even if there are no attractions he wants to visit in the destination city during the month; in other words, he will visit at least one new city every month.

Thanh needs to come up with a travelling/resting schedule, i.e, a string $x_1, x_2, \ldots, x_m$, where x_i is the index number of the city at where Thanh rests in month i. Since he has to finish his trip after the last month, $x_m = a_n$. For example: n = 5, m = 3, $(a_1, a_2, a_3, a_4, a_5) = (3, 2, 4, 1, 5)$, $(x_1, x_2, x_3) = (2, 1, 5)$, meaning: In month 1 he goes to cities 3 and 2, and rests at city 2; in month 2 he goes to city 4 and city 1, and rests at city 1; in month 3 he goes to city 5 and rests at city 5. There are many such plans.

For a schedule K, let the absolute value of the difference between the happy value and the sad value obtained during the trip of month i be d_i. The largest value in the sequence $d_1, d_2, \ldots, d_m$ is called C_K.

Thanh hopes that the C_K of the selected schedule is the smallest among all the schedules.

In fact, there can be many schedules in which C_K is smallest, so he wants to find the schedule with the smallest lexicographical order.

Pro tip: Comparing the lexical order of two strings is comparing the first different number, such as (1,2,3,4) < (1,2,4,3).

INPUT

The first line contains two positive integers n, m, indicating the number of cities and the number of months spent travelling ($n \le 5\times10^5$, $m \le 2\times10^5$).

Each of the next n lines contains 2 integers A_i and B_i which are the ordinal numbers of the city where Thanh visited i and B_i is 0 or 1. If $B_i = 0$ (1), it means that A_i city does not have (has) the tourist attractions that Thanh likes. The values Ai are distinct and $1 \le A_i \le N$, meaning $\{A_i\}$ is a permutation of $\{1,\ldots,N\}$.

OUTPUT

Print out on one line m positive integers $x_1, x_2, \ldots, x_m$, which means the route corresponding to Thanh's travel plan.

Sample Input	Sample Output
8 3 2 0 3 1 4 1 1 0 5 0 6 1 7 1 8 0	1 6 8

EXPLAIN

2 happy points and 2 sad points in month 1, 1 happy point and 1 sad point in month 2, and 1 happy point and 1 sad point in month 3. The maximum value of the difference between sad value and happy value at month 3 is 0, which is the minimum value for all schedules. Possible solutions are:

1 6 8

3 6 8

3 1 8

Among them, 1 6 8 is the smallest lexicographic order.