IOI Training Camp 2010 – Final 2, 26 June, 2010

Problem 2 Playground[1]

For years, the Siruseri Muncipal Corporation has held onto a vacant plot where they have promised to build a municipal recreation centre. Each year, residents have been holding public protests about this prime land lying unused. Finally, bowing to this pressure, the SMC has agreed to mark off at least half the plot to be used as a playground.

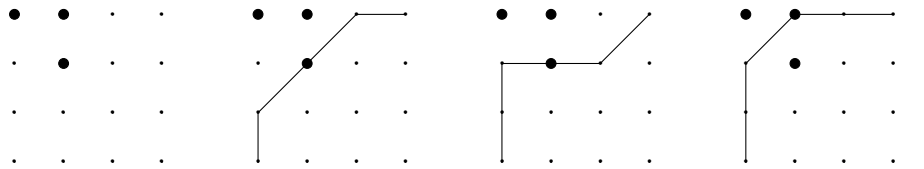
The ground is an $M \times N$ metre rectangle. If one designates the south-west corner of the plot $(0, 0)$, each point p in the plot can be described in terms of coordinates (x_p, y_p), where $0 \leq x_p \leq M$ and $0 \leq y_p \leq N$.

SMC's plans to separate the plot in two parts using a boundary wall. The wall will start at $(0, 0)$ and end at (M, N) and will be made up of straight line segments. Each segment of the wall will be built between two concrete pillars. The SMC's astrologer insists that all pillars must be located at integer coordinates—that is, positions (x, y) where both x and y are integers.

The playground will be the portion between the wall and the southeast corner of the plot. To prove that they are giving up at least half the plot to the playground, the wall will be *strictly convex*: walking along the wall from $(0, 0)$ to (M, N), at each pillar one *must* make a right turn.

However, as with all grandiose projects undertaken by the SMC, there is a small hitch. Some positions with integer coordinates are occupied by trees. Trees are not strong enough to serve as corner pillars, so a wall segment cannot end at a tree. Though it is environmentally indefensible to cut down a tree, fortunately it is permitted to have a tree embedded in a wall segment.

For instance, suppose the plot is 3m × 3m with trees at positions (0,3), (1,2) and (1,3). The first figure shows the empty plot, where all points with integer coordinates are marked and the three trees are drawn as larger dots. The second figure shows a legal wall with pillars at (0,1) and (2,3). The wall in the third figure is not convex because it turns left at the pillar at (2,2). The wall in the fourth figure is disallowed because it makes a turn at a tree.



Original plot *A legal wall* *Not convex* *Turns at a tree*

[1]Problem formulated by Harpreet and Prateek

Of course there are many ways to build a convex boundary wall that meets the requirements: in the example, there are 6 ways. Also, depending on how the wall is aligned, the area of the playground varies. In the figure, the maximum area that the playground can occupy is 8.0 m^2.

Your task is to help SMC compute the number of different ways to build a convex boundary wall, given the size of the plot and the location of the trees. You also have to compute the maximum area the playground can occupy, given all possible ways of constructing such a boundary wall.

Input format

The first line of input consists of three integers M, N and T where M and N describe the dimensions of the plot and T is the number of trees. The next T lines describe the trees. Each of these lines contains two integers X and Y, $0 \leq X \leq M$ and $0 \leq Y \leq N$, describing the coordinates of one tree.

Output format

The first line of output should be an integer describing the number of different ways of building a legal boundary wall on the given plot. Since this number may be large, you should report the answer modulo $10^8 + 7$.

The second line of output should be a floating point number, rounded off to 1 decimal place, describing the area (in m^2) of the largest playground that can be built on this plot using a legal boundary wall.

If only one part of your output is correct, either the first or the second line, you will receive 30% of the total score for that test case.

Test Data

You may assume that $1 \leq M, N \leq 60$ and $0 \leq T \leq (M+1)(N+1)$.

Sample input	Sample output
3 3 3 0 3 1 3 1 2	6 8.0

Time and memory limits

The time limit for this task is 1 second. The memory limit is 140 MB (actual limit 128 MB, plus 12 MB buffer for 64-bit compilation).