Problem D - Vigilância Noturna

Check our instructions page for detailed information on the qualification and the format of this problem.

The Museum of Notable Works and Inventions (ONI) has been opened to the public. Due to the rush surrounding the inauguration, nobody noticed in time the flaws in the electrical installation. Unfortunately, it has not yet been possible to ensure that the main hall is fully illuminated during the night, so there are illuminated areas and dark areas!

Due to this setback, it is necessary to reinforce the museum's security for the upcoming nights. The security team has hired you to conduct inspections and simulate the strategy of an intruder: the goal is to understand how quickly you could move between two points inside the main hall of the museum. It is guaranteed that any nighttime movement in illuminated areas will trigger the alarm, so the only scenario you need to worry about is the one in which you only move through dark areas.

The main hall of the museum is rectangular and can be represented by an $\boldsymbol{N} \times \boldsymbol{M}$ grid, where each cell may or may not be illuminated. Your goal as an expert is simple: given the configuration of cells (illuminated or dark) in the main hall of the museum, calculate the shortest time interval you need to move between certain pairs of points, without leaving the hall, if you **only pass through dark cells**.

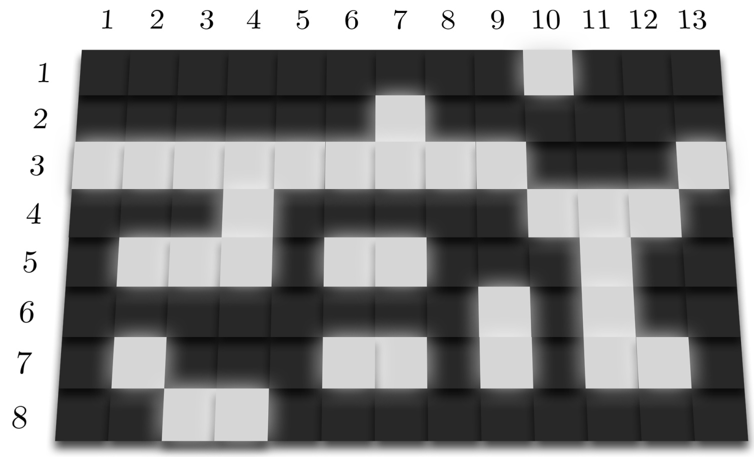
You can move from one cell to any of the four adjacent cells (up, down, left, right), if they exist, and doing so takes 1 second. It is guaranteed that the initial and final points always correspond to dark cells.

Part I

You are given the configuration of cells (illuminated or dark) in the main hall of the museum and $\boldsymbol{T}$ pairs of points in the form $(\boldsymbol{L}_1, \boldsymbol{C}_1)$, $(\boldsymbol{L}_2, \boldsymbol{C}_2)$. For each pair of points, determine the shortest time interval you need to move from $(\boldsymbol{L}_1, \boldsymbol{C}_1)$ to $(\boldsymbol{L}_2, \boldsymbol{C}_2)$ if you only pass through dark cells. The answer for one pair of points is independent of the answers for the remaining pairs of points.

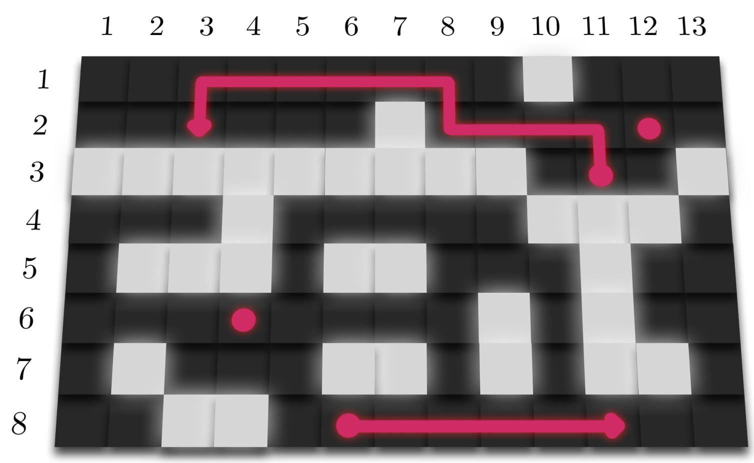
Example

Let's assume $\boldsymbol{N} = 8$ and $\boldsymbol{M} = 13$, and we have the following configuration of the hall:



In this case:

- If the goal is to move from cell **(3, 11)** to cell **(2, 3)**, you can do it in **11** seconds (and it is impossible to do it in less time). The figure below demonstrates one of the possible paths.
- If the goal is to move from cell **(8, 6)** to cell **(8, 11)**, you can do it in **5** seconds (and it is impossible to do it in less time). The figure below demonstrates one of the possible paths.
- If the goal is to move from cell **(6, 4)** to cell **(2, 12)**, it can be shown that it is **impossible** to do it without passing through illuminated cells.



Constraints

The following limits are guaranteed for all test cases of this Part that will be given to the program:

$2 \leq \boldsymbol{N}, \boldsymbol{M} \leq 300$	Grid dimensions
$1 \leq \boldsymbol{T} \leq 10$	Number of pairs of points
$1 \leq \boldsymbol{L}_{1_i}, \boldsymbol{L}_{2_i} \leq \boldsymbol{N}$	Coordinates of points (rows)
$1 \leq \boldsymbol{C}_{1_i}, \boldsymbol{C}_{2_i} \leq \boldsymbol{M}$	Coordinates of points (columns)
$(\boldsymbol{L}_{1_i}, \boldsymbol{C}_{1_i}) \neq (\boldsymbol{L}_{2_i}, \boldsymbol{C}_{2_i})$	Initial and final points do not coincide

The test cases of this Part of the problem are organized into two groups with different additional constraints:

Subtask	Points	Additional Constraints
1	10	$N = 1$
2	20	No further constraints

Part II

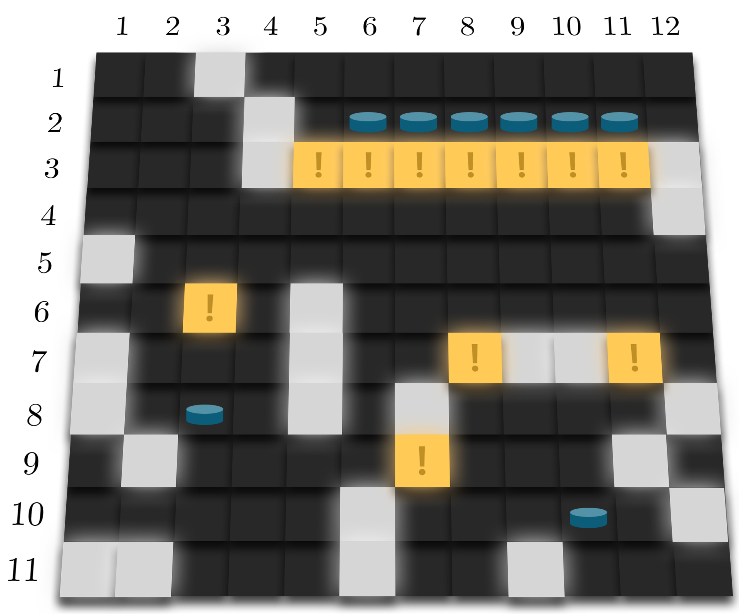
To further reinforce the museum's security, it has been decided to install two new devices in some **dark cells**: switches and trap-lights. Trap-lights are identical to lights in illuminated cells, but they start off disabled to save energy. If you pass through a cell that has a switch, all trap-lights in the hall are turned on and never turn off again. An (initially dark) cell that has a trap-light only triggers the alarm if you pass through it and the trap-light is enabled.

Once again, you are given the configuration of cells (illuminated, dark empty, dark with switch, and dark with trap-light) in the main hall of the museum and T pairs of points in the form (L_1, C_1), (L_2, C_2). For each pair of points, determine the shortest time interval you need to move from (L_1, C_1) to (L_2, C_2) if you only pass through dark cells. The answer for one pair of points is independent of the answers for the remaining pairs of points.

Just like in Part I, it is guaranteed that the initial and final points always correspond to dark cells, and additionally, these points do not have switches or trap-lights.

Example

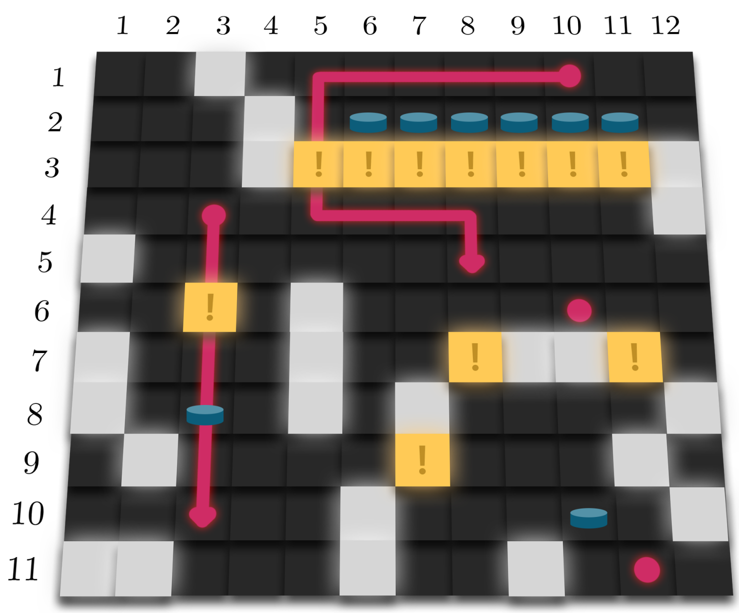
Let's assume $N = 11$ and $M = 12$, and we have the following configuration of the hall:



In this case:

- If the goal is to move from cell **(4, 3)** to cell **(10, 3)**, you can do it in **6** seconds by moving straight down (and it is impossible to do it in less time). You can pass through cell $(6, 3)$ with the trap-light since you will only pass through the switch in cell $(8, 3)$ later. The figure below demonstrates this path.

- If the goal is to move from cell **(11, 11)** to cell **(6, 10)**, **it is impossible** to do so without passing through illuminated cells because any path that passes through one of the three trap-lights in cells $(9, 7)$, $(7, 8)$, and $(7, 11)$ must necessarily have enabled the switch in cell $(10, 10)$.
- If the goal is to move from cell **(1, 10)** to cell **(5, 8)**, you can do it in **12** seconds (and it is impossible to do it in less time). All paths to reach the final cell pass through at least one trap-light, and the only way to ensure the trap-lights are disabled is by crossing cell $(2, 5)$, to avoid passing through the switches. The figure below demonstrates one of the possible paths.



Constraints

The limits guaranteed for all test cases in Part II are the same as those in Part I:

$2 \leq \boldsymbol{N}, \boldsymbol{M} \leq 300$	Grid dimensions
$1 \leq \boldsymbol{T} \leq 10$	Number of pairs of points
$1 \leq \boldsymbol{L}_{1_i}, \boldsymbol{L}_{2_i} \leq \boldsymbol{N}$	Coordinates of points (rows)
$1 \leq \boldsymbol{C}_{1_i}, \boldsymbol{C}_{2_i} \leq \boldsymbol{M}$	Coordinates of points (columns)
$(\boldsymbol{L}_{1_i}, \boldsymbol{C}_{1_i}) \neq (\boldsymbol{L}_{2_i}, \boldsymbol{C}_{2_i})$	Initial and final points do not coincide

The test cases of this Part of the problem are organized into three groups with different additional constraints:

Subtask	Points	Additional Constraints
3	20	There is at most one switch in the hall
4	20	There is at most one trap-light in the hall
5	30	No further constraints

Summary of Subtasks

The test cases for the problem are organized into five groups with different additional constraints:

Subtask	Points	Part	Additional Constraints
1	10	Part I	$\boldsymbol{N} = 1$
2	20	Part I	No further constraints
3	20	Part II	There is at most one switch in the hall
4	20	Part II	There is at most one trap-light in the hall
5	30	Part II	No further constraints

Input Format

The first line contains an integer $\boldsymbol{P}$, corresponding to the Part that the test case represents. If it is 1, then the test case refers to Part I; if it is 2, then it refers to Part II.

Next is a line with three space-separated integers $\boldsymbol{N}$, $\boldsymbol{M}$, and $\boldsymbol{T}$, indicating, respectively, the number of rows and columns of the grid and the number of pairs of points for which the answer is to be calculated.

Next comes a set of $\boldsymbol{N}$ lines, each with $\boldsymbol{M}$ characters without spaces, where each one can be:

- "`#`": illuminated cell
- "`.`": dark empty cell
- "`-`": dark cell with switch (only in Part II)
- "`!`": dark cell with trap-light (only in Part II)

Finally, $\boldsymbol{T}$ lines follow; the i^{th} one contains four space-separated integers, indicating the coordinates of the points in the order $\boldsymbol{L}_{1_i}$, $\boldsymbol{C}_{1_i}$, $\boldsymbol{L}_{2_i}$, $\boldsymbol{C}_{2_i}$.

Output Format

The output should contain $\boldsymbol{T}$ lines, each with an integer: the shortest time interval you need to move from $(\boldsymbol{L}_{1_i}, \boldsymbol{C}_{1_i})$ to $(\boldsymbol{L}_{2_i}, \boldsymbol{C}_{2_i})$ if you only pass through dark cells. If it is impossible to do so, you should print a line with the integer "`-1`".

Example 1 Input

```
1
8 13 3
.........#...
......#......
#########...#
...#.....###.
.###.##...#..
........#.#..
.#...##.#.##.
..##.........
3 11 2 3
8 6 8 11
6 4 2 12
```

Example 1 Output

```
11
5
-1
```

Example 1 Description

This example corresponds to the example mentioned in Part I of the problem statement.

Example 2 Input

```
2
11 12 3
..#.........
...#.------.
...#!!!!!!!#
...........#
#...........
..!.#.......
#...#..!##!.
#.-.#.#....#
.#....!...#.
.....#...-.#
##...#..#...
4 3 10 3
11 11 6 10
1 10 5 8
```

Example 2 Output

```
6
-1
12
```

Example 2 Description

This example corresponds to the example mentioned in Part II of the problem statement.

Organizers

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