Problem A. Another Coin Weighing Puzzle

Input file:	*standard input*
Output file:	*standard output*
Time limit:	2 seconds
Memory limit:	512 mebibytes

You have some bags of coins. Each bag contains exactly k coins. Exactly one bag contains only counterfeit coins (we'll call this the *fake bag*), while all other bags contain only real coins. All real coins weigh exactly the same number of grams. All counterfeit coins weigh exactly the same number of grams. You don't know the exact weights of a real or counterfeit coin. You do know a counterfeit coin is strictly heavier than a real coin, but you do not know exactly how much heavier it is. The weights of the coins are positive real numbers.

You have a scale which you can use at most m times. The scale has a left and right side. To use the scale, you can place any number of coins, taken from any of the bags, on each side of the scale, as long as the total number of coins on the left and right sides are exactly equal. The scale will return a single real number s. If s is zero, both sides of the scale weigh exactly the same. If s is negative, the left side is $|s|$ grams heavier than the right side. If s is positive, the right side is s grams heavier than the left side. Coins can be reused multiple times for different weighings, and you are able to keep track of which bag each coin came from. You must specify beforehand all weighings you want to perform (so you cannot adjust what gets weighed in future trials based on the results of previous trials). After using the scale m times, you would like to be able to determine which bag is the fake bag.

You are now wondering: given m and k, what is the maximum number of bags for which you can always determine the fake bag? This number can get large, so output it modulo the large prime $998\,244\,353$.

Input

The single line of input contains two space-separated integers m and k ($1 \le m, k \le 10^6$), where m is the number of weighings available to you and k is the number of coins in each bag.

Output

Output a single integer, which is the maximum number of bags for which you can determine the fake bag in m weighings, modulo the large prime $998\,244\,353$.

Examples

standard input	standard output
2 1	9
2 2	17

Note

One way we can use 2 weighings to determine the fake bag among 9 bags, each containing 1 coin, is as follows:

- On the first weighing, put the coins from bags 1,2,3 on the left, and the coins from bags 7,8,9 on the right.
- On the second weighing, put the coins from bags 1,4,7 on the left, and the coins from bags 3,6,9 on the right.

We can determine the fake bag as follows:

- The first weighing tells us which group of bags $(1, 2, 3)$, $(4, 5, 6)$, $(7, 8, 9)$ contains the fake bag (e.g. if the left side is heavier, then group $(1, 2, 3)$ contains the fake bag, if both sides are equal, then group $(4, 5, 6)$ contains the fake bag, otherwise group $(7, 8, 9)$ contains the fake bag).

- The second weighing will tell us which group of bags $(1, 4, 7)$, $(2, 5, 8)$, $(3, 6, 9)$ contains the fake bag. The resulting fake bag can be uniquely determined as a result.

Problem B. Mini Battleship

Input file:	*standard input*
Output file:	*standard output*
Time limit:	10 seconds
Memory limit:	512 mebibytes

Battleship is a game played by two players. Each player has their own grid, which is hidden from their opponent. Each player secretly places some ships on their grid. Each ship covers a horizontal or vertical straight line of one or more contiguous squares. Ships cannot overlap. All ships are considered distinct, even if they have the same size. The orientation of each ship is not important to the game, only the squares they occupy.

After placing their ships, the players then take turns taking shots at their opponent's ships by calling out a coordinate of their opponent's grid. The opponent must honestly say whether the shot was a hit or a miss. When all of a ship's squares are hit, that ship sinks ("You sunk my battleship!!"). A player loses when all of their ships are sunk.

Bob is playing a game of Mini Battleship against Alice. Regular Battleship is played on a 10×10 grid with 5 ships. Mini Battleship is much smaller, with a grid no larger than 5×5 and possibly fewer than 5 ships.

Bob wonders how many ship placements are possible on Alice's board given what he knows so far. The answer will be 0 if Alice is cheating! (Or, if the game setup isn't possible.)

Input

The first line of input contains two space-separated integers n ($1 \le n \le 5$) and k ($1 \le k \le 5$), which represent a game of Mini Battleship played on an $n \times n$ grid with k ships.

Each of the next n lines contains a string s ($|s| = n$). This is what Bob sees of Alice's grid so far.

A character '`X`' represents one of Bob's shots that missed.
A character '`O`' (Letter O, not zero) represents one of Bob's shots that hit.
A dot ('`.`') represents a square where Bob has not yet taken a shot.

Each of the next k lines contains a single integer x ($1 \le x \le n$). These are the sizes of the ships.

Output

Output a single integer, which is the number of ways the k distinct ships could be placed on Alice's grid and be consistent with what Bob sees.

Examples

standard input	standard output

`4 3`
`....`
`.OX.`
`....`
`O..X`
`3`
`2`
`1`
	`132`

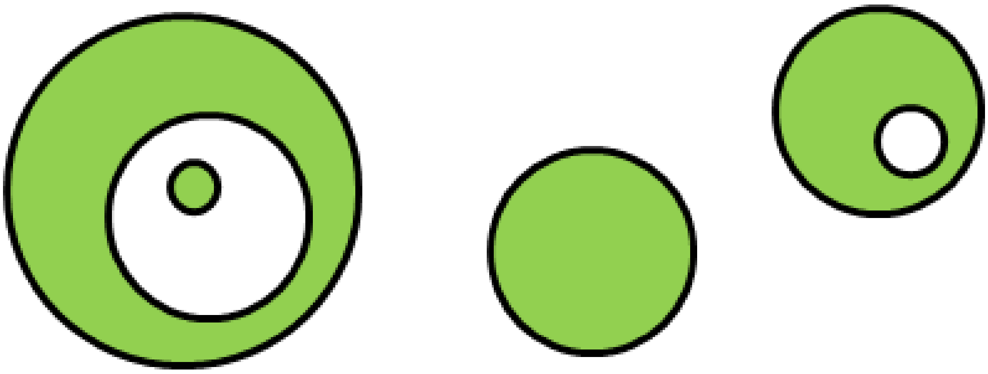
`4 4`
`.X.X`
`.XX.`
`...X`
`....`
`1`
`2`
`3`
`4`
	`6`

`2 2`
`..`
`..`
`2`
`2`
	`4`

Problem C. Bomas

Input file:	*standard input*
Output file:	*standard output*
Time limit:	4 seconds
Memory limit:	512 mebibytes

You are a manager of a zoo. The zoo is a collection of enclosed areas formed by circular fences (known as bomas). The bomas do not intersect nor do they touch, but they can nest. You may choose not to use all of the zoo's areas for holding animals at a given time (to prepare for future attractions). The animal types need to be separated by an empty enclosure, so for any two areas that share a border fence, at most one can hold animals (it might be the case that neither contain animals). Two different types of animals cannot be in the same area. Note that the "outer" area of the zoo can contain animals.



The zoo is looking to add a new boma. Given the existing bomas, how many animal types can the zoo display within the new boma subject to the above restrictions? The zoo has several options, so they will give you several queries, each consisting of a single boma to add. Only consider one query boma at a time; the queries are not cumulative.

Input

The first line of input contains two space-separated integers n and q ($1 \leq n, q \leq 10^5$), where n is the number of existing bomas and q is the number of queries.

Each of the next n lines contains three space-separated integers x, y ($-10^7 \leq x, y \leq 10^7$) and r ($1 \leq r \leq 10^7$), which describe an existing boma with center (x, y) and radius r.

Each of the next m lines contains three space-separated integers x, y ($-10^7 \leq x, y \leq 10^7$) and r ($1 \leq r \leq 10^7$), which describe a query boma with center (x, y) and radius r.

No two bomas of either type (existing or query) intersect or touch, but they can nest within one another.

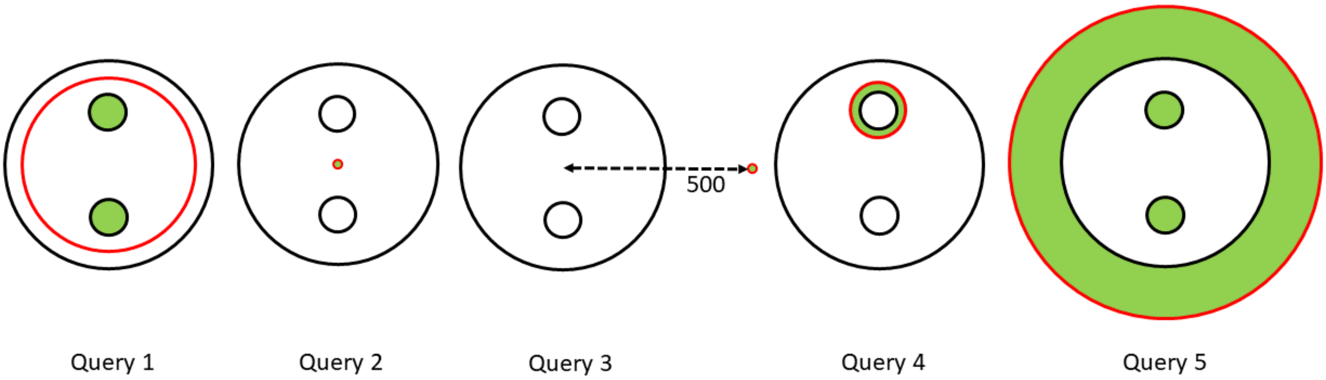
Output

For each query output a line with a single integer, which is the number of animal types the zoo can display within the queried region.

Example

standard input	standard output

Note



This image illustrates the five queries of the sample Input/Output. The existing bomas are black, the query bomas are red, and the areas where animals can be placed are green. Note that for query 4, putting animals only in the inner boma is also acceptable.

Problem D. All Kill

Input file:	*standard input*
Output file:	*standard output*
Time limit:	1 second
Memory limit:	512 mebibytes

You just finished participating in a programming contest with your friend. Unfortunately, you were unable to All Kill the contest (i.e., solve all of the problems), but you are now wondering if there might be some strategy that would have solved all of the problems.

Solving a problem has two phases, a thinking phase and a coding phase. Your friend is responsible for all the thinking while you are responsible for all the coding.

For each problem, you've computed exactly how long it would take for you to code. However, before you can code a problem in contest, your friend needs to get the idea to solve it first. You aren't sure how to estimate the time when your friend gets a solution idea, so you model it like this: For every problem, your friend gets the idea of how to solve this problem at a uniformly random minute during the contest. Each of these is an independent random variable. You can only code one problem at a time, so there may be several problems queued up at any moment of time. You always prioritize coding the lowest numbered problems first. You do this minute-by-minute, so you will switch to coding a lower-numbered problem if your friend gets the idea for it before you're finished coding a higher-numbered problem, but you would prefer not to do this. Context switching is an expensive operation, even in the human brain!

The contest strategy can be modeled as follows for each minute:

- For each problem that doesn't yet have an idea, your friend will get the idea to solve it with probability 1/(number of minutes remaining in contest). Your friend can get the idea to solve multiple problems in the same minute.
- Among the problems that still need code time and your friend has gotten the solution idea, you will take the lowest numbered one and spend the next minute coding it (if no problem satisfies the condition, you do nothing at this step).

You would like to know the probability of these two events happening together:

- Your team finishes coding all the problems by the end of the contest
- For each problem, the time spent coding that problem is a contiguous interval

Let p be this probability, n be the number of problems in the contest and t be the number of minutes in the contest. It can be shown that $p \cdot t^n$ is an integer. Output the value of $(p \cdot t^n) \pmod{998\,244\,353}$. Note that $998\,244\,353$ is a large prime.

Input

The first line of input contains two space-separated integers n ($1 \le n \le 10^5$) and t ($1 \le t \le 10^8$), where there were n problems in the contest, and the contest lasted t minutes.

Each of the next n lines contains a single integer x ($1 \le x \le 10^3$). These are the times to code each problem in minutes, in order. It is guaranteed that the sum of these times is less than or equal to t.

Output

Output a single integer, which is $(p \cdot t^n) \pmod{998\,244\,353}$, where p is the probability of the two events mentioned above happening together.

Examples

standard input	standard output
3 5 1 2 1	60
5 5 1 1 1 1 1	1296

Problem E. Grid Guardian

Input file:	*standard input*
Output file:	*standard output*
Time limit:	16 seconds
Memory limit:	512 mebibytes

Alice has an $n \times m$ grid and a 2×2 block. She would like to place her block in the grid. She must place it so that the block is axis-aligned and covers exactly 4 grid cells.

Bob wants to prevent Alice from doing that. To do this, he places obstacles in some of the grid cells. After Bob places his obstacles, all 2×2 subgrids of the grid should contain at least one obstacle. Bob wants to minimize the number of grid cells where he places obstacles.

Help Bob count the number of ways he can place the minimum number obstacles to prevent Alice from placing her block. Output this number modulo a prime number p. Note that the answer is not the minimum number of obstacles, but rather the count of the number of ways Bob can place the minimum number of obstacles. For example, if $n = m = 2$ for a 2×2 grid, Bob only has to place 1 obstacle, but there are 4 ways to place it, so the answer in this case is 4.

Input

The single line of input contains three space-separated integers n ($2 \le n \le 25$), m ($2 \le m \le 10^3$) and p ($10^8 \le p \le 10^9 + 7$, p is a prime number), where Alice's grid is of size $n \times m$, and p is a large prime modulus.

Output

Output a single integer, which is the number of ways Bob can place the minimum number of obstacles in the $n \times m$ grid to prevent Alice from placing her 2×2 block. Since this may be very large, output it modulo p.

Examples

standard input	standard output
4 4 999999937	79
5 5 100000037	1

Problem F. Hopscotch

Input file:	*standard input*
Output file:	*standard output*
Time limit:	1 second
Memory limit:	512 mebibytes

There's a new art installation in town, and it inspires you... to play a childish game. The art installation consists of a floor with an $n \times n$ matrix of square tiles. Each tile holds a single number from 1 to k. You want to play hopscotch on it. You want to start on some tile numbered 1, then hop to some tile numbered 2, then 3, and so on, until you reach some tile numbered k. You are a good hopper, so you can hop any required distance. You visit exactly one tile of each number from 1 to k.

What's the shortest possible total distance over a complete game of Hopscotch? Use the Manhattan distance: the distance between the tile at (x_1, y_1) and the tile at (x_2, y_2) is $|x_1 - x_2| + |y_1 - y_2|$.

Input

The first line of input contains two space-separated integers n ($1 \le n \le 50$) and k ($1 \le k \le n^2$), where the art installation consists of an $n \times n$ matrix with tiles having numbers from 1 to k.

Each of the next n lines contains n space-separated integers x ($1 \le x \le k$). This is the art installation.

Output

Output a single integer, which is the total length of the shortest path starting from some 1 tile and ending at some k tile, or -1 if it isn't possible.

Examples

standard input	standard output
10 5 5 1 3 4 2 4 2 1 2 1 4 5 3 4 1 5 3 1 1 4 4 2 4 1 5 4 5 2 4 1 5 2 1 5 5 3 5 2 3 2 5 5 2 3 2 3 1 5 5 5 3 4 2 4 2 2 4 4 2 3 1 5 1 1 2 5 4 1 5 3 2 2 4 1 2 5 1 4 3 5 5 3 2 1 4 3 5 2 3 1 3 4 2 5 2 5 3 4 4 2	5
10 5 5 1 5 4 1 2 2 4 5 2 4 2 1 4 1 1 1 5 2 5 2 2 4 4 4 2 4 5 5 4 2 4 4 5 5 5 2 5 5 2 2 2 4 4 4 5 4 2 4 4 5 2 5 5 4 1 2 4 4 4 4 2 1 2 4 4 1 2 4 5 1 2 1 1 2 4 4 1 4 5 2 1 2 5 5 4 5 2 1 1 1 1 2 4 5 5 5 5 5 5	-1

Problem G. ICPC Camp

Input file:	*standard input*
Output file:	*standard output*
Time limit:	5 seconds
Memory limit:	512 mebibytes

John is a leading organizer of this year's North America ICPC training camp. The camp lasts several days. On each day, there will be a lecture introducing two problems: one classical problem and one creative problem. Each problem can only be introduced once during the entire camp. Every problem has an integer difficulty level.

John knows that the lecture on each day should not be too overwhelming. Therefore, the sum of the difficulties of the two problems in a single day shall not exceed some fixed value. Also, the two problems on each day should be roughly on the same level. Let d's be the absolute difference between the difficulties of the two problems introduced on any given day. The maximum of all of the ds, defined as D, should be as small as possible.

If John chooses problems well and arranges them wisely, what is the smallest D he can achieve for the n days of the ICPC training camp?

Input

The first line of input contains four space-separated integers n, p, q ($1 \le n, p, q \le 2 \cdot 10^5$, $n \le \min(p, q)$) and s ($0 \le s \le 10^9$), where n is the number of days of the camp, p is the number of classical problems, q is the number of creative problems, and s is the maximum sum of difficulties on any given day.

Each of the next p lines contains an integer x ($0 \le x \le 10^9$). These are difficulties of the p classical problems.

Each of the next q lines contains an integer y ($0 \le y \le 10^9$). These are difficulties of the q creative problems.

Output

Output a single integer, which is the smallest D John can achieve, or -1 if there is no way John can select problems for the n training days.

Examples

standard input	standard output
3 4 5 10 3 4 4 9 0 1 5 6 6	2
4 4 4 15 1 5 10 12 1 3 10 14	13
4 4 4 10 1 12 5 10 1 10 3 14	-1

Problem H. Letter Wheels

Input file:	*standard input*
Output file:	*standard output*
Time limit:	2 seconds
Memory limit:	512 mebibytes

There are three horizontal wheels of letters stacked one on top of the other, all with the same number of columns. All wheels have one letter, either 'A', 'B' or 'C', in each of its columns on the edge of the wheel. You may rotate the wheels to adjust the positions of the letters. In a single *rotation*, you can rotate any single wheel to the right or to the left by one column. The wheels are round, of course, so the first column and last column are adjacent.

You would like to determine whether it is possible to rotate the wheels so that every column has three distinct letters across the three wheels, and if so, determine the minimum number of rotations required.

Input

The input has exactly three lines. Each line has a string s ($2 \le |s| \le 5 \cdot 10^3$) consisting only of upper-case letters 'A', 'B' or 'C', describing the letters of one wheel in their initial positions. All three strings will be of the same length.

Output

Output a single integer, which is the minimum number of rotations required, or -1 if it isn't possible.

Examples

standard input	standard output
ABC ABC ABC	2
ABBBAAAA BBBCCCBB CCCCAAAC	3
AABB BBCC ACAC	-1

Problem I. Editing Explosion

Input file:	*standard input*
Output file:	*standard output*
Time limit:	10 seconds
Memory limit:	512 mebibytes

Charles complains to Ada, "That Keats! So many spelling errors in this manuscript! How will I get them all fixed?"

Ada responds, "I've got a routine in the Engine that will help you. For a given word, it considers small errors and finds all the words that are close to that word, so they can be looked up in a lexicon of English. Here, hold my tea and watch this."

Ada punches and threads cards furiously, then starts the Engine. Steam pours out of the boilers, and the Engine rumbles softly then more quickly, shaking the room, until finally an overloaded cam jams and the machine comes to a sudden halt.

"Hmm," Ada muses, "I thought I had that worked out."

The Levenshtein Distance between two strings is the smallest number of simple one-letter operations needed to change one string to the other. The operations are:

- Adding a letter anywhere in the string.
- Removing a letter from anywhere in the string.
- Changing any letter in the string to any other letter.

You are given an input string on the alphabet 'A'-'Z' and a Levenshtein distance. Output the count of distinct strings on the alphabet 'A'-'Z', that are at exactly that Levenshtein distance from the input string. Since this number may be large, output it modulo the prime 998 244 353.

Input

The single line of input contains a string s ($1 \le |s| \le 10$, s contains only upper-case letters) followed by a space, and then an integer d ($0 \le d \le 10$), where s is the string in question and d is the Levenshtein distance of interest.

Output

Output a single integer, which is the count of distinct strings that are at Levenshtein distance d from the input string s, in the alphabet 'A'-'Z', modulo 998 244 353. Note that the empty string is considered a valid result string.

Examples

standard input	standard output
ICPC 1	230
PROGRAMMER 10	110123966

Problem J. Lunchtime Name Recall

Input file:	*standard input*
Output file:	*standard output*
Time limit:	8 seconds
Memory limit:	512 mebibytes

Mia is a newly hired administrative assistant. Though Mia was introduced to everyone in the company on her first day, she is forgetful and struggles to remember people's names. Being too shy to ask for names again, she discovers a way to recall people's names during lunchtime without asking.

Mia orders lunch for all of her colleagues in each of the next several days. On any day, Mia orders burgers for some of her colleagues and salads for the rest of her colleagues. The number of burgers she orders may vary per day. After placing the order, she sends an email to the colleagues who get a burger for lunch, and also to the remaining colleagues about their salads. Mia has an email list with all her colleagues' names. She may choose by name who gets a burger and who gets a salad. Mia can see her colleagues as they are eating their lunch. Thus, by observing who turns out to eat a burger in the office and who eats a salad, she may gain some information to help her uniquely identify the names of her colleagues.

For example, suppose there are three colleagues with names Alice, Danielle, and Jennifer, and Mia can order one burger plus two salads on each day. On the first day, if Mia orders a burger for Alice and salads for Danielle and Jennifer, she can then tell who is Alice by observing who eats a burger. On the second day, Mia may order a burger for Danielle and a salad for Jennifer (and a salad for Alice who is already identified). Consequently she can uniquely identify all three colleagues.

What is the maximum number of colleagues that Mia can uniquely identify in the next few days, if she allocates the burger and salad recipients optimally?

Input

The first line of input contains two space-separated integers n ($2 \le n \le 30$) and m ($1 \le m \le 10$), where Mia has n colleagues and will be ordering lunch for m days.

Each of the next m lines contains a single integer a ($1 \le a < n$), which is the number of burgers Mia orders on that day. The days are listed in order.

Output

Output a single integer, which is the maximum number of Mia's n colleagues that she can uniquely identify after m days.

Examples

standard input	standard output
4 2 2 2	4
16 3 6 8 8	5

Problem K. Rooted Subtrees

Input file:	*standard input*
Output file:	*standard output*
Time limit:	7 seconds
Memory limit:	512 mebibytes

A *tree* is a connected, acyclic, undirected graph with n nodes and $n-1$ edges. There is exactly one path between any pair of nodes. A *rooted tree* is a tree with a particular node selected as the root.

Let T be a tree and T_r be that tree rooted at node r. The *subtree* of u in T_r is the set of all nodes v where the path from r to v contains u (including u itself). In this problem, we denote the set of nodes in the subtree of u in the tree rooted at r as $T_r(u)$.

You are given q queries. Each query consists of two (not necessarily different) nodes, r and p. A set of nodes S is "obtainable" if and only if it can be expressed as the intersection of a subtree in the tree rooted at r and a subtree in the tree rooted at p. Formally, a set S is "obtainable" if and only if there exist nodes u and v where $S = T_r(u) \cap T_p(v)$.

For a given pair of roots, count the number of different non-empty obtainable sets. Two sets are different if and only if there is an element that appears in one, but not the other.

Input

The first line contains two space-separated integers n and q ($1 \le n, q \le 2 \cdot 10^5$), where n is the number of nodes in the tree and q is the number of queries to be answered. The nodes are numbered from 1 to n.

Each of the next $n-1$ lines contains two space-separated integers u and v ($1 \le u, v \le n$, $u \ne v$), indicating an undirected edge between nodes u and v. It is guaranteed that this set of edges forms a valid tree.

Each of the next q lines contains two space-separated integers r and p ($1 \le r, p \le n$), which are the nodes of the roots for the given query.

Output

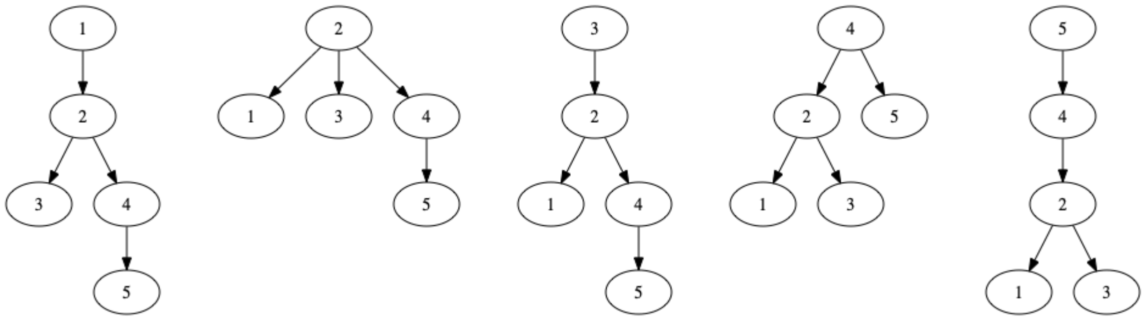
For each query output a single integer, which is the number of distinct obtainable sets of nodes that can be generated by the above procedure.

Example

standard input	standard output
5 2 1 2 2 3 2 4 4 5 1 3 4 5	8 6

Note

The possible rootings of the first tree are



Considering the rootings at 1 and 3, the 8 obtainable sets are:

1. $\{1\}$ by choosing $u = 1$, $v = 1$,
2. $\{1, 2, 4, 5\}$ by choosing $u = 1$, $v = 2$,
3. $\{1, 2, 3, 4, 5\}$ by choosing $u = 1$, $v = 3$,
4. $\{2, 3, 4, 5\}$ by choosing $u = 2$, $v = 3$,
5. $\{2, 4, 5\}$ by choosing $u = 2$, $v = 2$,
6. $\{3\}$ by choosing $u = 3$, $v = 3$,
7. $\{4, 5\}$ by choosing $u = 2$, $v = 4$,
8. and $\{5\}$ by choosing $u = 5$, $v = 5$.

If the rootings are instead at 4 and 5, there are only 6 obtainable sets:

1. $\{1\}$ by choosing $u = 1$, $v = 1$,
2. $\{1, 2, 3\}$ by choosing $u = 2$, $v = 4$,
3. $\{1, 2, 3, 4\}$ by choosing $u = 4$, $v = 4$,
4. $\{1, 2, 3, 4, 5\}$ by choosing $u = 4$, $v = 5$,
5. $\{3\}$ by choosing $u = 3$, $v = 2$,
6. and $\{5\}$ by choosing $u = 5$, $v = 5$.

For some of these, there are other ways to choose u and v to arrive at the same set.

Problem L. Tomb Raider

Input file:	`standard input`
Output file:	`standard output`
Time limit:	3 seconds
Memory limit:	512 mebibytes

Hu the Tomb Raider has entered a new tomb! It is full of gargoyles, mirrors, and obstacles. There is a door, with treasure beyond. Hu must unlock the door guarding the treasure. On that door is written, in an ancient tongue, the secret to opening the door:

Every face of every gargoyle shall see a face of a gargoyle.

This means that the gargoyles must be rotated in such a way that there is a path for a beam of light to connect each gargoyle's face to another gargoyle's face (possibly its own). The beam of light is reflected by mirrors.

The floorplan of the tomb can be described as a rectangular $n \times m$ grid of cells:

A dot ('`.`') represents an empty cell.
A hash ('`#`') represents an obstacle.
A slash ('`/`') represents a double-sided mirror, as does a Backslash ('`\`') .
A character '`V`' represents a gargoyle with two faces facing top and bottom.
A character '`H`' represents a gargoyle with two faces facing left and right.

In addition to the '`\`' and '`/`' mirrors, the tomb is surrounded by walls of mirrors. The following common sense about light is assumed:

1. Light travels in a straight line through empty cells.
2. Two beams of light can intersect without interfering with each other.
3. A '`\`' mirror reflects light coming from the top/bottom/left/right to the right/left/bottom/top. A '`/`' mirror reflects light coming from the top/bottom/left/right to the left/right/top/bottom.
4. Light is reflected by 180 degrees when it hits a wall (walls are all mirrors).
5. Light is blocked by obstacles and gargoyles.

Hu may rotate any gargoyle by 90 degrees. As time is running short, he wants to know the minimum number of gargoyles that have to be rotated in order to unlock the treasure door.

Input

The first line of input contains two space-separated integers n and m ($1 \le n, m \le 500$), which are the dimensions of the tomb.

Each of the next n lines contains a string s ($|s| = m$) with the characters described above. This is the floorplan of the tomb.

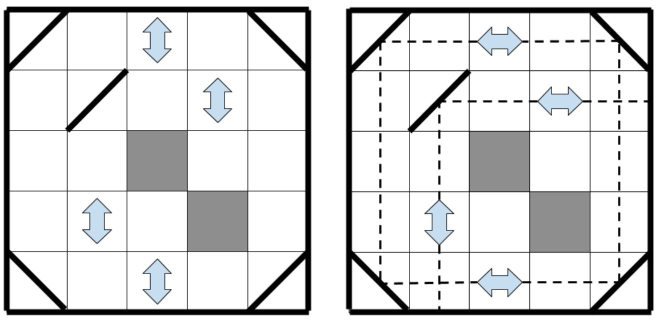
Output

Output a single integer, which is the minimum number of gargoyles that have to be rotated in order to unlock the treasure door. If the puzzle has no solution, output -1.

Examples

standard input	standard output
5 5 /.V.\ ./.V. ..#.. .V.#. \.V./	3
2 5 V...\ H...V	-1
2 2 VV VV	0

Note



The above are illustrations of Sample Input/Output 1 with the initial configuration on the left and the solution of the puzzle on the right. Three gargoyles are rotated to solve the puzzle.