Problem A. Colorful Segments

Input file:	`standard input`
Output file:	`standard output`
Time limit:	4 seconds
Memory limit:	1024 megabytes

Consider n segments on the number axis, where the left endpoint of the i-th segment is l_i and the right endpoint is r_i. Each segment has a color where the color of the i-th segment is c_i ($0 \le c_i \le 1$). There are two types of colors, where $c_i = 0$ indicates a red segment and $c_i = 1$ indicates a blue segment.

You need to choose some segments (you can also choose no segments at all). If any two chosen segments overlap, then they must have the same color.

Calculate the number of ways to choose segments.

We say segment i overlaps with segment j, if there exists a real number x satisfying both $l_i \le x \le r_i$ and $l_j \le x \le r_j$.

We say two ways of choosing segments are different, if there exists an integer $1 \le k \le n$ such that the k-th segment is chosen in one of the ways and is not chosen in the other.

Input

There are multiple test cases. The first line of the input contains an integer T indicating the number of test cases. For each test case:

The first line contains an integer n ($1 \le n \le 10^5$) indicating the number of segments.

For the following n lines, the i-th line contains three integers l_i, r_i and c_i ($1 \le l_i \le r_i \le 10^9$, $0 \le c_i \le 1$) indicating the left and right endpoints and the color of the i-th segment.

It's guaranteed that the sum of n of all test cases will not exceed 5×10^5.

Output

For each test case output one line containing one integer indicating the number of ways to choose segments. As the answer may be large, please output the answer modulo 998244353.

Example

standard input	standard output
2 3 1 5 0 3 6 1 4 7 0 3 1 5 0 7 9 1 3 6 0	5 8

Note

For the first sample test case, you cannot choose the 1-st and the 2-nd segment, or the 2-nd and the 3-rd segment at the same time, because they overlap with each other and have different colors.

For the second sample test case, as the 2-nd segment does not overlap with the 1-st and the 3-rd segment, you can choose them arbitrary.

Problem B. Be Careful 2

Input file:	`standard input`
Output file:	`standard output`
Time limit:	12 seconds
Memory limit:	1024 megabytes

Little Cyan Fish has an $n \times m$ rectangle located in a plane. The top-right corner of the rectangle is at (n, m), while the bottom-left corner is at $(0, 0)$. There are k banned points inside the rectangle. The i-th banned point is located at (x_i, y_i).

Little Cyan Fish would like to draw a square inside the rectangle. However, he dislikes all the banned points, so there cannot be any banned points inside his square. Formally, Little Cyan Fish can draw a square with the bottom-left corner at (x, y) and a side length d if and only if:

- Both x and y are non-negative integers while d is a positive integer.
- $0 \le x < x + d \le n$.
- $0 \le y < y + d \le m$.
- For each $1 \le i \le k$, the following condition must **NOT** be met:
  - $x < x_i < x + d$ and $y < y_i < y + d$.

Please calculate the sum of the areas of all the squares that Little Cyan Fish can possibly draw. Since the answer could be huge, you need to output it modulo 998244353.

Input

The is only one test case in each test file.

The first line of the input contains three integers n, m and k ($2 \le n, m \le 10^9$, $1 \le k \le 5 \times 10^3$) indicating the size of the rectangle and the number of banned points.

For the following k lines, the i-th line contains two integers x_i and y_i ($0 < x_i < n$, $0 < y_i < m$) indicating the position of the i-th banned point. It is guaranteed that all the banned points are distinct.

Output

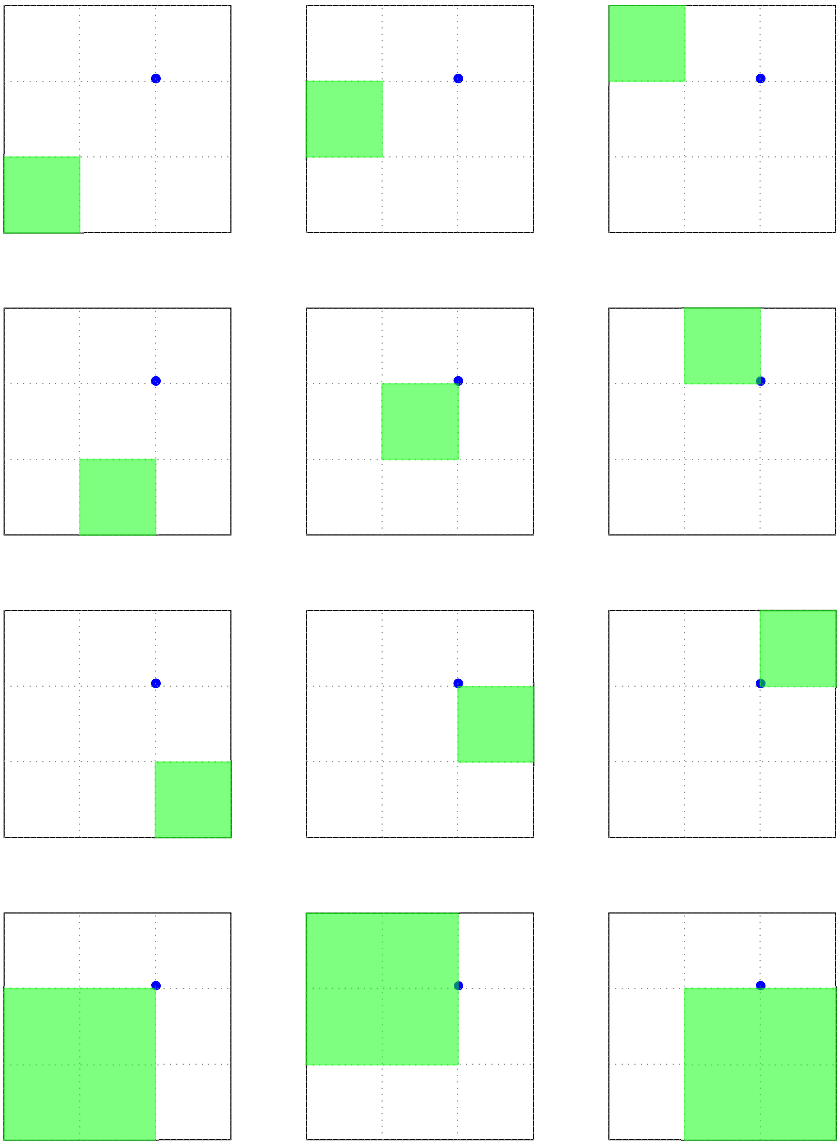
Output one line containing one integer indicating the answer modulo 998244353.

Examples

standard input	standard output
3 3 1 2 2	21
5 5 2 2 1 2 4	126

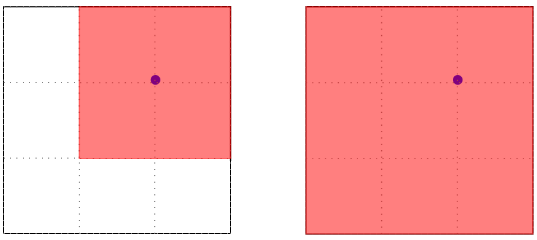
Note

For the first sample test case, Little Cyan Fish has 12 ways to draw a square, illustrated as follows.



There are 9 squares of side length 1 and 3 squares of side length 2. So the answer is $9 \times 1^2 + 3 \times 2^2 = 21$.

Note that the following plans are invalid since there's a banned point in the square.



Problem C. Connected Intervals

Input file:	`standard input`
Output file:	`standard output`
Time limit:	1 second
Memory limit:	256 megabytes

DreamGrid has just found a tree of n vertices in his backyard. As DreamGrid loves connected components, he defines an interval $[l, r]$ $(1 \le l \le r \le n)$ as a "connected interval" if the induced subgraph formed from the set $\mathbb{V} = \{v_i | i \in [l, r]\}$ consists of exactly one connected component, where v_i indicates the vertex whose index is i.

Given the tree in DreamGrid's backyard, your task is to help DreamGrid count the number of connected intervals.

Recall that an induced subgraph G' of a graph G is another graph, formed from a subset $\mathbb{V}$ of the vertices of the graph G and all of the edges in graph G connecting pairs of vertices in $\mathbb{V}$.

Input

There are multiple test cases. The first line of the input contains an integer T indicating the number of test cases. For each test case:

The first line contains an integer n $(1 \le n \le 3 \times 10^5)$ indicating the size of the tree.

For the following $(n-1)$ lines, the i-th line contains two integers a_i and b_i $(1 \le a_i, b_i \le n)$ indicating that there is an edge connecting vertex a_i and vertex b_i in the tree.

It's guaranteed that the given graph is a tree and that the sum of n in all test cases will not exceed 3×10^5.

Output

For each test case output one line containing one integer, indicating the number of connected intervals.

Example

standard input	standard output
2 4 1 2 2 3 3 4 4 1 2 2 3 2 4	10 9

Note

For the first sample test case, all intervals are connected intervals.

For the second sample test case, all intervals but [3, 4] are connected intervals.

Problem D. DS Team Selection 2

Input file:	`standard input`
Output file:	`standard output`
Time limit:	2 seconds
Memory limit:	1024 megabytes

Before participating in IOI 2023, you need to solve the following practice problem.

You have a sequence a of length n. You need to perform q queries.

1. Given v, change all a_i to $\min(a_i, v)$.
2. Change all a_i to $a_i + i$.
3. Given l, r, print the sum $\sum_{i=l}^{r} a_i$.

You may not go to IOI 2023, but the problem is still interesting to solve. Therefore, Little Cyan Fish asks you to solve it!

Input

The first line of the input contains two integers n and q ($1 \le n, q \le 2 \times 10^5$).

The next line of the input contains n integers $a_1, a_2, \cdots, a_n$ ($0 \le a_i \le 10^{12}$).

The next q lines of the input describes all the queries in the following format:

- $1\ v$ ($0 \le v \le 10^{12}$): Change all a_i to $\min(a_i, v)$.
- 2: Change all a_i to $a_i + i$.
- $3\ l\ r$ ($1 \le l \le r \le n$): Print the sum $\sum_{i=l}^{r} a_i$.

Output

For each query of type 3, output a single line contains a single integer, indicating the answer.

Example

standard input	standard output
13 11 6 14 14 6 3 6 4 13 10 3 12 5 11 1 2 2 2 2 1 11 3 4 6 2 1 6 2 1 9 3 2 13	33 107

Problem E. Computational Geometry

Input file:	`standard input`
Output file:	`standard output`
Time limit:	2 seconds
Memory limit:	1024 megabytes

Given a convex polygon P with n vertices, you need to choose three vertices of P, denoted as a, b and c in counter-clockwise order. There must be exactly k edges from b to c in counter-clockwise order (that is to say, a is not an endpoint of these k edges).

Consider cutting through P with segment ab and ac. Let Q be the polygon consisting of ab, ac and the k edges between b and c. It's easy to see that this polygon has $(k+2)$ edges.

Find the maximum possible area of Q.

Note that ab and ac can overlap with edges of P.

Input

There are multiple test cases. The first line of the input contains an integer T indicating the number of test cases. For each test case:

The first line contains two integers n and k ($3 \le n \le 10^5$, $1 \le k \le n-2$) indicating the number of vertices of the convex polygon P and the number of edges from b to c in counter-clockwise order.

For the following n lines, the i-th line contains two integers x_i and y_i ($-10^9 \le x_i, y_i \le 10^9$) indicating the x and y coordinate of the i-th vertex of the convex polygon P. Vertices are given in counter-clockwise order. It's guaranteed that the area of the convex polygon is positive, and there are no two vertices with the same coordinate. It's possible that three vertices lie on the same line.

It's guaranteed that the sum of n of all test cases will not exceed 10^5.

Output

For each test case output one line containing one real number indicating the maximum possible area of Q. Your answer will be considered correct if its relative or absolute error is less than 10^{-9}.

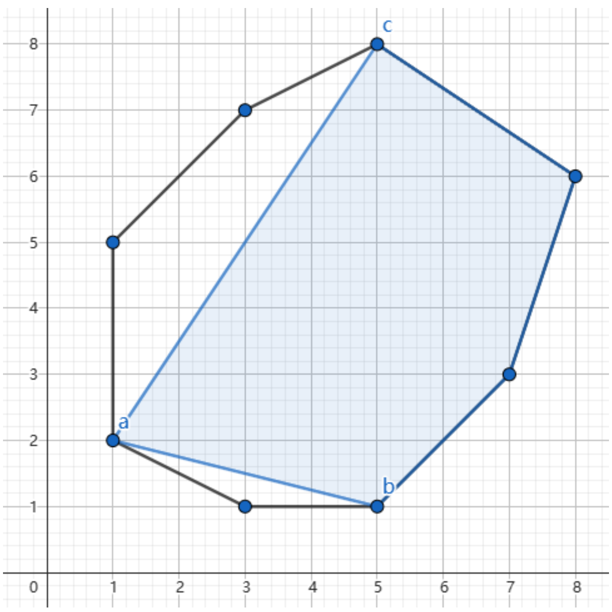
Example

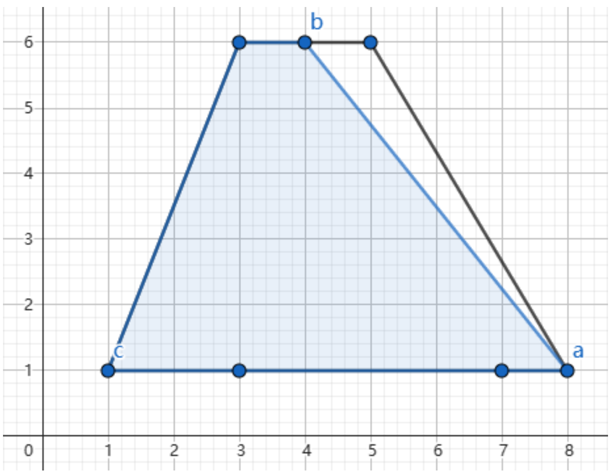
standard input	standard output
3 3 1 0 0 1 0 0 1 8 3 1 2 3 1 5 1 7 3 8 6 5 8 3 7 1 5 7 2 3 6 1 1 3 1 7 1 8 1 5 6 4 6	0.500000000000 26.500000000000 20.000000000000

Note

For the first sample test case, Q is the whole triangle. Its area is 0.5.

The second and third sample test case are shown below.





Problem F. Puzzle: Sashigane

Input file:	`standard input`
Output file:	`standard output`
Time limit:	1 second
Memory limit:	1024 megabytes

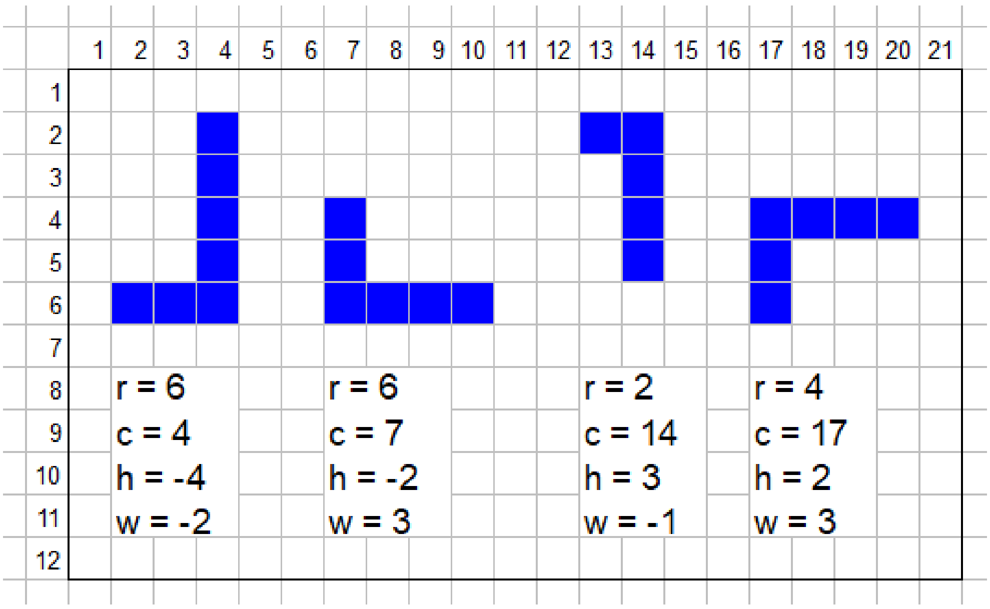
Given a grid with n rows and n columns, there is exactly one black cell in the grid and all other cells are white. Let (i, j) be the cell on the i-th row and the j-th column, this black cell is located at (b_i, b_j).

You need to cover all white cells with some L-shapes, so that each white cell is covered by exactly one L-shape and the only black cell is not covered by any L-shape. L-shapes must not exceed the boundary of the grid.

More formally, an L-shape in the grid is uniquely determined by four integers (r, c, h, w), where (r, c) determines the turning point of the L-shape, and h and w determine the direction and lengths of the two arms of the L-shape. The four integers must satisfy $1 \le r, c \le n$, $1 \le r + h \le n$, $1 \le c + w \le n$, $h \ne 0$, $w \ne 0$.

- If $h < 0$, then all cells (i, c) satisfying $r + h \le i \le r$ belong to this L-shape; Otherwise if $h > 0$, all cells (i, c) satisfying $r \le i \le r + h$ belong to this L-shape.
- If $w < 0$, then all cells (r, j) satisfying $c + w \le j \le c$ belong to this L-shape; Otherwise if $w > 0$, all cells (r, j) satisfying $c \le j \le c + w$ belong to this L-shape.

The following image illustrates some L-shapes.



Input

There is only one test case in each test file.

The first line contains three integers n, b_i and b_j ($1 \le n \le 10^3$, $1 \le b_i, b_j \le n$) indicating the size of the grid and the position of the black cell.

Output

If a valid answer exists first output `Yes` in the first line, then in the second line output an integer k ($0 \le k \le \frac{n^2-1}{3}$) indicating the number of L-shapes to cover white cells. Then output k lines where the i-th line contains four integers r_i, c_i, h_i, w_i separated by a space indicating that the i-th L-shape is uniquely determined by (r_i, c_i, h_i, w_i). If there are multiple valid answers you can print any of them.

If there is no valid answer, just output `No` in one line.

Examples

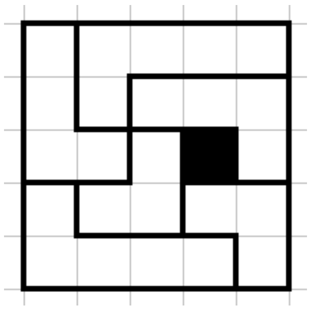
standard input	standard output

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

`1 1 1`	`Yes` `0`

Note

We illustrate the first sample test case as follows.



Problem G. Gem Island 2

Input file:	`standard input`
Output file:	`standard output`
Time limit:	2 seconds
Memory limit:	1024 megabytes

After solving the problem *Gem Island* from the ACM-ICPC World Finals 2018, Little Cyan Fish thinks that this problem is too easy. Luckily, Little Cyan Fish's good friend, Little DrinkDrinkCongee, prepared the following problem for him. So he would like to solve the following problem.

There are n boxes in a row. Initially there is exactly one ball in each box. You will perform the following operation exactly d times:

- Choose a ball x from all the balls uniformly at random.
- Assume the ball x is in the box b, add one more ball to the box b.

Apparently, during the i-th operation, each ball has a probability of $\frac{1}{n+i-1}$ to be chosen. Suppose that after d operations the numbers of balls in these n boxes are listed in non-increasing order as $a_1 \geq a_2 \geq \cdots \geq a_n$. Find the expected value of $\sum_{i=1}^{r} a_i$, modulo $998\,244\,353$.

Since the problem is too hard for Little Cyan Fish, he asked you to help him to solve this problem.

Input

The first line of the input contains three integers n, d and r ($1 \leq n, d \leq 1.5 \times 10^7$, $1 \leq r \leq n$).

Output

Output a single line contains a single integer, indicating the answer modulo $998\,244\,353$.

Examples

standard input	standard output
`2 3 1`	`499122180`
`3 3 2`	`698771052`
`5 10 3`	`176512750`

Problem H. Not Another Path Query Problem

Input file:	`standard input`
Output file:	`standard output`
Time limit:	4 seconds
Memory limit:	1024 megabytes

What age is it that you are still solving traditional path query problems?

After reading the paper *Distributed Exact Shortest Paths in Sublinear Time*, you have learned how to solve the distributed single-source shortest paths problem in $\mathcal{O}(D^{1/3} \cdot (n \log n)^{2/3})$. To give your knowledge good practice, Little Cyan Fish prepared the following practice task for you.

Little Cyan Fish has a graph consisting of n vertices and m bidirectional edges. The vertices are numbered from 1 to n. The i-th edge connects vertex u_i to vertex v_i and is assigned a weight w_i.

For any path in the graph between two vertices u and v, let's define the value of the path as the bitwise AND of the weights of all the edges in the path.

As a fan of high-value paths, Little Cyan Fish has set a constant threshold V. Little Cyan Fish loves a path if and only if its value is at least V.

Little Cyan Fish will now ask you q queries, where the i-th query can be represented as a pair of integers (u_i, v_i). For each query, your task is to determine if there exists a path from vertex u_i to vertex v_i that Little Cyan Fish would love it.

Input

There is only one test case in each test file.

The first line contains four integers n, m, q and V ($1 \le n \le 10^5$, $0 \le m \le 5 \times 10^5$, $1 \le q \le 5 \times 10^5$, $0 \le V < 2^{60}$) indicating the number of vertices, the number of edges, the number of queries and the constant threshold.

For the following m lines, the i-th line contains three integers u_i, v_i and w_i ($1 \le u_i, v_i \le n$, $u_i \ne v_i$, $0 \le w_i < 2^{60}$), indicating a bidirectional edge between vertex u_i and vertex v_i with the weight w_i. There might be multiple edges connecting the same pair of vertices.

For the following q lines, the i-th line contains two integers u_i and v_i ($1 \le u_i, v_i \le n$, $u_i \ne v_i$), indicating a query.

Output

For each query output one line. If there exists a path whose value is at least V between vertex u_i and v_i output `Yes`, otherwise output `No`.

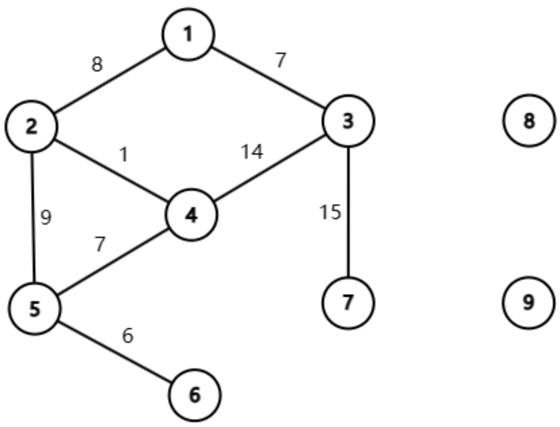
Examples

standard input	standard output
9 8 4 5 1 2 8 1 3 7 2 4 1 3 4 14 2 5 9 4 5 7 5 6 6 3 7 15 1 6 2 7 7 6 1 8	Yes No Yes No
3 4 1 4 1 2 3 1 2 5 2 3 2 2 3 6 1 3	Yes

Note

We now use & to represent the bitwise AND operation.

The first sample test case is shown as follows.



- For the first query, a valid path is $1 \to 3 \to 4 \to 5 \to 6$, whose value is $7 \,\&\, 14 \,\&\, 7 \,\&\, 6 = 6 \geq 5$.
- For the third query, a valid path is $7 \to 3 \to 4 \to 5 \to 6$, whose value is $15 \,\&\, 14 \,\&\, 7 \,\&\, 6 = 6 \geq 5$.
- For the fourth query, as there is no path between vertex 1 and 8, the answer is `No`.

For the only query of the second sample test case, we can consider the path consisting of the 2-nd and the 4-th edge. Its value is $5 \,\&\, 6 = 4 \geq 4$.

Problem I. Heap

Input file:	`standard input`
Output file:	`standard output`
Time limit:	1 second
Memory limit:	256 megabytes

DreamGrid is learning the insertion operation of a heap in the data structure course.

In the following description, we denote $i/2$ to be the maximum integer x that $2x \le i$. Recall that

- A heap of size n is an array $a_1, a_2, \ldots, a_n$ which satisfies one of the following two conditions:
  - For all $2 \le i \le n$, $a_{i/2} \le a_i$. This is called a min heap.
  - For all $2 \le i \le n$, $a_{i/2} \ge a_i$. This is called a max heap.
- The insertion operation can be described by the following pseudo-code:

```
procedure insert(
  v: value to insert,
  a: heap array,
  is_max: if a is a max heap)
{Let n be the length of the heap array after insertion}
a_n := v
i := n
while i > 1
  if is_max is false and a_{i/2} ≤ a_i
    {The heap array now satisfies the condition to be a min heap}
    break
  else if is_max is true and a_{i/2} ≥ a_i
    {The heap array now satisfies the condition to be a max heap}
    break
  swap a_{i/2} and a_i
  i :=  i/2
{Insertion ends}
```

DreamGrid has prepared an initially empty array a as the heap array and n integers $v_1, v_2, \ldots, v_n$. He is just about to insert these n integers into the heap array in order when his cellphone rings, so he leaves this work to his roommate BaoBao.

Unfortunately, BaoBao doesn't understand what the argument is_max means in the insertion function (but for our dear contestants, we hope that you've understood the meaning of this argument), so he generates a binary string (a string which only contains '0' and '1') $b = b_1 b_2 \ldots b_n$ of length n, where b_i indicates the i-th character in the string, and decides the value of is_max according to the string. When inserting v_i into a, if b_i equals to '0', then is_max **during this insertion** will be false; otherwise if b_i equals to '1', then is_max **during this insertion** will be true.

When DreamGrid comes back, he finds with dismay that the final "heap" array $a_1, a_2 \ldots, a_n$ does not seem to be a valid heap! Given the n inserted integers $v_1, v_2, \ldots, v_n$, the final array and given that BaoBao has inserted $v_1, v_2, \ldots, v_n$ in order, please help DreamGrid restore the binary string b BaoBao generates.

Input

There are multiple test cases. The first line of the input contains an integer T, indicating the number of test cases. For each test case:

The first line contains an integer n ($1 \le n \le 10^5$), indicating the size of the final array.

The second line contains n integers $v_1, v_2, \ldots, v_n$ ($1 \le v_i \le 10^9$), indicating the integers in the order they are inserted.

The third line contains n integers $a_1, a_2, \ldots, a_n$, which is a permutation of $v_1, v_2, \ldots, v_n$, indicating the final "heap" array.

It's guaranteed that the sum of n of all test cases will not exceed 10^6.

Output

For each test case output one line containing one binary string, indicating the string BaoBao generates for inserting the integers. If there are multiple valid answers, output the one with the smallest lexicographic order. If the binary string does not exist, output "Impossible" (without quotes) instead.

Recall that, for two binary strings s and t of length n, we say s is lexicographically smaller than t, if there exists an integer k satisfying all the following constraints:

- $1 \le k \le n$.
- For all $1 \le i < k$, $s_i = t_i$.
- s_k = '0' and t_k = '1'.

Example

<table>
<tr><th>standard input</th><th>standard output</th></tr>
<tr><td><pre>3
4
2 3 1 4
4 1 3 2
5
4 5 1 2 3
3 4 1 5 2
3
1 1 2
2 1 1</pre></td><td><pre>0101
Impossible
001</pre></td></tr>
</table>

Note

We now explain the first sample test case.

i	v_i	b_i	**"Heap" Array after Insertion**
1	2	0	{2}
2	3	1	{3, 2}
3	1	0	{1, 2, 3}
4	4	1	{4, 1, 3, 2}

Problem J. Triangle City

Input file:	`standard input`
Output file:	`standard output`
Time limit:	2 seconds
Memory limit:	256 megabytes

Triangle City is a city with $\frac{n(n+1)}{2}$ intersections arranged into n rows and n columns, where the i-th row contains i intersections.

The intersections are connected by bidirectional roads. Formally, if we denote (i, j) as the intersection on the i-th row and the j-th column, for all $1 \le j \le i < n$,

- there is a road whose length is $a_{i,j}$ connecting intersection (i, j) and $(i + 1, j)$, and
- there is a road whose length is $b_{i,j}$ connecting intersection (i, j) and $(i + 1, j + 1)$, and
- there is a road whose length is $c_{i,j}$ connecting intersection $(i + 1, j)$ and $(i + 1, j + 1)$.

What's more, for all $1 \le j \le i < n$, there exists a triangle whose sides are of length $a_{i,j}$, $b_{i,j}$ and $c_{i,j}$. That's why the city is called the Triangle City!

Our famous traveler BaoBao has just arrived in the Triangle City, planning to start his journey from intersection $(1, 1)$ and end his trip at intersection (n, n). To fully enjoy the landscape, BaoBao would like to find the longest path from $(1, 1)$ to (n, n) such that each road is passed no more than once. Please help BaoBao find such a path.

Recall that if the sides of a triangle are of length a, b and c, we can infer that $a + b > c$, $a + c > b$ and $b + c > a$.

Input

There are multiple test cases. The first line of the input contains an integer T, indicating the number of test cases. For each test case:

The first line contains an integer n ($2 \le n \le 300$), indicating the size of the city.

For the following $(n - 1)$ lines, the i-th line contains i integers $a_{i,1}, a_{i,2}, \ldots, a_{i,i}$ ($1 \le a_{i,j} \le 10^9$), where $a_{i,j}$ indicates the length of the road connecting intersection (i, j) and $(i + 1, j)$.

For the following $(n - 1)$ lines, the i-th line contains i integers $b_{i,1}, b_{i,2}, \ldots, b_{i,i}$ ($1 \le b_{i,j} \le 10^9$), where $b_{i,j}$ indicates the length of the road connecting intersection (i, j) and $(i + 1, j + 1)$.

For the following $(n - 1)$ lines, the i-th line contains i integers $c_{i,1}, c_{i,2}, \ldots, c_{i,i}$ ($1 \le c_{i,j} \le 10^9$), where $c_{i,j}$ indicates the length of the road connecting intersection $(i + 1, j)$ and $(i + 1, j + 1)$.

It's guaranteed that the sum of n of all test cases will not exceed 5×10^3.

Output

For each test case output three lines.

The first line contains one integer l, indicating the length of the longest path from $(1, 1)$ to (n, n) such that each road is passed no more than once.

The second line contains one integer m, indicating the number of intersections on the longest path.

The third line contains $2m$ integers $i_1, j_1, i_2, j_2, \ldots, i_m, j_m$ separated by a space, where (i_k, j_k) indicates the k-th intersection on the longest path. Note that according to the description, there must be $(i_1, j_1) = (1, 1)$ and $(i_m, j_m) = (n, n)$.

If there are multiple valid answers, you can output any of them.

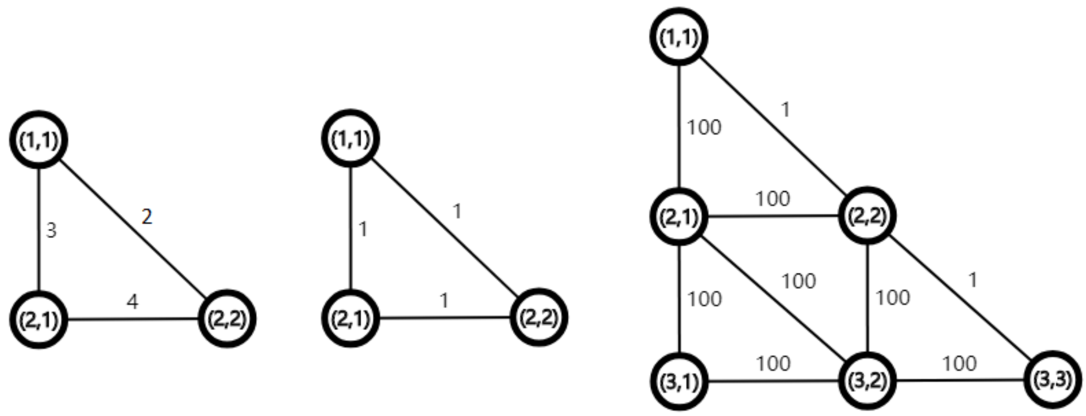
Please, DO NOT output extra spaces at the end of each line, or your solution may be considered incorrect!

Example

standard input	standard output
3 2 3 2 4 2 1 1 1 3 100 100 100 1 100 1 100 100 100	7 3 1 1 2 1 2 2 2 3 1 1 2 1 2 2 700 8 1 1 2 1 3 2 2 2 2 1 3 1 3 2 3 3

Note

The sample test cases are shown below:



Problem K. Are you a bot?

Input file:	`standard input`
Output file:	`standard output`
Time limit:	3 seconds
Memory limit:	1024 megabytes

"What does the heartbeat of a bot, arranged into a graph, look like?"

You have a competitive programming bot, whose heart beats n times per minute. The intensity of the i-th heartbeat is a_i. Here, $a_1 \sim a_n$ is a permutation of $1 \sim n$.

Let A_i be the sequence obtained by deleting the i-th element from the sequence a, i.e., $A_i = [a_1, \cdots, a_{i-1}, a_{i+1}, \cdots, a_n]$.

For a sequence p of distinct elements, let $G(p)$ be an undirected graph with $|p|$ vertices, numbered $1 \sim |p|$. For every pair of positive integers $1 \le i < j \le |p|$, if $\forall k \in [i, j] \cap \mathbb{Z}$, we have $p_k \in [\min(p_i, p_j), \max(p_i, p_j)]$, then in $G(p)$, there is an edge between vertices i and j. Let $F(p)$ be the shortest path length from vertex 1 to vertex $|p|$ in $G(p)$, where a path length is defined as its number of edges.

Let $f(a) = [F(A_1), F(A_2), \ldots, F(A_n)]$.

Given a sequence of length n as $[b_1, \cdots, b_n]$, your task is to find any permutation a of $1 \sim n$ such that $f(a) = b$.

It is guaranteed that at least one solution exists.

Input

There are multiple test cases in a single test file.

The first line of the input contains a single integer T ($1 \le T \le 40\,000$), indicating the number of the test cases.

For each of the test case:

- The first line contains a single integer n ($4 \le n \le 10^5$).
- The next line contains n integers $b_1, b_2, \cdots, b_n$.
- It is guaranteed that at least one solution exists.

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

Output

For each test case, output a single line contains n integers $a_1, a_2, \cdots, a_n$, indicating the permutation you found.

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

Example

standard input	standard output
11 4 2 2 1 1 4 2 2 2 2 4 2 1 1 2 7 5 5 4 4 4 5 5 7 1 3 2 2 2 2 4 7 3 3 2 4 4 5 3 8 2 2 3 5 3 3 3 4 8 5 4 4 4 4 6 6 5 8 4 4 4 2 4 4 2 3 9 4 7 5 5 5 5 3 4 4 9 3 4 4 4 4 4 4 4 6	1 2 4 3 2 1 4 3 1 3 2 4 3 1 7 2 6 4 5 3 1 6 4 2 5 7 2 3 1 6 4 7 5 5 6 3 1 7 4 2 8 1 8 2 7 3 5 6 4 6 3 2 7 4 5 1 8 5 8 6 3 7 1 9 2 4 8 1 7 9 2 5 3 4 6

Problem L. Difficult Constructive Problem

Input file:	`standard input`
Output file:	`standard output`
Time limit:	1 second
Memory limit:	1024 megabytes

Given a string $s_1 s_2 \cdots s_n$ of length n where $s_i \in \{\text{'0'}, \text{'1'}, \text{'?'}\}$ and an integer k, please fill out all the '?' with '0' or '1' such that the number of indices i satisfying $1 \le i < n$ and $s_i \ne s_{i+1}$ equals to k. Different '?' can be replaced with different characters.

To make this problem even more difficult, we ask you to find the answer with the smallest possible lexicographic order if it exists.

Recall that a string $a_1 a_2 \cdots a_n$ of length n is lexicographically smaller than another string $b_1 b_2 \cdots b_n$ of length n if there exists an integer k ($1 \le k \le n$) such that $a_i = b_i$ for all $1 \le i < k$ and $a_k < b_k$.

Input

There are multiple test cases. The first line of the input contains an integer T indicating the number of test cases. For each test case:

The first line contains two integers n and k ($1 \le n \le 10^5$, $0 \le k < n$) indicating the length of the string and the required number of indices satisfying the condition.

The second line contains a string $s_1 s_2, \cdots s_n$ ($s_i \in \{\text{'0'}, \text{'1'}, \text{'?'}\}$).

It's guaranteed that the sum of n of all test cases will not exceed 10^6.

Output

For each test case output one line. If the answer exists output the lexicographically smallest one (you need to output the whole given string after filling out all the '?' and make this string the lexicographically smallest); Otherwise output `Impossible`.

Example

standard input	standard output
5 9 6 1?010??01 9 5 1?010??01 9 6 100101101 9 5 100101101 9 3 ????????1	100100101 Impossible 100101101 Impossible 000000101

Problem M. Trie

Input file:	`standard input`
Output file:	`standard output`
Time limit:	1 second
Memory limit:	1024 megabytes

Recall the definition of a trie:

- A trie of size n is a rooted tree with n vertices and $(n-1)$ edges, where each edge is marked with a character.
- Each vertex in a trie represents a string. Let $s(x)$ be the string vertex x represents.
- The root of the trie represents an empty string. Let vertex u be the parent of vertex v, and let c be the character marked on the edge connecting vertex u and v, we have $s(v) = s(u) + c$. Here $+$ indicates string concatenation, not the normal addition operation.
- The string each vertex represents is distinct.

We now present you a rooted tree with $(n+1)$ vertices. The vertices are numbered $0, 1, \cdots, n$ and vertex 0 is the root. There are m key vertices in the tree where vertex k_i is the i-th key vertex. It's guaranteed that all leaves are key vertices.

Please mark a lower-cased English letter on each edge so that the rooted tree changes into a trie of size $(n+1)$. Let's consider the sequence $A = \{s(k_1), s(k_2), \cdots, s(k_m)\}$ consisting of all strings represented by the key vertices. Let $B = \{w_1, w_2, \cdots, w_m\}$ be the string sequence formed by sorting all strings in sequence A from smallest to largest in lexicographic order. Please find a way to mark the edges so that sequence B is minimized.

We say a string $P = p_1 p_2 \cdots p_x$ of length x is lexicographically smaller than a string $Q = q_1 q_2 \cdots q_y$ of length y, if

- $x < y$ and for all $1 \le i \le x$ we have $p_i = q_i$, or
- there exists an integer $1 \le t \le \min(x, y)$ such that for all $1 \le i < t$ we have $p_i = q_i$, and $p_t < q_t$.

We say a string sequence $F = \{f_1, f_2, \cdots, f_m\}$ of length m is smaller than a string sequence $G = \{g_1, g_2, \cdots, g_m\}$ of length m, if there exists an integer $1 \le t \le m$ such that for all $1 \le i < t$ we have $f_i = g_i$, and f_t is lexicographically smaller than g_t.

Input

There are multiple test cases. The first line of th input contains an integer T indicating the number of test cases. For each test case:

The first line contains two integers n and m ($1 \le m \le n \le 2 \times 10^5$) indicating the number of vertices other than the root and the number of key vertices.

The second line contains n integers $a_1, a_2, \cdots, a_n$ ($0 \le a_i < i$) where a_i is the parent of vertex i. It's guaranteed that each vertex has at most 26 children.

The third line contains m integers $k_1, k_2, \cdots, k_m$ ($1 \le k_i \le n$) where k_i is the i-th key vertex. It's guaranteed that all leaves are key vertices, and all key vertices are distinct.

It's guaranteed that the sum of n of all test cases will not exceed 2×10^5.

Output

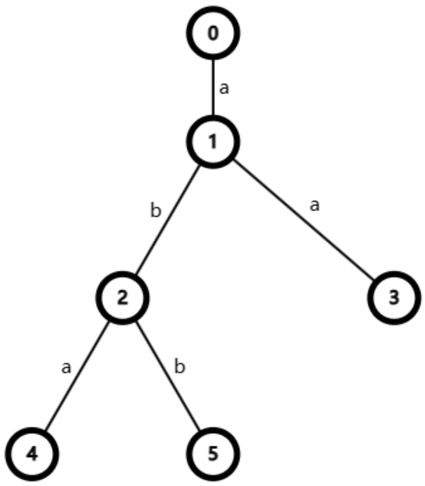
For each test case output one line containing one answer string $c_1 c_2 \cdots c_n$ consisting of lower-cased English letters, where c_i is the letter marked on the edge between a_i and i. If there are multiple answers strings so that sequence B is minimized, output the answer string with the smallest lexicographic order.

Example

standard input	standard output
2 5 4 0 1 1 2 2 1 4 3 5 1 1 0 1	abaab a

Note

The answer of the first sample test case is shown as follows.



The string represented by vertex 1 is “a”. The string represented by vertex 4 is “aba”. The string represented by vertex 3 is “aa”. The string represented by vertex 5 is “abb”. So $B = \{$“a”, “aa”, “aba”, “abb”$\}$.