



South African Computer Olympiad Training Camp 2, 2005 Day 1



Overview

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Problem	muffins	wedding	shift	sites
Source	muffins.pas muffins.c muffins.cpp muffins.java	wedding.pas wedding.c wedding.cpp wedding.java	shift.pas shift.c shift.cpp shift.java	sites.pas sites.c sites.cpp sites.java
Input file	muffins.in	wedding.in	shift.in	sites.in
Output file	muffins.out	wedding.out	shift.out	sites.out
Time limit	1 second	1 second	1 second	5 seconds
Number of tests	10	10	10	10
Points per test	10	10	10	10
Total points	100	100	100	100

The maximum total score is 400 points.





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Muffin swap

Author

Bruce Merry

Introduction

Having finished sorting his pies, Fred the manic store-keeper is now going to sort his muffins. The same restriction applies: he can only swap two muffins that are next to each other. However, this time he is employing an assistant to sort the muffins for him.

Task

You will be given the current order of the muffins. Help Fred by determining the minimum number of swaps required to sort them, so that he can decide how much to pay for the job.

Example

Suppose there are four muffins. Let them be numbered 1–4 in the order that Fred wants them. The current order is 2 4 1 3. His assistant can arrange the pies using the following sequence of three swaps:

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

Input (muffins.in)

The first line of input contains N , the number of muffins. The following N lines each contain one integer, listing the current order of the muffins from left to right. Each integer from 1 to N will appear exactly once in these lines.

Sample input

```
4
2
4
1
3
```

Output (muffins.out)

The output must contain a single line containing only a single integer, the minimum number of swaps required to sort the muffins.

Sample output

```
3
```

Constraints

$1 \leq N \leq 50000$

50% constraints

$1 \leq N \leq 1000$

Time limit

1 second.

Scoring

A correct answer scores 100%, an incorrect one scores 0%.





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Wedding

Author

Migael Strydom

Introduction

It is time for the Guji tribe's annual wedding ceremony. They have lined up N eligible young men and women to be married to each other. They have, however, run in to a slight problem concerning who gets married to whom. The men and women to be married refused to listen to the village elders about whom they should marry but instead each made their own list ranking their desired partners. Since the Guji do not believe in divorce, the priest will have to look through these lists and marry the men and women in such a way that they are satisfied as far as possible.

Task

Your task is to pair up the N men and women with each other in such a way that there are no two people who would leave their partners for each other. You therefore need to find a stable marriage configuration given each person's list of preferences. Often there are several different stable configurations, but you only need to find one.

Example

Suppose the men are represented by letters and the women by numbers, and their preferences are shown in table 1. This means that A would rather be married to 2 than to

Table 1: Marriage preferences

A	2	3	4	1
B	3	4	2	1
C	3	4	2	1
D	4	3	1	2
1	D	A	C	B
2	C	A	B	D
3	D	C	A	B
4	A	B	C	D

3, and rather to 3 than to 4. Similarly, 1 would rather marry D than A and would prefer C to B.

An unstable configuration is, for example, A1 B4 C2 D3. This is because A would rather be married to 4 than to 1, and 4 would rather marry A than B. This means

that A and 4 would leave their respective partners for each other.

A stable configuration of marriages would be A4 B1 C2 D3, because it is impossible to select any two people who would leave their partners for each other.

Input (wedding.in)

The first line of input contains the integer N , the number of wedding pairs. The following N lines, from man 1 to man N , each have N space-separated integers which are the order in which the men prefer the women (from most wanted to least wanted). There is then a blank line, after which come N lines, from woman 1 to woman N , which contain the order in which the women prefer the men.

Sample input

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

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

Output (wedding.out)

There should be N lines of output, containing the couples to be married to each other. Each line should have two space-separated integers, the first being the number of the man in the couple, and the second the number of the woman who is to be his wife.

Sample output

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

Constraints

$2 \leq N \leq 100$

50% constraints

$2 \leq N \leq 10$





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Time limit

1 second.

Scoring

If your output for a test-case differs in any way from the format prescribed above, then your program will score 0% for that test-case. If your program gives a stable marriage configuration, you will score 100%. If the configuration is not stable, you will score 0%.





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Shift Game

Author

Keegan Carruthers-Smith

Introduction

Mr B. Dover, your eccentric maths teacher, has invented a game to help the juniors in your school learn to add numbers quickly. The game contains a board of numbers, where you have the ability to shift a column of numbers up or down. Below is an example of an *up-shift* and a *down-shift*.

```
1 -> 2 4
2 -> 3 1
3 -> 4 2
4 -> 1 3
      Up  Down
```

The object of the game is to find the maximum sum of all the numbers in one row, using a certain number of shifts. You do not have to use all the given shifts, and you may only shift each column at most once.

Mr B. Dover is too busy writing his doctorate, so he has asked you to write a program to work out the maximum possible sum of a row.

Task

Find the value of the largest possible sum of the numbers of a row, given the maximum number of shifts allowed.

Example

Say you are allowed to use 2 shifts, and you are provided with a board with a width of 5 and a height of 3 as shown below:

```
9 6 3 9 13
6 7 5 10 9
10 6 8 4 11
```

To create a maximum row you would shift the 4th column down, and the 5th column up. You would end up with a table like below:

```
9 6 3 4 9
6 7 5 9 11
10 6 8 10 13
```

Now it can be seen that sum of the bottom row is the largest (47).

Input (shift.in)

The first line of the input contains an integer, N , which is the maximum number of shifts allowed. The second line contains two space-separated integers, W and H , indicating the width and the height of the table. The following H lines contain W space-separated integers, $V_{i,j}$, indicating the values for each position on the board.

Sample input

```
2
5 3
9 6 3 9 13
6 7 5 10 9
10 6 8 4 11
```

Output (shift.out)

The output file contains a line with a single integer, M , the maximum possible sum of a row.

Sample output

```
47
```

Constraints

- $2 \leq W, H \leq 500$
- $0 \leq N \leq W$
- $0 \leq V_{i,j} \leq 20000$

50% constraints

- $2 \leq W, H \leq 20$
- $0 \leq N \leq W$
- $0 \leq V_{i,j} \leq 20000$

Time limit

1 second.

Scoring

You will score 100% if your value is the maximum, otherwise you will score 0%.





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Web Communities

Author

Timothy Stranex

Introduction

A social software firm is investigating online communities consisting of separate web sites linked together. To do this, they wrote an automatic web crawling script to generate a list of links between various web sites.

Task

Your task is to find the number of web sites in the largest web site community. A web site community is defined as a set of web sites that link only between each other; that is, not to any other web sites than those that are in the set. Web sites may link to themselves. A link from web site A to web site B implies a link from web site B to web site A .

Example

Suppose that five links were found between five web sites as shown in Table 1.

Link From	Link To
1	2
3	2
1	3
5	4
4	5

Table 2: An example of the links between various web sites.

Then, there are two web site communities, $\{1, 2, 3\}$ and $\{4, 5\}$. These sets consist of three and two web sites respectively. Therefore, the largest web site community has three web sites.

Input (sites.in)

The first line of the input contains a single integer, N , the number of links found. The next N lines each contain two space-separated integers, A and B , which indicates that there is a link from web site A to web site B (and from web site B to web site A).

Sample input

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

Output (sites.out)

The program must output a line containing a single integer, M , the number of web sites in the largest web site community.

Sample output

```
3
```

Constraints

- $1 \leq N \leq 1000000 = 10^6$
- $1 \leq A, B \leq 100000000 = 10^8$

50% constraints

- $1 \leq N \leq 1000000 = 10^6$
- $1 \leq A, B \leq 4000$

Time limit

5 seconds.

Scoring

If your program outputs the correct answer for the test-case, you will score 100% for that test-case. Otherwise, you will score 0% for that test-case.

