

Boomerang (10 points)

Today you've found yourself standing on an infinite 2D plane at coordinates (X_0, Y_0) . There are also N targets on this plane, with the i th one at coordinates (X_i, Y_i) .

You have a boomerang which you can throw in a straight line in any direction from your initial location. After you throw it, you may instantaneously run to any location on the plane. After the boomerang has travelled a distance of exactly D along its initial trajectory, it will return directly to you — that is, to your chosen final location. Note that you cannot move around once the boomerang has started its return trip — its path will always consist of 2 line segments (the first of which has a length of exactly D). The boomerang and the targets have infinitesimal size.

Let A be the number of targets which your boomerang hits (directly passes through) during the first segment of its flight, and B be the number of targets which it hits during the second segment. Your throw is then awarded a score of $A * B$. What's the maximum score you can achieve? Note that, if there is a target at the exact location at which the two segments meet (at a distance of D from your initial location), then it counts towards both A and B !

Input

Input begins with an integer T , the number of planes. For each plane, there is first a line containing the space-separated integers X_0 and Y_0 . The next line contains the integer D , and the one after contains the integer N . Then, N lines follow, the i th of which contains the space-separated integers X_i and Y_i .

Output

For the i th plane, print a line containing "Case # i : " followed by the maximum score you can achieve.

Constraints

$$1 \leq T \leq 20$$

$$1 \leq N \leq 3,000$$

$$1 \leq D \leq 100$$

$$-100 \leq X_i, Y_i \leq 100, \text{ for } 0 \leq i \leq N$$

All coordinates are pairwise distinct. The following restrictions are also guaranteed to hold for the input given:

For any three targets at distinct points $\mathbf{a}$, $\mathbf{b}$, and $\mathbf{c}$, it is guaranteed that $\mathbf{c}$ is either closer than 10^{-13} away from the infinite line between $\mathbf{a}$ and $\mathbf{b}$ (and is considered to be on the line), or is further than 10^{-6} away (and is considered to not be on the line).

Let $\mathbf{p}$ be any point at which the boomerang may change direction after hitting a target. For any two targets at distinct points $\mathbf{a}$ and $\mathbf{b}$, it is guaranteed that $\mathbf{p}$ is either closer than 10^{-13} away from the infinite line between $\mathbf{a}$ and $\mathbf{b}$ (and is considered to be on the line), or is further than 10^{-6} away (and is considered to not be on the line).

Explanation of Sample

On the first plane, one optimal strategy is to throw the boomerang in the direction of the positive x-axis (that is, to (6, 0)), and then run to (0, 0). It will hit targets 2 and 3 on the first segment of its flight, and all 3 targets on the second segment, for a score of $2 \times 3 = 6$.

Example input	Example output
5 2 0 2 3 1 0 3 0 4 0 2 0 1 3 1 0 3 0 4 0 5 5 10 4 0 0 10 0 10 10 0 10 0 0 2 6 -1 -1 0 8 0 9 0 10 10 1 10 2 0 0 10 6 -1 -1 0 8 0 9 0 10 10 1 10 2	Case #1: 6 Case #2: 3 Case #3: 2 Case #4: 1 Case #5: 9

Lunch Scheduling (15 points)

James and Wilson are the best of buddies. And, conveniently enough, they both work at Corpro Corp! Every day, they have the opportunity to eat lunch together, while talking about how well their favourite sports teams are doing and how strict their managers are. However, their work obligations can often get in the way of that.

At Corpro Corp, each workday is 80,000,000 milliseconds long, and the company uses the phrase "time t " to refer to the moment in time t milliseconds after the start of the workday. All employees arrive at time 0, and leave at time 80,000,000.

On a certain day, James gets invited to J optional meetings. The i th of these meetings starts at time A_i and ends at time B_i . Similarly, Wilson gets invited to W optional meetings, with the i th one starting at time C_i and ending at time D_i . All $J+W$ meetings might arbitrarily overlap with one another.

Both James and Wilson may choose to accept any subset of their invitations, possibly none of them or all of them. The meetings are all conducted virtually, making it possible to attend multiple meetings at the same time — as such, two invitations may be accepted even if their time ranges overlap.

As it turns out, James and Wilson actually hate having lunch together, but they feel obligated to do so if they're able to. Eating lunch takes exactly L milliseconds, and so the two friends will meet up for lunch if there's a consecutive interval of at least L milliseconds within their work hours during which neither of them is taking part in any meetings.

Less surprisingly, James and Wilson hate attending meetings. If James accepts x of his J invitations, and Wilson accepts y of his W invitations, then the combined inconvenience they experience is $\max(x, y)$. Determine whether or not it's possible for them to avoid having to eat lunch together — and, if so, determine the minimum combined inconvenience they must incur to do so.

Input

Input begins with an integer T , the number of days James and Wilson go to work. For each day, there is first a line containing the space-separated integers J , W , and L .

Then, J lines follow, the i th of which contains the space-separated integers A_i and B_i .

Then, W lines follow, the i th of which contains the space-separated integers C_i and D_i .

Output

For the i th day, print a line containing "Case $\#i$: " followed by the minimum combined inconvenience James and Wilson must experience, or "Lunchtime" if they cannot avoid having lunch together.

Constraints

$$1 \leq T \leq 20$$

$$0 \leq J, W \leq 3000$$

$$1 \leq L \leq 100,000,000$$

$$0 \leq A_i < B_i \leq 80,000,000$$

$$0 \leq C_i < D_i \leq 80,000,000$$

Explanation of Sample

In the first case, James can attend the meeting from time 40,000,000 to 70,000,000, and Wilson can attend the meeting from time 10,000,000 to time 21,000,000. They each attend one meeting, so the combined inconvenience is 1.

Example input	Example output
5 2 2 200000000 0 500000000 400000000 700000000 100000000 210000000 150000000 160000000 2 2 100 20 300 800 800000000 500 1000 800 800000000 2 2 100 20 300 650 1000 350 600 1050 800000000 2 1 100 20 300 350 1000 650 800000000 0 5 100000000 99999999 200000000 100000000 400000000 12345678 33333333 450000000 600000000 54321234 76543456	Case #1: 1 Case #2: Lunchtime Case #3: 2 Case #4: 2 Case #5: 4

Gentrification (35 points)

The residents of Townsville have made it clear to the mayor that they're greatly concerned about gentrification, a process by which wealthy people move into the city in large numbers, displacing the people who currently live there. The mayor of Townsville knows a thing or two about this, and she would like to put the people's minds at ease by determining the worst-case scenario.

Townsville is made up of N neighbourhoods, with M one-way roads running between them. The i th road runs from neighbourhood A_i to neighbourhood B_i . A swarm of rich migrants will move to the city all at once, immediately gentrifying any neighbourhood they decide to move into.

The mayor knows the following facts about these new affluent residents: First, they like to visit other gentrified neighbourhoods. If there's a way of getting from their home neighbourhood to another gentrified neighbourhood, they will surely go visit. Second, they never walk anywhere; they only drive. Consequently, they'll get very angry if they end up in some neighbourhood with no way to drive back home.

Putting these facts together, it means that if rich migrants move into and gentrify any two neighbourhoods u and v , then it must be the case that there is a series of roads connecting u to v if and only if there is a series of roads connecting v to u .

Given this self-imposed constraint, and the layout of the roads in Townsville, what is the maximum number of neighbourhoods that can be gentrified?

Input

Input begins with an integer T , the number of test cases. For each test case, there is first a line containing the space-separated integers N and M .

Then, M lines follow, the i th of which contains the space-separated integers A_i and B_i .

Output

For the i th test case, print a line containing "Case #i: " followed by the maximum possible number of gentrified neighbourhoods.

Constraints

$$1 \leq T \leq 20$$

$$1 \leq N \leq 500$$

$$1 \leq M \leq 20,000$$

$$0 \leq A_i, B_i < N \text{ for all } 1 \leq i \leq M$$

$$A_i \neq B_i \text{ for all } 1 \leq i \leq M$$

Explanation of Sample

In the first test case, you can get from any neighbourhood to any other neighbourhood, so they can all be gentrified.

In the second test case, any single neighbourhood can be gentrified, but that's it. If any two neighbourhoods are gentrified, there would be a path from one to the other, but no path back.

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Example input	Example output
5 4 4 0 1 1 2 2 3 3 0 4 3 0 1 1 2 2 3 6 6 0 1 1 0 2 3 3 2 4 5 5 4 6 8 0 1 1 0 2 3 3 2 4 5 5 4 0 2 1 4 4 4 0 1 0 2 1 3 2 3	Case #1: 4 Case #2: 1 Case #3: 6 Case #4: 4 Case #5: 2

Fox Rocks (40 points)

Mr. Fox sure loves his rocks! In fact, when he's not in a hurry, he often looks at the rocks lying around near him to decide where to wander in his forest.

Mr. Fox lives in a forest with N clearings, numbered from 0 to $N-1$, with P one-way trails initially running amongst them. The i th trail runs from clearing A_i to a different clearing B_i , and is littered with R_i rocks. No two clearings are connected by multiple trails running in the same direction, though they could be connected by 2 trails running in opposite directions. Additionally, an interesting property of this forest is that a trail from clearing a to clearing b may only exist if $0 \leq \text{floor}(b/4) - \text{floor}(a/4) \leq 1$.

To entertain himself over a period of D days, Mr. Fox will cause one event to occur on each day. The i th event may be one of 3 types, determined by the value of E_i :

1. Given 3 integers X_i , Y_i , and Z_i , Mr. Fox will create a new trail from clearing X_i to a different clearing Y_i , and drop Z_i rocks onto it. It's guaranteed that no trail from X_i to Y_i will exist at the start of the i th day, and that $0 \leq \text{floor}(Y_i/4) - \text{floor}(X_i/4) \leq 1$ will hold.
2. Given 2 distinct integers X_i and Y_i , Mr. Fox will completely destroy the trail from clearing X_i to clearing Y_i (which is guaranteed to exist at the start of the i th day). Note that, once such a trail is destroyed, a new trail from X_i to Y_i may be created in the future.
3. Given 2 distinct integers X_i and Y_i , Mr. Fox will take a "random stroll" starting at clearing X_i , and would like to determine the probability that he'll visit clearing Y_i at least once during it.

A "random stroll" consists of repeating the following process potentially infinitely: If Mr. Fox is currently in some clearing c , and there are no outgoing trails from c , then the stroll ends immediately. Otherwise, he'll consider all of the rocks on all of the outgoing trails from c , choose one of these rocks uniformly at random, follow the trail on which that rock lies to its destination clearing (without removing any rocks), and repeat the process from his new clearing.

For each event of type 3, output the requested probability.

Input

Input begins with an integer T , the number of test cases. For each test case, there is first a line containing the space-separated integers N , P , and D .

Then, P lines follow, the i th of which contains the space-separated integers A_i , B_i , and R_i .

Then, D lines follow, the i th of which contains the space-separated integers E_i , X_i , and Y_i . If $E_i = 1$, this line additionally contains the integer Z_i .

Output

For the i th test case, print a line containing "Case # i : " followed by the computed probabilities for each stroll that Mr. Fox takes. These probabilities should be space-separated, and rounded to 6 decimal places.

Absolute errors of up to $2 * 10^{-6}$ will be ignored.

Constraints

$1 \leq T \leq 20$
 $1 \leq N \leq 50,000$
 $0 \leq P \leq 100,000$
 $1 \leq D \leq 20,000$
 $0 \leq A_i, B_i, X_i, Y_i < N$
 $1 \leq E_i \leq 3$
 $1 \leq R_i, Z_i \leq 5$

Explanation of Sample

In the first test case, Mr. Fox does multiple strolls from clearing 0 while looking out for clearing 3. His first stroll has probability 1 as he must always end up at clearing 3. His second stroll has probability $1/2$ as there's a 50% chance he gets stuck in clearing 4. His third stroll has probability $2/3$ as he now only goes to clearing 4 $1/3$ of the time. His fourth stroll has probability $1/3$ as he gets stuck in clearing 4 $1/3$ of the time, and in clearing 1 $1/3$ of the time.

Example input	Example output
5	Case #1: 1.000000 0.500000 0.666667 0.333333
8 0 10	Case #2: 0.333333 0.500000 0.600000 0.666667
1 0 1 1	Case #3: 0.250000 0.125000 0.266667 0.066667
1 1 2 1	Case #4: 0.200000 1.000000 0.600000 0.750000
1 2 3 1	Case #5: 0.500000 0.750000 0.875000 1.000000
3 0 3	
1 0 4 1	
3 0 3	
1 0 3 1	
3 0 3	
2 1 2	
3 0 3	
4 4 10	
0 1 1	
1 0 1	
1 2 1	
0 3 1	
3 0 2	
2 0 1	
1 0 1 2	
3 0 2	
2 0 1	
1 0 1 3	
3 0 2	
2 0 1	
1 0 1 4	
3 0 2	
8 7 5	
0 1 1	
1 2 1	
2 3 1	
0 4 1	
1 5 1	
2 6 1	
3 7 1	
3 0 5	
3 0 7	
1 3 0 1	
3 0 5	
3 0 7	
8 4 10	
4 5 1	

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5 6 1	
6 7 1	
7 4 1	
1 0 4 1	
1 0 1 4	
3 0 7	
1 1 6 1	
3 0 7	
1 1 2 1	
1 2 3 1	
3 0 7	
1 2 0 1	
3 0 7	
12 5 7	
0 4 1	
4 8 1	
0 1 1	
1 2 1	
2 3 1	
3 0 8	
1 1 4 1	
3 0 8	
1 2 4 1	
3 0 8	
1 3 4 1	
3 0 8	