MŰEGYETEM 1782

8th BME International 24-hour Programming Contest

Qualifying Round Problem Set

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http://www.challenge24.org

MAVE

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Introduction

Welcome to the Challenge24 2008 Electronic Contest!

This year the Electronic Contest consists of 8 algorithmic problems. You will find 10 input files for each of the 8 problems enclosed in the zip file of the problem set. You can use any programming language or environment to generate the correct output files for these inputs. Once you are done, you can upload your output files through the Electronic Contest website after logging in with your email address and password.

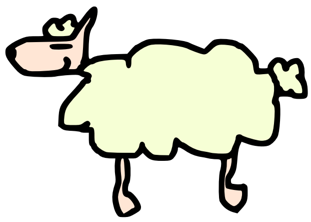
Be quick about uploading the output files, because the scores awarded for every output file decrease with time. Uploading a correct output file at the start of the contest is worth 100 points. Uploading it just before the end of the contest is worth 80 points. During the contest its value decreases linearly with time. However you should also be careful with uploading solutions. Uploading an incorrect solution is worth -10 points.

Note that points are awarded per output file and not per problem. If your solution only works for 9 of the 10 input files, you will still be awarded points for those 9 output files. A single output file however is either correct or wrong – partially correct output files are not worth any points.

Good luck and see you in the finals!

Problem A

The Sheep of the Wizard



Hildrath, the great wizard has a flock of sheep. These sheep are of a quite calm type, they do not wander all about the place like normal sheep do, they just stay where they are, each at a given point on the plane. Nevertheless the sheep have to be watched. Until now, the wizard looked after them himself, as he was pleased to count them again and again and enjoyed seeing how rich he was.

But now, he kind of got bored of counting sheep. He decided to use his magic powers to turn one of his sheep into a shepherd. Your task is to choose the right sheep for him, unless you want to make him mad, and be turned into a sheep – or something much worse – yourself. Given the coordinates of the sheep, you have to find one that if turned into shepherd can watch all the others with the least eye movement. That is, find the one sheep from which the rest of the flock is seen in the smallest angle.

Input:

The first line contains a single integer, N the number of sheep specification lines. The following N lines contain the X and Y coordinates of the sheep separated by spaces.

Output:

Two integers, X and Y, separated by a space, that are the coordinates of the best sheep.

Example input:

```
3
0 0
1 1
10 0
```

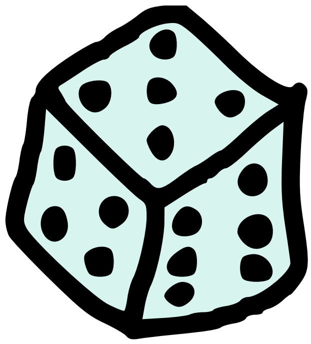
Example output:

```
10 0
```

Problem B

Random Numbers

Linear congruential generators (LCGs) are simple random number generators of the form



$$X_{i+1} = (aX_i + c) \bmod m$$

LCGs are periodic, because due to "mod m" there will be a smallest $P > 0$ (the length of the period) where $X_{i+P} = X_i$ for some i. You have to look at the first P elements of the output from the LCG starting with $X_0 = 0$.

The output of an LCG is the number it provides for our use which we calculate as

$$Y_i = X_i \bmod k$$

where k is yet another constant.

You have to look for repetitions in this list of $Y_0 \ldots Y_{P-1}$.

A repetition is a sequence of numbers which occurs in two different positions in this list. For every LCG given in the input you have to output the length of the longest repetition. ($Y_i \ldots Y_{i+R-1}$ is a repetition of length R if $i + R \leq P$ and there is a $j \neq i$, $j + R \leq P$ for which $Y_{i+x} = Y_{j+x}$ for every $0 \leq x < R$.)

Input:

The first line on the input contains the number of LCGs described in the file. The rest of the file contains one line for every LCG that contains the four numbers a, c, m and k separated by spaces.

Output:

Every line of the output file must contain a single number that is the length of the longest repetition. If there are no repetitions (all numbers in Y are different), output 0.

Example Input:

```
1 1 4 2
```

Example output:

```
2
```

(In this case $X = (0, 1, 2, 3)$, $Y = (0, 1, 0, 1)$ and the longest repetition is $(0, 1)$.)

Problem C

Pandas Playing

Do you know the game where you whisper a sentence into someone's ear, they whisper the sentence into someone else's ear as best they understood it and so on, until everyone has heard (some version of) the sentence and it is finally whispered back into your ear and you can laugh at how much distortion it has suffered? Well guess what! A group of young cuddly pandas have just met each other, and they want to play this game! However some pandas are still shy and they will only whisper into the ears of those, whom they like. Of course a smile can do wonders (especially that of a panda) and so all attractions are returned in kind – if a panda likes another, they are always liked back!

They are now in the process of deciding if this game is at all possible for them. Currently they just assume that they can talk, and investigate more pressing concerns. They have already counted the total number of players and there are N of them. Some of them with a background in social networks have noticed that the lowest number of whispers from Sally to Sue (two pandas) is at least $\lceil \frac{N}{2} \rceil$. That is following the constraint that only friends can whisper to each other, to send a sentence from Sally to Sue takes at least $\lceil \frac{N}{2} \rceil$ whispers (if they were friends, it would take only 1).

Right now they are trying to decide whether they are able to play the game. This is where you come in (saviour of all games panda) and help them decide! Of course, the game is only fun if everybody participates, and the sentence never gets back more than once to anyone's ear.

Input:

The first line contains T, the number of test cases in the file. This is followed by the test cases.

The first line of a test case contains N. The following N lines each start with $|L_i|$, the number of pandas panda number i (numbered from 1 to N) likes, and contains $L_{i,1}, L_{i,2}, L_{i,3}, \ldots$, the numbers of the first, second, third, etc., pandas (numbered from 1 to N as well) that panda number i likes, separated by spaces.

Output:

For every test case output `POSSIBLE` or `IMPOSSIBLE` on a separate line.

Example input:

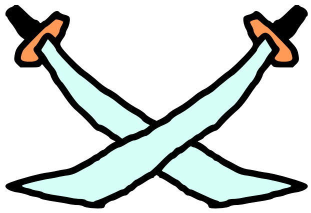
```
2
4
2 2 4
2 1 3
2 2 4
2 3 1
3
1 2
2 1 3
1 2
```

Example output:

```
POSSIBLE
IMPOSSIBLE
```

Problem D

Samurai Swords



A craftsman and his apprentices are producing samurai swords. However at the end of its production each sword is tested and breaks with a probability p, independently of everything else.

The craftsman has an order of N swords which he has to produce in the next K months. At the end of that period, if he has not managed to produce K swords which passed the test, he has to pay a penalty of A gold coins for each sword missing. Surplus swords and swords that failed the test are not worth anything.

At the beginning of each month, the craftsman has to decide the number of swords they try to produce that month. Producing at least one sword has a fixed cost of C units plus an additional 1 unit per sword (regardless whether the sword passes the test or not).

Calculate the expected cost of the whole production if the craftsman follows an optimal plan to minimize the expected cost.

Input:

The input files contain several test cases. The first line of the file contains a single integer, the number of test cases, T. The next T lines each describe a test case.

The test cases are described in lines containing the numbers p, N, K, A and C separated by spaces.

Output:

Output a single integer (the expected cost rounded down) for every test case on a separate line.

Example input:

```
2
0.1 1 1 5 1
0.9 1 1 5 1
```

Example output:

```
2
5
```

(In the first case, the expected value is 2.5 before rounding, in the second case it is 5.)

Problem E

Fuel Consciousness

To visit a friend you haven't seen for a long time, you have to travel from city Alham to city Baynor by car. Luckily the shortest way is the Highway №8, which is N km long (from Alham to Baynor). Your car's tank has a maximal capacity C, which is full at the beginning of the trip, and your car's consumption is 1 liter/km. However, it is not enough to make the whole trip without refueling, so you plan to stop at some gas stations along the road. Each gas station has a different price of fuel, due to the fact that they may belong to different companies. As a smart, but poor computer scientist, you would like to pay as little for the fuel as possible. Obviously, leaving the car with an empty tank on the road and walking is not your style (computer scientists are infamous for being lazy as well).

How would you do this, if you can assume that your GPS navigation software contains all the information about the gas stations on the highway?

Input:

The first line contains N, the length of the trip. The second line contains C the fuel capacity of the car. The third line contains the number of gas stations. Then there is one line for each gas station containing the distance of the station from Alham and the price of the fuel there separated by a space character (both are integers).

Output:

The output contains a single integer, the minimal total cost.

Example input:

```
100
50
4
20 100
30 10
50 60
70 70
```

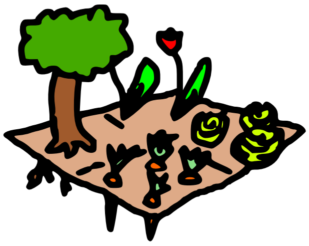
Example output:

```
1500
```

(Achieved by buying 30 l fuel at the second station and 20 l more at the third.)

Problem F

Farming



Your task in this problem is to satisfy the curiosity of farmer Mr. Boggis by calculating how many ways he could plan cultivation for the next five years.

Mr. Boggis owns seven (distinguishable) parcels of excellent quality field. Each year, he grows one of three kinds of crops on each of the seven parcels. The parcels cannot be further subdivided. He has been doing this for two years now, and wants to plan now which kind of crop he will grow in each field the next five years.

We call the three kinds of crops 0, 1, and 2. Boggis lives in a country with a very stable economy, so each year the demand for the three products are the same. For this reason, he has to produce crop 0 on exactly two parcels of land, crop 1 on exactly two parcels, and crop 2 on three parcels.

Mr. Boggis values variety, so he refuses to do the same thing any two years. Thus, in any two years (not only adjacent ones), he will have at least one parcel that he uses differently.

For conserving the soil in best quality, Mr. Boggis has decided that he will use each parcel evenly, which means that during the seven years we are examining, each parcel has to be used for growing crop 0 exactly two times, crop 1 exactly two times, and crop 2 exactly three times.

Finally, Boggis has to take care not to use two parcels exactly the same in the seven year period, for because of the arcane laws in his country, that would have count as "industrial scale cultivation", which implies very high taxes. Thus, for any two parcels, there has to be at least one year out of the seven years when a different crop is grown on them.

Mr. Boggis tells you what he did in the two years that have passed. From this, you must calculate the number of different production plans he could follow in the remaining five years.

Input:

The input file contains two lines. Each of the lines have exactly seven decimal integer between 0 and 2 (inclusive), separated by spaces. The J^{th} number in line I is the plant produced on field J in the I^{th} year.

Output:

The output must be a file of a single line, which contains a single decimal integer: the number of possible plans.

Example input:

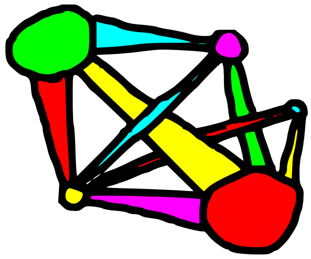
```
2 0 0 2 1 1 2
2 0 0 1 1 2 2
```

Example output:

```
384240
```

Problem G

Impossible Toys



The Retarded Toys Inc. creates building toys for not-that-talented kids. It consists of joints and colored sticks linking the joints together. To lighten the burden on poor kids, they do not have to assemble the sticks and joints together on their own, the game comes already fully assembled. But to give a little freedom, the sticks can be turned in all possible directions, independently to each other around the joints. When assembling a toy, the machine at the factory takes the first joint, then takes another one and links it to the first with a stick, then takes another one and links it to one of the joints of the already assembled game part, and so on, always linking a new joint to one of the previous ones with one stick.

These games are delivered in space bending magic containers. These non-Euclidean 3D boxes contains holes for the joints and tunnels between certain pairs of holes that can contain sticks (there can be even more than one strictly straight tunnel between a pair of holes, thanks to some dark magic). The lengths of all tunnels and all sticks are the same. Each hole and each tunnel can hold any number of joints and sticks respectively. Also, for aesthetic purposes, a set of colors is assigned to each tunnel, and only sticks with one of the given colors can be put in the given tunnel. One of the magical properties of the box is that no any Euclidean rules normally governing lengths in our universe apply to it, that is do not even think about relying on triangle inequality, Pythagoras' theorem or anything of that sort. They just won't necessarily hold.

The company has a very special equipment that can stuff a toy into a box if we can assign the joints to the holes so that:

- Each joint is assigned to a hole, but there are no assumptions about the number of joints assigned to a given hole whatsoever.
- If there is stick S between joints A and B, and they are assigned to holes C and D respectively, then there must be a tunnel between C and D that allows for the storage of sticks with the color of S.

How the kids are going to take the toy OUT of the box, is a completely different issue, about which we do not care the slightest bit.

Your task is to write a program, that given the specifications of a toy and a box, decides if the toy fits in the box or not.

Input:

The first line contains C, the number of test cases. The following are repeated C times:

- A line containing J, the number of joints in a toy.
- The name of the first joint.
- Each of the next $J - 1$ lines contain three strings separated by spaces: the identifier of the joint, the identifier of the joint it is connected to with a stick (can only be one previously mentioned) and the color of the stick.
- Two integers separated by a space: H, the number of holes and T, the number of tunnels.
- Each of the next T lines contain separated by spaces: the indices of the two holes connected by the tunnel (two integers between 0 and $H - 1$) and a list of allowed colors in the tunnel.

Output:

C lines, each containing the word `YES` or `NO`.

Example input:

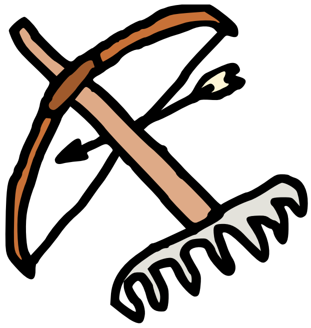
```
2
3
first
second first red
third first blue
3 3
0 1 blue grey
0 2 red black
1 2 green
3
first
second first red
third first blue
4 4
0 1 blue grey
1 2 purple black
2 3 red
3 0 green
```

Example output:

```
YES
NO
```

Problem H

Hunters and Gatherers



N couples live on an island; each couple consists of a hunter and a farmer. They formed several committees. The Hunting Committee divided the island up into N hunting fields. Independently, the Farming Committee divided the island into N farms.

You, as the leader of the Distribution Committee, have to distribute hunting fields to hunters and farms to farmers. However, the Marriage Committee only accepts distributions where for each couple, their hunting field and farm have an intersection of positive area.

Find a distribution where the minimum of those intersections has the maximum possible value.

Input:

The first line contains the value of N.

The next N lines each contain N numbers separated by spaces that are the areas of the intersection of the i^{th} hunting field and the j^{th} farm (where i is the line number (minus one) and j is the index of the number in the line).

Output:

The minimum of the intersections.

Example input:

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

Example output:

```
3
```