South African Computer Olympiad
Camp 3 - 2010
Day 2

Overview

Problem	**pvsnp**	**wordwalk**	**mapping**
Source	pvsnp.c pvsnp.cpp	wordwalk.c wordwalk.cpp	N/A
Input file	stdin	stdin	mapping.in
Output file	stdout	stdout	mapping.out
Time limit	2 seconds	1 second	N/A
Memory limit	64MiB	64MiB	N/A
Number of tests	20	10	10
Points per test	5	5	10
Detailed feedback	Yes	No	No
Total points	**100**	**100**	**100**

The maximum total score is 300 points.

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Prime vs. Non-Prime

Introduction

Prime vs. Non-Prime is a number game played by two players, labelled P and NP respectively. P is trying to make prime numbers; NP is trying to avoid this.

The game starts with a number N. The players then take turns, starting with P, to say another number, which must be formed from the previous number by either doubling or adding 1.

Player P wins if either player says a prime less than or equal to the limit L. Player NP wins if either player says a number larger than L.

Task

Write a program that plays for player P; if it is possible to win, your program must do so in the smallest possible number of moves. If this is impossible, it should make the opponent take the largest possible number of moves to win.

The opponent program plays in the same manner.

Example

Suppose $L = 9$ and $N = 3$. P cannot force a win, but it can make the game last as long as possible by playing 4. NP could play 5 and lose, or 8. In this case, P should play 9 and NP will play 18 to win. If P played 6 first instead, NP could then play 12 and win.

Interaction

Your program will interact with the opponent and judge through standard input and standard output. First your program should read a line containing two integers, L and N.

It should then play a number by outputting it, followed by a newline, and flushing standard output. It should then read in a line consisting of the opponent's number. This alternates until the game is over. Once either player wins, your program must exit.

Sample interaction

Input	Output
9 3	
	4
8	
	9
18	

Testing

You can test your program using the web interface by uploading a test file containing a single line with two integers: L and N.

Constraints

- $1 \leq N < L \leq 2^{20}$

Time limit

2 seconds.

Detailed feedback

Detailed feedback is enabled for this problem.

Scoring

If your program plays optimally on a testcase, it will score 5 points. If it wins a game in a sub-optimal number of moves, it will score 2 points. Otherwise, it will score zero.

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Wordy Walks

Introduction

During a recent sporting extravaganza, Fred the Manic Storekeeper earned enough money selling paraphernalia to buy an extremely large house. The house has some unusual features: for example, every door is labelled by a letter of the alphabet.

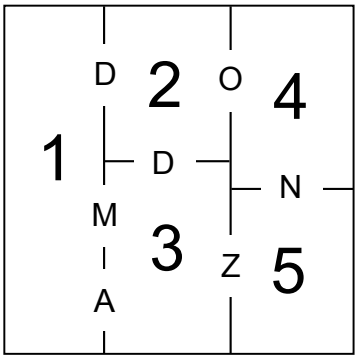
Of course, Fred has developed an obsession regarding these letters: he will only travel along paths where the letters spell out a sentence. Fortunately he has little respect for grammar and will consider any sequence of words to be a sentence, as long as he knows all the words.

Task

Write a program which, given the W words that Fred knows and a map of his house, helps Fred get around his house by finding a route from room A to room B, such that the door labels spell out zero or more words.

It is guaranteed that such a route exists, as Fred checked when he bought the house.

Example



In the example room (pictured) the shortest path from room 1 to room 5 is 1–3–5, but neither `MZ` nor `AZ` are in Fred's vocabulary, so he must go 1–3–1–2–4–5 to spell `MAD ON` (which is a shortest route).

Input (stdin)

The first line of input contains an integer W. The next W lines each contain a single word consisting of uppercase English letters. Line $W+2$ contains two integers, N and D, the number of rooms and doors in Fred's house, respectively. The next D lines contain two integers and a letter, representing a door between two rooms. The last line contains two integers, A and B. Doors are numbered from 1 to N, and may go from a room to itself.

Sample input

```
5
MAD
ON
NOD
MOOD
DAM
5 7
1 2 D
1 3 M
1 3 A
2 3 D
2 4 O
3 5 Z
4 5 N
1 5
```

Output (stdout)

The first line of output consists of the sentence corresponding to a shortest route from room A to room B, with spaces between words. The next line consists of space-separated integers representing the rooms along the route, including both end-points.

Sample output

```
MAD ON
1 3 1 2 4 5
```

Constraints

- $1 \leq$ total number of letters in dictionary ≤ 1000
- $1 \leq N \leq 1000$
- $0 \leq D \leq 1000$

Time limit

1 second.

Scoring

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

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Map Drawing

Introduction

Fred the Manic Storekeeper has discovered yet another strange feature of his new house: some of the doors are not doors at all, but portals. To help him find his way around, he wants you to draw a map of the house showing where each door leads.

Because of the portals, he cannot simply draw a scaled-down version of the house. He has decided to represent each room as a distinct point on the map, and doors and portals as straight lines between points. Fred's obligatory obsession: he doesn't want these lines to cross (except those that lead to the same room).

Task

There are N rooms in the house, numbered from 1 to N. There are D doors (including portals), each leading between two distinct rooms. Between any pair of rooms, there is at most one door.

Find distinct coordinates for the rooms, so that the number of intersecting lines is minimized. No line may go through a room's point, unless it is an endpoint of the corresponding door.

Example

If Fred's house has four rooms, each connected to all the others, then we can place the rooms at $(1,0)$, $(1,1)$, $(0,2)$ and $(2,2)$ to draw the map with no crossings.

On the other hand, suppose the house has six rooms, with room 1 connected to 4, 5 and 6; room 2 connected to 4, 5 and 6; and, room 3 connected to 4, 5 and 6. The best solution has one crossing: for example, place the rooms at $(0,0)$, $(1,2)$, $(0,3)$, $(0,1)$, $(1,1)$ and $(3,1)$ respectively.

Input (mapping.in)

The first line of each file contains two space-separated integers, N and D. The next D lines each contain two space-separated integers, specifying the two rooms that a door or portal leads between.

Sample input

```
6 9
1 4
1 5
1 6
2 4
2 5
2 6
3 4
3 5
3 6
```

Output (mapping.out)

The output file contains N lines, with the ith line containing two space-separated integers, x_i and y_i, the coordinates of room i.

Invalid solutions will be rejected by the hand-in system.

Sample output

```
TBA
```

Constraints

- $|x_i|, |y_i| \leq 10^9$ for $i = 1..N$

Scoring

TODO: check this

Suppose that the best solution submitted by any contestant or coach has B intersections, and some solution has C intersections. Then the submission will score

$$\max\{0, \lfloor 10 - \log_2(C - B + 1) \rfloor\}.$$