Problem 3 - Flowers and rocks (`flowers`)

A farmer has to plant F flowers in a field. To grow well, flowers must be placed as far apart as possible. Help the farmer find the optimal distance between flowers.

The field is represented as a rectangle of $W \times H$ cells.

Some cells in the field contain rocks where you cannot plant flowers. Other cells in the field are G cells where you can plant flowers.

The distance between two flowers is calculated as the Manhattan distance between their positions:

$$Dist((x_1, y_1), (x_2, y_2)) = |x_1 - x_2| + |y_1 - y_2|$$

The flower distance for a specific flower distribution is the minimum distance between any two flowers:

$$Dist_{field} = \min_{(i,j) \in F} (Dist((x_i, y_i), (x_j, y_j)))$$

Your task is to find the maximum flower distribution distance that will guarantee you can plant all the flowers in the field.

Input data

The first line of the input file contains an integer T, the number of test cases to solve.

For each test case, the first line of the input file contains the integers:

- W, the width of the field
- H, the height of the field
- F, the number of flowers to plant in the field
- G, the number of ground patches in the field free of rocks

The next G lines will contain the coordinates of ground patches, one per line, in the format `X Y`, where X is the column and Y is the row.

Coordinate values start with 0. The upper left corner of the field has coordinates $(0, 0)$.

Output data

The output file must contain **T** lines.

For each test case in the input file, the output file must contain a line with the characters:

`Case #t: D`

Where **t** is the test case number, from 1 to **T**, and D is the maximum distance between flowers that can guarantee that all F flowers can be planted in the field.

Note: the lines of the output file must be ordered from `Case #1:` to `Case #T:`.

Constraints

- $1 \le T \le 20$, the number of test cases
- $1 \le W, H \le 150$
- $1 \le F, G \le 50$
- $G < W \times H$
- $F \le G$

Scoring

- **input 1** : $T = 1$, $W, H \le 10$, $G \le 10$, $F \le 6$
- **input 2** : $T = 5$, $W, H \le 20$, $G \le 20$, $F \le 8$
- **input 3** : $T = 10$, $W, H \le 50$, $G \le 30$, $F \le 10$
- **input 4** : $T = 15$, $W, H \le 100$, $G \le 40$, $F \le 15$
- **input 5** : $T = 20$, $W, H \le 150$, $G \le 50$, $F \le 15$

Examples

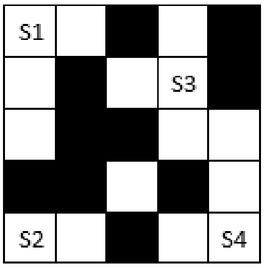
input	output
1 5 5 4 15 0 0 0 1 0 2 0 4 1 0 1 4 2 1 2 3 3 0 3 1 3 2 3 4 4 2 4 3 4 4	Case #1: 4

Explanation

In the example we have to plant 4 flowers on a field of 5×5 cells.

There are 15 rocks on the field, at coordinates $(0, 0)$, $(0, 1)$, $(0, 2)$, $(0, 4)$, $(1, 0)$, $(1, 4)$, $(2, 1)$, $(2, 3)$, $(3, 0)$, $(3, 1)$, $(3, 2)$, $(3, 4)$, $(4, 2)$, $(4, 3)$ and $(4, 4)$.

Flowers can be planted in the following way:



The distances between all the flowers are:

- $Dist(S1, S2) = 4$
- $Dist(S1, S3) = 4$
- $Dist(S1, S4) = 8$
- $Dist(S2, S3) = 6$
- $Dist(S2, S4) = 4$
- $Dist(S3, S4) = 4$

The minimum distance between the flowers is 4, so the distance for this distribution is 4.

There is no other distribution that can plant flowers with a distance of 5, so the answer is 4.