



# South African Computer Olympiad Training Camp 2, 2007 Day 1



## Overview

Author	Timothy Stranex	Marco Gallotta	Bruce Merry
Problem	cheat	monkey	phil
Source	cheat.c cheat.cpp cheat.pas	monkey.c monkey.cpp monkey.pas	phil.c phil.cpp phil.pas
Input file	cheat.in	monkey.in	phil.in
Output file	cheat.out	monkey.out	phil.out
Time limit	1 second	1 second	1 second
Number of tests	10	10	10
Points per test	10	10	10
<b>Total points</b>	<b>100</b>	<b>100</b>	<b>100</b>

The maximum total score is 300 points.



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## Cheating Students

### Author

Timothy Stranex

### Introduction

Professor Meisenstuvén suspects that the students in his computer science course are copying assignments from one another. It is now the end of the semester and he has to decide which students should be failed for plagiarism. Unfortunately, his hard drive crashed and he lost all the assignments. All he has is the marks list.

### Task

The Professor suspects that in all the  $N$  assignments submitted (one per student), there are only  $K$  unique assignments. From the marks list, he knows the mark  $M_i$  given to each assignment  $i$ .

Since a copied assignment should have been given a similar mark to the original, he wants to group the assignments into  $K$  sets  $S_1, S_2, \dots, S_K$  in such a way that the sum  $\chi$  of squared differences to the median of each set is minimized. That is, he wants to minimize

$$\chi = \sum_{i=1}^K \sum_{j \in S_i} (M_j - \mu_i)^2$$

where  $\mu_i$  is the median mark of the set  $S_i$ .

The median mark of a set of  $n$  assignments is calculated as follows: First order the assignments in increasing mark order to obtain a sequence  $a_0, a_1, \dots, a_{n-1}$ . Then the median mark is the mark of the middle assignment:

$$\mu = M_{a_{\lfloor n/2 \rfloor}}$$

where  $\lfloor x \rfloor$  is  $x$  rounded downwards to the nearest integer.

You must help the Professor by outputting the minimal value of  $\chi$ .

### Example

Suppose  $N = 3$  and  $K = 2$ , and the marks are  $M_1 = 5$ ,  $M_2 = 1$  and  $M_3 = 6$ . Then if we group the assignments into sets  $S_1 = \{2\}$  and  $S_2 = \{1, 5\}$ , we get median marks  $\mu_1 = 1$  and  $\mu_2 = 5$ , and  $\chi = (0^2) + (0^2 + 1^2) = 1$ . This value of  $\chi$  is minimum so the output is 1.

### Input (cheat.in)

The first line contains the two integers  $N$  and  $K$  separated by a space. The next  $N$  lines each contain the single integer  $M_i$ .

### Sample input

```
3 2
5
1
6
```

### Output (cheat.out)

The output consists of a single line containing a single integer, the minimal value of the sum.

### Sample output

```
1
```

### Constraints

- $1 \leq K \leq 25$
- $K \leq N \leq 1000$
- $0 \leq M_i \leq 1000$

### 50% constraints

- $K \leq N \leq 100$

### Time limit

1 second.

### Scoring

A correct answer gets 100%. An incorrect or badly formatted answer gets 0%.



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## Infinite Monkey Theorem

### Author

Marco Gallotta

### Introduction

The Infinite Monkey Theorem states that a monkey hitting keys at random on a keyboard will eventually recreate a chosen piece of text given an infinite amount of time. We aim to take this theorem to the next phase though and prove that monkeys can produce their very own masterpieces.

### Task

Given a piece of text typed by a monkey and a dictionary of words, your task is to find the longest string of words in the text. A string of words is longer if it contains more characters.

To make it easier on the monkey, the keyboard has no spaces or other punctuation – only the 26 uppercase letters A-Z. You will have to take this into account as words can start and end anywhere.

### Example

Suppose we take a short dictionary of the words:

- AND
- AT
- THE

And the first monkey types the text “LATTHEPAND”. The words “AT”, “THE” and “AND” all appear in the text. Since “AT” and “THE” follow one another we can take them together and get a string of five characters. “AND” on its own is only three characters so we discard it.

### Input (monkey.in)

The first line contains a single integer  $N$ , the number of words in the dictionary. The next  $N$  lines contain a word  $w_i$ , which together form the dictionary. The last line will contain the text entered by the monkey.

### Sample input

```
3
AND
AT
THE
LATTHEPAND
```

### Output (monkey.out)

The output should consist of a single integer, the largest number of characters in a string of consecutive words found in the text.

### Sample output

```
5
```

### Constraints

- $1 \leq N \leq 1000$
- $1 \leq \text{length of } w_i \leq 100$
- $1 \leq \text{length of text} \leq 100000$
- Characters in the words and text will only be uppercase letters A-Z

### 50% Constraints

- $1 \leq N \leq 100$
- $1 \leq \text{length of } w_i \leq 10$
- $1 \leq \text{length of text} \leq 1000$

### Time limit

1 second.

### Scoring

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



# South African Computer Olympiad Training Camp 2, 2007 Day 1



## Philosophy

### Author

Bruce Merry

### Introduction

The Bruces at the Philosophy Department of the University of Wallamalloo like to play logic games. One of the Bruces has a collection of boolean (true or false) variables. He gives the other Bruces information about these variables, but sometimes he might lie. The goal of the other Bruces is to catch him out in a contradiction as soon as possible.

### Task

Each statement that Bruce makes is of the form “Variable A is ? OR Variable B is ?”, where each of the question marks is either “true” or “false”. This is also a logician’s or programmer’s OR, meaning that one or both of the assertions holds.

Write a program that accepts a list of the statements made by Bruce, and determines the first of the statements that contradicts the previous statements.

### Example

Suppose Bruce makes the following claims:

1. A is true OR A is true.
2. C is false OR B is false.
3. B is true OR A is false.
4. A is false OR C is true.
5. B is true OR C is false.

The first three statements can be satisfied, by making A true, B true and C false. However, there is no way in which the first four statements can all be true.

### Input (phil.in)

The first line of input contains  $N$ , the number of statements made by Bruce. The next  $N$  lines describe these statements in order. Each line contains two strings, separated by a single space, representing the two parts of the OR statement. Each part is either a variable name, indicating “this variable is true”, or an exclamation mark

(!) immediately followed by a variable name, indicating “this variable is false”. Variable names consist of 1–10 uppercase letters.

### Sample input

```
5
A A
!C !B
B !A
!A C
B !C
```

### Output (phil.out)

Output a single line containing the index of the first statement which contradicts the statements that come before it, where 1 is the first statement in the file. If all of Bruce’s statements could be true at once, then output  $-1$  instead.

### Sample output

```
4
```

### Constraints

- $1 \leq N \leq 100$

### 50% constraints

- $1 \leq N \leq 10$

### Time limit

1 second.

### Scoring

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