Problem C - Aztec Maze

1 Description

Once you found the total number of distinct card assignments, you hear the deep voice once again, "Well done, you may pass".

You go through the door and find yourself in a new room. In the center of this room you see a model of a maze made up of square spaces. On one of those spaces, at the end of the maze, there is what seems to be the exit! You are almost out!

You also notice that there is a door in front of you, and you see the same door at the bottom of the model maze.

Dr Henry Jones notices this too and says: "Hmm, it seems we will enter the maze on the model if we go through the door. It seems we can use this model to guide us to the exit".

"But look sir", you say, "it seems that in some locations there are some manholes. I suspect that once we go through the door, the maze will start filling with water from these manholes!"

Dr Jones, looking at an inscription below the model says "It seems you are right, this inscription here says 'Block the water to be free"'.

"And what is this?", you ask. You are holding what seems to be several model manhole covers, and one model flood gate. When you place them on the model, or take them out, you hear noises coming from the maze, as if what you are doing in the model is also happening inside the maze.

"If my translation is correct", says Dr Jones looking at a manuscript he found near the model, "we can use the manhole covers to stop water from coming out of the manholes, and the flood gate to stop water from crossing between two spaces. I think that we need to place these objects in the model to create a safe path from the start of the maze to the exit".

You agree, and start working on a program to help with this task.

2 Goal

Given a maze, find where to place the flood gate and manhole covers to create a safe path that can go from the start of the maze to the exit without crossing any water. You must also return this path. It is guaranteed that there is always at least one way to create a safe path.

You can consider that water only flows in directions up, left, down or right (never diagonally), and cannot cross walls. Moreover, you assume that every place in the maze reachable by water from an uncovered manhole is immediately filled with water once you enter the maze.

3 Input

The first line of the input gives the number of test cases. There are at most 10 test cases per input.

The first line of each test cases gives two space-separated integers $1 \leq N \leq 500$ and $1 \leq M \leq 500$ denoting the number of rows and columns used to represent the maze.

The following N lines give the maze. Each line contains M characters. Each character is one of:

- `#` A wall
- `.` An empty space
- `E` The exit (this is always on the first line)
- `D` The door where you will start (this is always on the last line)
- `M` A manhole where water will come from once you open the door

Lastly, there is one line with an integer C denoting the number of manhole covers you have available. It is guaranteed that C is less than the number of manholes in the maze (which means that you must always use the flood gate).

4 Output

For each test case you must print several lines.

The first line must contain four space-separated integers r_1, c_1, r_2, c_2 which will give the location of the flood gate. In particular, this means that the flood gate will stop water from crossing from $(r1, c1)$ to $(r2, c2)$ and vice-versa. **The two spaces must be adjacent**.

The second line starts with an integer $0 \leq X \leq C$ denoting the number of manhole covers used.

The following X lines two space-separated integers denoting the coordinates r_i, c_i of the i-th manhole cover. **A manhole cover must be placed on a manhole**.

The next line starts with an integer $P \geq 2$ denoting the number of steps to get from the door to the exit.

The following P lines give the path. In particular, each line contains two integers denoting the coordinates r_j, c_j of this path in the order they are visited. The first coordinates should be the coordinates of the door, and the last should be the coordinates of the exit. **The safe path cannot go over walls or cross the flood gate**. There can be no repeated coordinates in this path, that is, you cannot go over the same place twice in the safe path.

Consider that the top-left corner of the map has coordinates (0, 0).

5 Example

5.1 Input

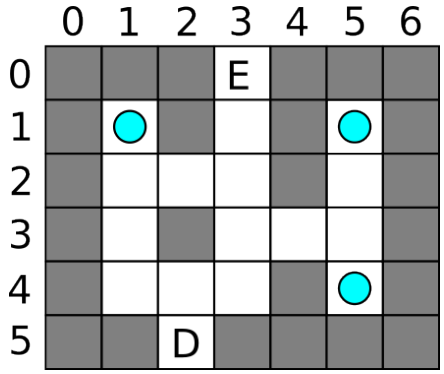
```
1
6 7
###E###
#M#.#M#
#...#.#
#.#...#
#...#M#
##D####
2
```

5.2 Output

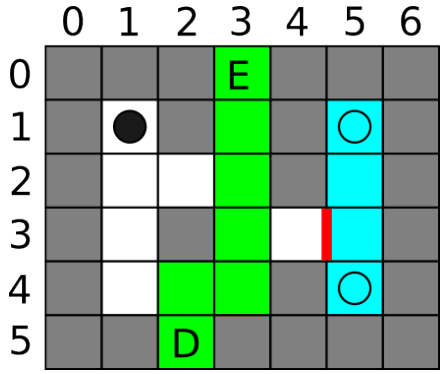
```
3 4 3 5
1
1 1
7
5 2
4 2
4 3
3 3
2 3
1 3
0 3
```

5.3 Explanation

In the following figure we see our input where the door is marked with `D` and the exit with `E`. Moreover, walls are marked in grey and manholes from where water will come from are marked with blue circles.



The following figure represents the output solution. The red line represents the flood gate, the black circle represents a covered manhole, the green squares give the path, and the blue squares give the places that water can reach from the uncovered manholes.



A different valid solution can be seen in the following figure.