National Taiwan University

2013 Team Qualification

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A. White Dwarf

time limit: 5 seconds

> *A white dwarf, also called a degenerate dwarf, is a stellar remnant composed mostly of electron-degenerate matter. They are very dense; a white dwarfs mass is comparable to that of a sun, and its volume is comparable to that of the Earth.* — from Wikipedia.

A group of archaeologists claimed that they found N dwarven sculptures in an ancient tomb, and each of them is painted by some color id c_i. All colors of distinct id are different.

It is known that in drawven culture, when a batch of sculptures are put inside the same tomb, all sculptures with the largest density are always painted white. Given all sculptures' mass and volume, and their color id's respectively, could you identify how many white sculptures there are?

If it is certain that there is something wrong in the data provided by the archaeologist (i.e. it does not match the known fact), please also point it out.

Input Format

The first line of the input file contains an integer T $(1 \leq T \leq 100)$ indicating the number of test cases.

Each test case starts with a line containing an integer N $(1 \leq n \leq 10^5)$. Each of the next N lines contains three integers m_i, v_i, c_i $(1 \leq m_i, v_i, c_i \leq 10^9)$, being the mass, volume, and color id of the i-th sculpture.

Output Format

For each test case output the number of white sculptures. If there is any thing suspicious with the data provided, output "hmm, curious." without quotes.

Sample Input

```
3
3
1 1 1
2 2 1
3 3 1
3
1 3 1
2 2 2
3 1 3
3
1 1 1
2 2 3
3 3 5
```

Sample Output

```
3
1
hmm, curious.
```

B. Black Orlov

time limit: 1 second

There are so many stones that were cursed in the history. Now you get n magical stones. In order to gain most magical power of these stones, you must seperate them into two sets A and B with strongest interconnections. The interconnections can be measured as follows: For each magic stone there is a nonnegative integer value v_i, and for any two stones with values u, v in different sets, they contribute the interconnection power value by $f(u \oplus v)$, where $\oplus$ denotes the bitwise-xor operation and $f(x)$ counts the number of 1-bits in x. The interconnection power between A and B can then be formulated as

$$\sum_{u \in A, v \in B} f(u \oplus v)$$

Please output the value of the largest interconnection power.

Input Format

The first line of the input file contains an integer T $(1 \leq T \leq 100)$ indicating the number of test cases.

Each test case starts with a line containing an integer n $(1 \leq n \leq 16)$. Next line contains n integers $v_1, v_2, \cdots, v_n$ $(0 \leq v_i \leq 10^9)$.

Output Format

For each test case output the value of the largest interconnection power in a line.

Sample Input

```
3
5
1 1 1 1 1
5
1 2 3 4 5
5
5 0 2 1 6
```

Sample Output

```
0
13
13
```

C. Gray Code?

time limit: 2 seconds

No, this problem has nothing to do with Gray codes.

Given a sequence of binary bits, how many distinct *subsequences* of length k are there among them? Since the answer might be large, please answer the problem modulo m.

Recall that a *subsequence* of a given sequence is a subset of elements of the orginal sequence, put together into a new sequence in the same order as they are in the original sequence.

Input Format

The first line of the input file contains an integer T ($1 \leq T \leq 100$) indicating the number of test cases.

For each test case, first line contains three integers n, k, m ($1 \leq k \leq n \leq 2000$; $1 \leq m \leq 1000000007$). Second line contains a binary string of length n.

Output Format

For each test case, please output the number of distinct subsequences of length k modulo m.

Sample Input

```
3
6 2 10
000111
6 2 10
000000
6 2 10
010101
```

Sample Output

```
3
1
4
```

D. Red Bomb

time limit: 1 second

In order to build a red park, we decide to throw a powerful red bomb to destroy a lot of things on the red land. There are N target objects on the 2D plane, with each one located at position (x_i, y_i). Each object has two property values: defence D_i and corevalue C_i. Once a red bomb is thrown at (x, y), all the objects will receive a positive damage measured by

$$\frac{C_i}{D_i + (x - x_i)^2 + (y - y_i)^2}$$

Your job is to obtain the maximum possible *harmonic mean* of damage values.

Input Format

The first line of the input file contains an integer T $(1 \le T \le 100)$ indicating the number of test cases.

For each test case, there is an integer N $(1 \le N \le 10000)$. In each of the next N lines, there are four integers x_i, y_i, C_i, D_i $(0 < x_i, y_i, C_i, D_i \le 10^7)$.

Output Format

For each test case output the required value. Any answer with a relative or absolute error of at most 10^{-5} will be accepted.

Sample Input

```
3
1
1 1 1 1
2
1 1 1 1
2 2 2 2
3
1 1 1 1
2 2 2 2
3 3 3 3
```

Sample Output

```
1.0000000000
0.7500000000
0.5789473684
```

Hint

The *harmonic mean* of some numbers $a_1, a_2, \cdots, a_k$ is defined as

$$\frac{k}{\sum_{i=1}^{k} \frac{1}{a_i}}$$

E. Orange Baseball

time limit: 3 seconds

I can throw an orange like a baseball, but I cant eat a baseball like an orange. Let that be a life lesson for you.

— Jarod Kintz, A Zebra is the Piano of the Animal Kingdom

Earthworm is interested in palindromes, while Shik loves hash functions. I521530 decides to merge these two things, so he invented the magic hash function in C which only takes palindromes as input string:

```
int hash(const char *s, int m) {
    int h = 0;
    for (int i = 0; s[i]; i++) h = (h * Z7LL + s[i] - 'a' + 1) % m;
    return h;
}
```

Looks familiar, huh? But when Earthworm compiled the code, it halted with the following error:

```
variable Z7LL is not defined.
```

In order to generate the world-wide-worst testdata, Earthworm needs to carefully define this value so that for some cherished palindromes they will have the same hash value. Can you help him to find out how many such values exist between 0 and $m - 1$ inclusively?

Input Format

The first line of the input file contains an integer T ($1 \le T \le 100$) indicating the number of test cases.

For each test case there are two palindromes P_1, P_2 and an integer m ($1 \le |P_1|, |P_2| \le 100000$; $1 \le m \le 1000$).

Output Format

For each test case, please output the number of possible Z7LL values in a line.

Sample Input

```
3
abba abccba 100
xyx abbccbba 1
egge ffff 1000
```

Sample Output

```
18
1
24
```

F. Yellow Duck

time limit: 5 seconds

The Yellow Duck is coming to NTU – in the form of a problem in a programming contest! She loves traveling through the rivers, especially for collecting shining characters during the trip.

The river can be modeled as many conjunctions and paths. The conjunctions are labeled from 1 to n. Each conjunction has a height. The larger number a conjunction is labeled, the lower in altitude it is. Therefore the ducks may travel from a conjunction with smaller label to a larger one if there is a path between them. The origin is labeled with 1, and the ocean is labeled with n.

For each river path connecting two conjunctions, there is a single shining character that can be collected. The yellow duck must collect this character if she flows down through this path.

Now, as a palindromic fan, the yellow duck wants to know how many different paths there are, such that the collected characters, when view as a string in the order they are collected, forms a palindrome. Can you help her? Since the answer may be very large, output the answer modulo the magic number 1000000007.

Input Format

The first line of the input file contains an integer T ($1 \leq T \leq 20$) indicating the number of test cases.

For each test case, first line contains two integers n, m ($2 \leq n \leq 5000; 1 \leq m \leq 5000$), representing number of conjunctions and number of rivers. Each of the next m lines contains x_i, y_i, c_i ($1 \leq x_i < y_i \leq n$; c_i is a lower-case English letter), representing that there is a river from x_i to y_i, containing the character c_i that can be collected. It is possible having several river paths connects same conjuction pair.

Output Format

For each test case please output the answer in one line.

Sample Input

```
2
4 3
1 2 a
2 3 b
3 4 a
3 3
1 2 a
2 3 b
1 3 c
```

Sample Output

```
1
1
```

G. Green Cards

time limit: 1 second

There was a shop selling different kinds of cards. One day, there is a special event that you can get cards for free!

The rule of the event is as follows: There are n kinds of cards, and m kinds of card packs available. Each card pack contains a number of cards, possibly with repetition. You can take any number of card packs of each kind. But when you leave the shop, for each kind of card, if there are a total of X cards of that kind in all card packs you've taken, you'll only get $X \ mod \ 514514999$ cards of that kind.

Unfortunately, you don't like cards, except a ultimate special kind of card called the Green Card. So you want to take away as many Green Cards as you can, but **only if you don't get any other cards at all**. What is the maximum number of Green Cards you can take?

Input Format

The first line of the input contains an integer T $(1 \leq T \leq 100)$ indicating the number of test cases.

For each test case, first line contains two integers n, m $(1 \leq n, m \leq 70)$. Then m lines follow, each with n space-separated integers. The i-th integer in the j-th line represents the number of cards of kind i in pack j. The Green Card is the card of kind 1.

All input integers are non-negative and less than 10^9.

Output Format

For each test case please output the answer in one line.

Sample Input

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

Sample Output

```
514514998
0
```

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H. Blue Monkey

time limit: 5 seconds

There are some rivers on a plane. Since the plane is so big, we can treat each river as a straight horizontal line. Each day when the sun rises, a monkey would appear at some random point (x, y) in the square $[0, L] \times [0, L]$, where the probability of appearing at any interior point is uniform. The monkey would then uniformly and randomly choose an angle θ in $[0^\circ, 360^\circ]$ and walks in a straight line to the point $(x + D\cos\theta, y + D\sin\theta)$. After the monkey arrives, it simply vanishes into thin air (*magical monkeys are magical!*). If the monkey walks across any river on the plane during his journey, it would become very upset (*magic monkey no like water! eek!*).

Before the first day, there were no river on the plane. Each day before sunrise, either one new river will emerge, or one existing river may disappear. For each day please calculate the probability that the magical monkey would be upset.

Input Format

The first line of the input contains an integer T ($1 \le T \le 100$) indicating the number of test cases.

For each test case, the first line contains two numbers L, D ($1 \le L, D \le 10^9$). The second line contains one number m ($1 \le m \le 10^5$), indicating the number of days. And m lines follow. The i-th line contains two numbers t, a. The first integer t determine the type of the event before sunrise of day i.

- If $t = 1$, then a river with equation $x = a$ emerges on the plane. ($|a| \le 2 \times 10^9$)
- If $t = 2$, then the river that emerged on the a-th day will disappear ($1 \le a < i$, and the event on day a would be of type 1).

It is guarateed that all input is valid. That is, each river would disappear at most once, and the river that disappear would be currently existing. And there would not be two rivers with exactly same location. All input numbers are given to at most 3 digits.

Output Format

For each test case, print m numbers, indicating the probability that the monkey would be upset on each day. Any answer with a relative or absolute error of at most 10^{-6} will be accepted.

Sample Input

```
1
10.0 1.0
2
1 5.0
2 1
```

Sample Output

```
0.0636620
0.0000000
```

I. Indigo Children

time limit: 3 seconds

Indigo Children are those children who are believed to possess special, or even supernatural abilities. DarkKnight is one of them. As one of the most gifted youth of the 21-st century, he possesses many special abilities, such as never having to wear more than a pair of shorts no matter how cold the weather is.

Anyway, today we're concerned about another special ability of DarkKnight. After he has curry as lunch, his vision would enhance and he could virtually visualize the social network around him as a graph.

Formally, each friend of him could be regarded as a node, and people who befriend each other (you can assume that if A consider B a friend, so does B consider A) are connected with bidirectional edge. Now, DarkKnight believe that each person could be characterized by a 16-bit integer, which he regards as the "characteristic value" of the person. The more alike two people are, the more likely they will be friend.

Now, DarkKnight already know the "characteristic value" of some of his friends, and he want to estimate the "characteristic value" of those friends whose value he does not know yet. For an assignment Y of "characteristic value" to his friends, where $Y(v)$ is the characteristic value of friend v, we denote the cost $C(Y)$ to be:

$$C(Y) = \sum_{(v,u)\in E} Y(v) \oplus Y(u)$$

where $\oplus$ denotes the "XOR" (exclusive-or) operation between the two integers. As can be seen, intuitively, the more alike v and u is, the smaller the corresponding cost term $Y(v) \oplus Y(u)$. So given the characteristic values for some of DarkKnight's friend, DarkKnight wants to assign adequate interger value to the rest of his friends, so that the total cost $C(Y)$ is as small as possible.

Input Format

The first line of the input file contains an integer T ($1 \leq T \leq 100$) indicating the number of test cases.

Each test case begins with three integers N ($1 \leq N \leq 100$), M ($0 \leq M \leq \frac{N(N-1)}{2}$), and K ($0 \leq K \leq N$), being the number of friends in DarkKnight's social network, the number of friend-relations, and the number of known characteristic values, respectively. Then follows M lines, each consisting of a pair of integer v_i, u_i ($1 \leq v_i, u_i \leq N$), denoting that person v_i and u_i are friends. Finally there are K lines, each being two integers v_j, c_j, indicating that person v_j is known to have characteristic value c_j ($1 \leq v_j \leq N$, $0 \leq c_j < 2^{16}$).

The input is valid. That is, a person will appear zero or one time in the list of known characteristic values.

Output Format

For each test case, please output the smallest cost among all possible assignment.

Sample Input

```
2

3 3 0
1 2
1 3
2 3

4 3 3
1 2
1 3
1 4
2 1
3 1
4 2
```

Sample Output

```
0
3
```

J. Violet Composer

time limit: 5 seconds

Legend has said that a mysterious composer may combine any two integers into their least common multiple. On one of those days that seems totally normal, the famous taxi-traveller Shik found a mysterious box on the taxi during his trip.

To open the box, he needs to enter some mysterious code. As far as he knows, the code must have something to do with the mysterious sequence $(a_1, a_2, a_3, \cdots, a_m)$ and a mysterious integer n.

Curiously, he put all the numbers in the sequence into the mysterious composer and got the magic keyword L, which equals to the least common multiple of all the integers.

Shik has discovered the relationship between the mysterious code and the key pair (n, L). The mysterious code is the number of integers between 1 and n that can divide L exactly.

Shik's nemesis, Tourist is also on to the mysterious box. Can you help Shik figure out the mysterious code as soon as possible?

Input Format

The first line of the input file contains an integer T $(1 \leq T \leq 10)$ indicating the number of test cases.

For each test case, the first line contains two integers n, m $(1 \leq n \leq 10^8; 1 \leq m \leq 5 \times 10^4)$. The next line contains m integers $a_1, a_2, \cdots, a_m$ $(1 \leq a_i \leq 10^9)$.

Output Format

For each test case please output the answer in a line.

Sample Input

```
2
8 3
5 6 7
50216 1
514
```

Sample Output

```
6
4
```

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K. Gold Rush

time limit: 10 seconds

Gold rush!!! In a field of $R \times C$ cells, each of them contains various amount of gold. The grid is surrounded by natural walls along the border. The amount of gold in each cells are distinct. When a prospector arrives in a cell, he will spend one unit time in the cell searching for gold. After that the prospector will move to one of the neighboring cells (top, left, bottom, or right cell, except one cannot move into a wall) which contains the largest amount of gold, or stay in the same cell if this cell has larger amount of gold than its neighbors.

The prospectors are all fierce and repulsive, so if two of them walk into the same cell at the same unit of time, the two will begin a furious fight. Now, that is definitely not something the authorities want, so the authorities want to prevent such situation, or at least predict when the conflict will break out.

There are Q queries, each query begins with a number of K_i, being the number of prospectors in this query; then follows K_i pairs of integer (r_j, c_j), being the cell each prospector starts digging at time 0. For each query please answer when is the earliest time that some conflicts begin.

Input Format

The first line of the input file contains an integer T ($1 \leq T \leq 50$) indicating the number of test cases.

Each case begins with two integers R, C ($1 \leq R, C \leq 300$), denoting the number of rows and columns of the grid, respectively. Then follow $R \times C$ distinct integers denoting the amount of gold in each cell of the grid.

Finally an integer Q ($Q \leq 50000$) denotes the number of queries you need to process. Each of the Q following lines starts with K_i, the number of prospectors that start digging simultaneously, then K_i different locations (r_j, c_j) ($1 \leq r_j \leq R$; $1 \leq c_j \leq C$) indicating the starting positions of each prospector.

The sum of all K_i will not exceed 200000.

Output Format

For each query output the earliest time that some prospectors meet in the same cell and begin a conflict. If no conflict is expected to occur no matter how long the time pass, just output "thanks to the powerpuff girls." without quotes. Output a blank line after each test case.

Sample Input

```
1
1 5
1 4 2 3 5
3
2 1 1 1 3
2 1 1 1 2
2 1 1 1 4
```

Sample Output

```
1
1
thanks to the powerpuff girls.
```

L. Transparent Walker

time limit: 8 seconds

Recently, it had been reported that due to some genetic anomaly, people with the ability to cloak themselves when they want, so called "invisible men," or "transparent walker" by some TV shows that want to create sensations, have appeared in SkyDrake Kingdom. These people have totally normal appearance when they do not use their ability (i.e. invisibility), but when they do they are absolutely transparent, and cannot be seen by any device.

The VSDTAD (Very Secret Don't Tell Anyone Department) has located possible appearance of (possibly multiple) invisible men living in an old apartment. They are here to ask for your help, please read along.

There are a total of K residences in the apartment. The apartment has N entrances, each guarded by a loyal security. The securities carefully monitor every single person that enters or exits through his entrance. However, as one can imagine, if an invisible man passes through an entrace when he is cloaked, the security, attentive as they are, will not be able to see the man passing through (and thus the entrance/exit will not appear in the security's record). It is thus possible to prove the existence of invisible men just by using the securities' records. For instance, consider the following record: (In the beginning before the record starts, no one is in the apartment.)

entrance/exit of resident	1	2	3	4	5	total records
Record for entrance 1	+3/-1	+54/-3	+1/-4	+0/-0	+2/-3	71
Record for entrance 2	+2/-3	+0/-0	+2/-1	+1/-0	+1/-5	15
Record for entrance 3	+4/-4	+0/-0	+3/-1	+0/-0	+9/-4	25
currently in apartment?	y	y	n	y	n	

In the table above, each row is a record kept by one security guarding a specific entrance. Each column consists of the enter/exit records for a specific resident. "+a/-b" indicates that the resident of that corresponding column enters a times, and exits b times through the corresponding entrance. The total records is simply the number of events recorded by a security.

As can be seen, one can clearly infer that there's definitely something wrong with resident 2, as even though he enters the building 54 times, he only exits thrice and he's not in the apartment right now. Now, even though the details of other two records are not seen, judging by the total number of records being only 15 and 25, the facts cannot add up. Therefore it is very likely he is one of those invisible men the news are talking about (though he can also be Teleport Man, Germ Man or someone carrying a Portal Opening Device, but let's settle with the simple explanation for now).

The VSDTAD wants to prove the existence of invisible men using these records. However there's one prolem: the securities are very loyal (to the residents inside), they will not give up their very secret records to the public (that somehow the VSDTAD managed to get hold on) easily, so it is necessary to bribe a number (possibly all) of them so they will publish their record publicly. Luckily for VSDTAD, the number of total records of each entrance are available to the public, so even without bribery the VSDTAD will be able to use these numbers in their report.

The VSDTAD thus want to bribe a minimum number of securities (of their selection) so that the records of these bribed security, combined with the number of records of each entrance (which is always available to public) will be enough to prove the existence of invisible man. (It is however not necessary to pin down exactly who the invisible man is.) Please answer: at least how many securities need to be bribed.

Input Format

The first line of the input file contains an integer T ($1 \leq T \leq 30$) indicating the number of test cases.

Each case begins with an integer N ($1 \leq N \leq 36$), denoting the number of entrances of the apartment, then an integer K ($1 \leq K \leq 20$), denoting the number of residents in this apartment. Then follow N lines, being the records of each security guarding each entrance. Each record consists of $2K$ non-negative integers (whose value does not exceed 10^6), the $(2i-1)$-th number being the number of times resident i enters through this entrace, and the $2i$-th number being the number of times resident i exits through this entrance. At the end of the test case there is one more line consisting K characters, either '`y`' or '`n`', denoting whether the resident is currently in the apartment.

Output Format

For each test case output the minimum number of securities that need to be bribed, so that the publicly visible informations (i.e. the number of total records, and the detail records of the bribed securities) are sufficient to prove the existence of invisible men.

In case that it is not possible to do so no matter what VSDTAD does, please output "no eureka."

Sample Input

```
2

3 5
3 1 54 3 1 4 0 0 2 3
2 3 0 0 2 1 1 0 1 5
4 4 0 0 3 1 0 0 9 4
y y n y n

2 1
1 1
1 0
y
```

Sample Output

```
1
no eureka.
```