



# South African Computer Olympiad

## Web Training, 2009

### IOI Squad March Contest



## Overview

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Problem	<b>bnumbers</b>	<b>hotdates</b>	<b>connect</b>	<b>wifitow</b>
Source	bnumbers.c bnumbers.cpp	hotdates.c hotdates.cpp	connect.c connect.cpp	wifitow.c wifitow.cpp
Input file	stdin	stdin	stdin	stdin
Output file	stdout	stdout	stdout	stdout
Time limit	1 second	1 second	1 second	1 second
Number of tests	10	10	10	10
Points per test	10	10	10	10
Detailed feedback	Yes	Yes	No	Yes
<b>Total points</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

The maximum total score is 400 points.

<https://olympiad.cs.uct.ac.za/contests/web-2009/>



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## Beautiful Numbers

Kosie van der Merwe

### Introduction

Bruce and Carl decided to start their own software company, called “Good And Evil Tech”. They have commissioned you to test their proposed copy protection system or at least help to. As can be expected they are very secretive of the actual algorithm so they will only let you see a part of it.

They are saying something about finding the number of Beautiful Numbers, but are mysteriously tight lipped about what a Beautiful Number might be used for and they just barely wanted to tell you what one actually is...

### Task

The task they want you to help with is counting the number of Beautiful Numbers that satisfy the given restrictions and then tell them the remainder of the count after division by 1 000 000 007.

You are given the base the number is in,  $N$ , and the maximum number of digits the number may consist of,  $M$ . So you must consider all numbers that are at most  $M$  digits long when written in base  $N$ .

None of the numbers may start with 0, including the number 0, and consecutive digits must differ by exactly 1, for instance the number in base 10, 9876543210, satisfies the two mentioned conditions. Lastly they want all numbers to use all the available digits in that base, i.e. the digits from 0 to  $N - 1$  must be used in the number.

A number that meets the above requirements is called a Beautiful Number.

### Example

Consider you are told  $N$  is 2 and  $M$  is 4.

0 isn't a Beautiful Number because it isn't allowed nor does it contain the digits from 0 to 1 ( $N - 1$ ).

Similarly 1 isn't a Beautiful Number because it doesn't contain all the digits from 0 to 1.

01 isn't one as well because it starts with 0.

10 is however a Beautiful Number because the digits differ by 1, it contains all the digits (0 to 1) and doesn't start with 0.

110 isn't a valid Beautiful Number because its consecutive digits don't differ by one, although it meets all the other requirements.

So the only Beautiful Numbers for  $N = 2$  and  $M = 4$  are 10, 101 and 1010. Thus the answer is 3.

### Input (stdin)

The input consists of a single line with 2 space separated integers:  $N$  and  $M$ .

### Sample input

```
2 4
```

### Output (stdout)

The output consists only of a single integer on one line: the remainder of the number of Beautiful Numbers after division by 1 000 000 007

### Sample output

```
3
```

### Constraints

In all test cases the following holds:

- $1 \leq N \leq 10$
- $0 \leq M \leq 100$

Additionally, in 50% of the test cases:

- $1 \leq N^M \leq 10\,000\,000\,000$

Additionally, in 30% of the test cases:

- $1 \leq N^M \leq 100\,000$

### Time limit

1 second.

### Detailed feedback

Detailed feedback is enabled for this problem.

### Scoring

A correct solution will score 100, while an incorrect solution will score 0.



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## Hot Dates

Michiel Baird

### Introduction

Hot Dates is a brand new dating agency. Their first week of set ups went quite bad as everyone left with someone different to the one they were set up with. They need to stop this as their clients are refusing to pay. They decided to give each person a survey. The survey asks each person to rate the group of the opposite sex, giving them a score from 1 to 1000.

### Task

Given the survey scores for  $N$  males and  $N$  females, find a pairing that is stable. That is, for each pair of couples there are no such 2 people of the opposite sex that would prefer to be with each other than their current partners. NOTE: There might be multiple stable set-ups you only need to find one of them.

### Example

Given the survey scores of 3 males and 3 females.  
Male Survey

	Female 1	Female 2	Female 3
Male 1	20	10	15
Male 2	17	10	15
Male 3	50	45	40

Female Survey

	Male 1	Male 2	Male 3
Female 1	30	10	1
Female 2	10	10	50
Female 3	60	20	1

A stable dating set up would be:

Male 1 and Female 1  
Male 2 and Female 3  
Male 3 and Female 2

### Input (stdin)

The first line contains a single integer  $N$

The next  $N$  lines contains the survey score for each

male.

The line contains  $N$  space-separated integers, containing the score for each female.

The last  $N$  lines contains the survey scores for each female,

in the same format as the male survey.

### Sample input

```
3
20 10 15
17 10 15
50 45 40
30 10 1
10 100 50
60 20 1
```

### Output (stdout)

The output contains  $N$  lines. The  $i$ th line contains the integer of the female that male  $i$  should be set up with.

### Sample output

```
1
3
2
```

### Constraints

- $1 \leq N \leq 1000$
- $1 \leq S_{ij} \leq 1000$  for each survey score

Additionally, in 30% of the test cases:

- $1 \leq N \leq 9$

### Time limit

1 second.

### Detailed feedback

Detailed feedback is enabled for this problem.

### Scoring

A correct solution will score 100% while an incorrect solution will score 0%.



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## Connecting the Grid

Graham Manuell

### Introduction

Mark and James are playing a game on an grid with  $N$  blocks (labelled 1 to  $N$ ), in which the players take turns to join two blocks. A block may be joined to multiple other blocks (adjacent or otherwise), but not to itself. However, any pair of blocks may only be connected once, and only one connection may be made per turn. Naturally, if  $A$  is connected to  $B$ , so is  $B$  to  $A$ .

The aim of the game is to form as many cycles as possible, as shown in the diagram. One point is awarded for each turn in which a cycle is created. Only one point may be obtained per turn, regardless of the number of cycles formed in the turn.

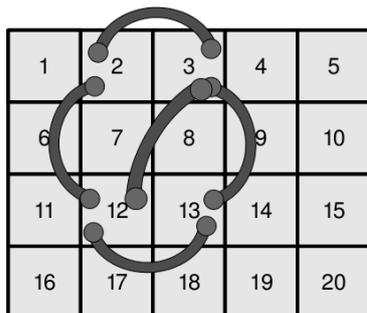
These games can become quite intense and could take many moves before the player with the most points is declared the winner. Mark and James do not trust each other to keep score and have thus appointed you as the impartial umpire.

### Task

You will be presented with a sequence of the  $K$  moves played, alternating between players, with Mark going first. You will be required to find the total score of each player. Despite many nights of playing the game, Mark and James are not guaranteed to play optimally.

### Example

Mark goes first and links 2 to 3; James links 12 to 13. Then Mark links 2 to 12 and James links 3 to 12, forming a cycle. Finally, Mark links 13 to 3, forming multiple cycles of his own.



### Input (stdin)

The first line of the input contains two space-separated integers,  $N$  and  $K$ . The next  $K$  lines each contain two space-separated integers,  $A_i$  and  $B_i$ , the blocks to be connected.

### Sample input

```
20 5
2 3
12 13
2 12
3 12
13 3
```

### Output (stdout)

Output two space-separated integers, the scores of Mark and James respectively.

### Sample output

```
1 1
```

### Constraints

- $2 \leq N \leq 100\,000\,000$
- $2 \leq K \leq 800\,000$
- $1 \leq A_i, B_i \leq N$  for each move

Additionally, in 50% of the test cases:

- $K \leq 1\,000$

Additionally, in 70% of the test cases:

- $N \leq 1\,000\,000$

### Time limit

1 second.

### Scoring

A correct solution will score 100% while an incorrect solution will score 0%.



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## WiFi Tower

Schalk-Willem Krüger

### Introduction

Bruce wants to start his own political party. To win some votes, he decides to put up a huge wireless tower in order to give all his potential voters free internet. The tower covers a circular area with the tower as the midpoint.

Because Bruce doesn't want to waste money, he wants to make the signal strength of the tower as small as possible. The signal must still reach all the potential voters. Help Bruce to decide where to put the tower and what the signal's radius must be.

### Task

Write a program that will, given the  $(x,y)$  positions of all the potential voters, calculate the radius and midpoint of the smallest enclosing circle that covers the voters. The tower's coverage includes the circumference of the circle as well as the area inside it.

### Example

Suppose there are seven voters at positions  $(1,1)$ ,  $(2,3)$ ,  $(4,4)$ ,  $(5,1)$ ,  $(4,3)$ ,  $(4,2)$ . The smallest enclosing circle that covers all the points have a radius of 2.24 units and a midpoint at  $(3,2)$ .

### Input (stdin)

The first line of input contains a single number  $N$ . The next  $N$  lines each contain two space-separated integers,  $x$  and  $y$ .  $(x, y)$  represents a potential voter. All points are unique.

### Sample input

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

### Output (stdout)

The output should consist of two lines. The first line must contain a single number representing the radius of the minimum enclosing circle, rounded off to two decimal places. The second line must contain two space-separated numbers, rounded off to two decimal places that represents the coordinate of the midpoint.

### Sample output

```
2.24
3.00 2.00
```

### Constraints

- $1 \leq N \leq 100\,000$
- $0 \leq x, y \leq 1\,000\,000$  for each position of a potential voter

Additionally, in 30% of the test cases:

- $1 \leq N \leq 1\,000$

### Time limit

1 second.

### Detailed feedback

Detailed feedback is enabled for this problem.

### Scoring

A correct solution will score 100% while an incorrect solution will score 0%.