South African Programming Olympiad
Day 2

Overview

Problem	sortrum	shipping	fetch
Source	N/A	shipping.java shipping.py shipping.c shipping.cpp	fetch.java fetch.py fetch.c fetch.cpp
Input file	sortrum.in	stdin	stdin
Output file	sortrum.out	stdout	stdout
Time limit	N/A	2 seconds. Python: 20 seconds.	2 seconds. Python: 20 seconds.
Memory limit	N/A	256MiB	256MiB
Detailed feedback	No	20	No
Total points	**100**	**100**	**100**

The maximum total score is 300 points.

http://olympiad2.cs.uct.ac.za/contest.html

Sorting Rum

Introduction

Captain Sparrow has acquired a large collection (and taste for) rum. He stores his collection in crates, ordered by date of bottling. No two crates contain rum of the same bottling date. As any connoisseur can tell you, rum does not improve with age, but nobody can be accused of calling the good Captain a connoisseur.

Being a very particular pirate, Sparrow keeps his crates of rum ordered by date of bottling. Unfortunately, during some particularly high seas, the crates have been knocked out of order. Captain Sparrow wants to put them back again. He will use his large crew of deck hands to do this.

However, the deck hands know only one operation, compare-and-swap. When told to compare-and-swap A and B, a deck hand will pick up the crates at position A and position B, and replace the older crate in position A and the other at B.

Captain Sparrow thinks he sees another storm on the horizon. He wants to write down a schedule of instructions to get the crates sorted (oldest in the lower numbered positions) as soon as possible. Help him do this.

Task

Given N, the number of crates, you must write orders for the deck hands that will result in the crates being sorted, regardless of their original ordering.

The orders consist of a list of instructions for each minute, and each instruction consists of two numbers, the positions A and B to be compared-and-swapped. Positions are numbered from 1 to N.

If two hands try to pick up a single crate at the same time, they will drop it, and its contents will be destroyed. However, any number of hands can compare-and-swap different pairs of crates in the same minute.

The orders should take as few minutes as possible.

Example

Suppose there are four crates. If the deck hands compare-and-swap 1 and 2, then 2 and 3, then 1 and 2 at the same time as 3 and 4, followed by 2 and 3 and finally 1 and 2, the crates will be sorted no matter what the order was originally.

Input (sortrum.in)

The input file consists of a single integer, N.

Sample input

```
4
```

Output (sortrum.out)

The first line of output contains a single integer, T, the number of minutes that it will take to sort the rum.

Each of the following T lines describes a set of instructions. The first integer is K, the number of instructions in that minute. This is followed by K pairs of integers, A and B to be compared-and-swapped in that minute. Every minute must have at least one instruction.

Sample output

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

Scoring

When you submit an output file, the handin system will check the validity of your submission. If it is incorrectly formatted, causes a crate to be dropped, or there is an ordering of crates which would not be sorted by your instructions, the submission will be rejected (and score 0%). Otherwise, it will be saved for evaluation.

Let B be the number of timesteps used by the best submission from all contestants. Then a solution using T timesteps will score

$$\max\left\{1, \left\lfloor 17e^{-\frac{T}{2B}} \right\rfloor\right\}$$

(in words, between one and ten, with better solutions scoring more).

Shipping Routes

Introduction

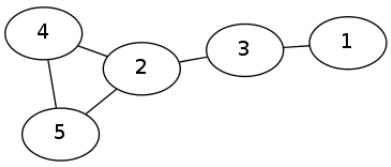
Fred the Manic Storekeeper, frustrated by the limitations of keeping his store in one place, has taken to the high seas! He now sails from port to port in the Caribbean, selling things wherever he stops. Unfortunately, the Swashbuckling Arrrrring Pirate Organisation monitors some of the ports of the Caribbean looking for storekeepers to rob. Help Fred avoid the SAPO by telling him which ports he can visit.

Task

There are N ports in the Caribbean, numbered 1 to N and connected by M shipping lanes. A "circuit trade route" is a route of at least three ports where each port is connected to the previous port with a shipping lane, the last port is also connected to the first port with a shipping lane and no port appears twice in the route. The SAPO knows that these circuit trade routes are lucrative, so monitors all ports which are included in some circuit trade route. Find all ports which are not on any such trade route and report them to Fred so that he can visit them.

Example

In the map of shipping lanes below, there are 5 ports. Ports 2, 4 and 5 form a circuit trade route, but ports 1 and 3 are not on any circuit trade route.



Input (stdin)

The first line of the input consists of two space-separated integers, N and M. The next M lines each contain two integers A_i and B_i, indicating that there is a shipping lane between port A_i and port B_i.

Sample input

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

Output (stdout)

Print the numbers of the ports which are not on any circuit trade route, one per line, in ascending order.

Sample output

```
1
3
```

Constraints

- $1 \leq A_i, B_i \leq N$
- $A_i \neq B_i$
- There is at most one shipping lane between any two ports.
- $1 \leq N$
- $0 \leq M$

Subtask 1 (12 points)

- $N \leq 10$, $M \leq 45$

Subtask 2 (25 points)

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

Subtask 3 (15 points)

- $N \leq 100\,000$, $M \leq 300\,000$
- There is at most one circuit trade route.

Subtask 4 (18 points)

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

Subtask 5 (30 points)

- $N \leq 100\,000$, $M \leq 300\,000$

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Time limit

2 seconds. Python: 20 seconds.

Detailed feedback

Detailed feedback is enabled for this problem. You are limited to 20 submissions with detailed feedback.

Scoring

For each **subtask** you will receive either 100 % or 0 %. You score will be the sum of your scores on the subtasks of your last submission.

Fetch

Introduction

The pirates have gone into town to obtain supplies. Their ship is anchored over the horizon where the authorities won't see it, and they are using the lifeboat to get to and from town. The N pirates are extremely punctual: each pirate returns to the harbour at a known time, and waits to take the lifeboat back to the ship. The lifeboat is big enough to hold all the pirates at once, and it has a round-trip time (the time to take some pirates to the ship and return to the harbour) of T seconds.

The pirates are all wanted for their crimes, so they do not want to wait at the harbour any longer than necessary. The captain has decreed that the lifeboat trips must be scheduled so as to minimise the maximum length of time that any pirate has to wait at the harbour.

Task

Write a program that, given the arrival times of the pirates at the harbour and the turn-around time of the lifeboat, finds the minimum possible maximum waiting time of all the pirates.

Example

There are several possible schedules in which all pirates wait at most 2 seconds from the sample input. One of them is to have the lifeboat leave at 0, 3 and 7 seconds after the start of the day. However, in any valid schedule, some pirate has to wait at least 2 seconds, because there must be at least 3 seconds between departures.

Input (stdin)

Line 1: Two integers, N and T, separated by a space.
Lines 2 to $N+1$: The i^{th} of these lines contains the integer A_i, the time (in seconds after the pirates went into town) that the i^{th} pirate arrives at the harbour.

Sample input

```
5 3
0
1
7
2
5
```

Output (stdout)

Line 1: The minimum possible maximum waiting time in seconds.

Sample output

```
2
```

Constraints

In all test cases, $N \geq 1$, $T \geq 1$, $A_i \geq 0$ for all i, and no two pirates arrive at the same time.

Subtask 1 (20 points)

- $N \leq 10$, $T \leq 10$, $A_i \leq 50$

Subtask 2 (20 points)

- $N \leq 10^5$, $T \leq 50$, $A_i \leq 10^6$

Subtask 3 (20 points)

- $N \leq 100$, $T \leq 10^9$, $A_i \leq 10^9$

Subtask 4 (20 points)

- $N \leq 1\,000$, $T \leq 10^9$, $A_i \leq 10^9$

Subtask 5 (20 points)

- $N \leq 10^5$, $T \leq 10^9$, $A_i \leq 10^9$

Time limit

2 seconds. Python: 20 seconds.

Scoring

Each subtask will consist of multiple test cases, each of which receives 100% for a correct solution and 0% for an incorrect solution.