
# South African Computer Olympiad
# Final Round
# Day 1

## Overview

| **Author** | **Shen Tian** | **Bruce Merry** | **Carl Hultquist** |
|---|---|---|---|
| **Problem** | **phrase** | **scales** | **ni** |
| Source | phrase.java<br>phrase.py<br>phrase.c<br>phrase.cpp<br>phrase.pas | scales.java<br>scales.py<br>scales.c<br>scales.cpp<br>scales.pas | ni.java<br>ni.py<br>ni.c<br>ni.cpp<br>ni.pas |
| Input file | phrase.in | scales.in | ni.in |
| Output file | phrase.out | scales.out | ni.out |
| Time limit | 1 second | 1 second | 8 seconds |
| Number of tests | 10 | 10 | 10 |
| Points per test | 10 | 10 | 10 |
| **Total points** | **100** | **100** | **100** |

The maximum total score is 300 points.

# Hungarian Phrase book

## Author

Shen Tian

## Introduction

In 1971, the British Empire lies in ruins. Foreign nationals frequented the streets, many of them Hungarian. Not the streets, the foreign nationals. Anyways, many of these Hungarians carry an English-Hungarian phrase book published by Mr Yalk. He did so with the intention of breaching the peace.

For example, the Hungarian phrase meaning "Can you direct me to the railway station?" is translated as the English phrase "Please fondle my b*****ks."

All tobacconists (where many of these Hungarian nationals go to buy cigarettes) are urged to familiarise themselves with the contents of this phrase book, so that when a Hungarian customer starts to speak, they can tell whether or not he has been using the phrase book. In doing so, the shop owner shall be able to avoid any unnecessary embarrassment and conflicts.

## Task

Given a list of phrases from the infamous phrase book, and a list of phrases said by Hungarians, determine whether or not each phrase said is the beginning of a phrase from the phrase book. In other words, determine whether or not each phrase said is a prefix of a phrase from the book.

## Example

If it is known that the phrase book contains the following phrases:

- I will not buy this record, it is scratched.
- My hovercraft is full of eels.
- Do you want to come back to my place? Bouncy, bouncy.

And a Hungarian said the following:

- I will not buy this rec
- My helicopter is
- Do you want to come back
- I will not buy this cat.

Then the first and third phrase said are prefixes of phrases from the phrase book, whereas the second and fourth are not.

## Input (phrase.in)

The first two lines of the input contains numbers $M$ and $N$. The next $M$ lines contains the $M$ phrases from the phrase book. After that, there are $N$ further lines containing things said by Hungarians.

### Sample input

```
3
4
I will not buy this record, it is scratched.
My hovercraft is full of eels.
Do you want to come back to my place? Bouncy, bouncy.
I will not buy this rec
My helicopter is
Do you want to come back
I will not buy this cat.
```

## Output (phrase.out)

The output file should contain $N$ lines, each corresponding to a phrase said by a Hungarian. Each line should contain either "true" if the phrase said is a prefix of some phrase from the phrase book, or "false" otherwise.

### Sample output

```
true
false
true
false
```

## Constraints

- $1 \leq M \leq 1000$
- $1 \leq N \leq 100000$
- Each phrase (from the book or said) contains at most 60 characters.
- Phrases can include characters 'a' to 'z', 'A' to 'Z', period, comma, question mark and space. The phrases are free of leading or trailing space characters, as well as double spaces.
- Everything is **Case sensitive.**

### 50% constraints

- $1 \leq M \leq 200$
- $1 \leq N \leq 30000$

## Time limit

1 second.

## Scoring

You will score 100% if all results and output format are correct. Otherwise, no points shall be given.


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# Scales

## Author

Bruce Merry

## Introduction

Sir Bedevere has a balancing scale which he uses to weigh ducks and suspected witches. He also has a set of weights with known masses, which allows him measure the mass of a duck. He places the duck on one side of the scale, then adds weights to the other side until they balance (he does not put weights on the same side as the duck, since the duck tends to eat them).

His weights also have a curious property: when lined up from smallest to biggest, each weight (from the third one on) has at least as much mass as the previous two combined.

## Task

Sir Bedevere wants to determine the maximum mass that he can use his weights to measure. His scale will break if he uses more than a certain total mass, so he cannot necessarily just put all his weights onto the scale. He also might not be able to exactly measure this maximum mass, because he might not have a set of weights that exactly sums to this amount.

Write a program that, given a list of Sir Bedevere's weights and the maximum mass the scale can take, will determine the maximum mass that Sir Bedevere can weigh.

## Example

Suppose Sir Bedevere has weights with masses of 3kg, 6kg, 10kg and 18kg, and his scale can only take up to 20kg. Then the most that he can weigh is 19kg, using the 3kg, 6kg and 10kg weights. If he had used the 18kg weight, he would not have been able to add any more weights and would only have obtained 18kg.

## Input (scales.in)

The first line of input contains two positive integers, $N$ and $C$. Sir Bedevere has $N$ weights, and his scale can take up to $C$kg. The following $N$ lines each contain a positive integer, the mass of one of the weights in kilograms. The weights are listed from smallest to largest.

### Sample input

```
4 20
3
6
10
18
```

## Output (scales.out)

The output consists of $N$ lines, describing a combination of weights that will give the maximal mass (there may be several ways to obtain the maximal mass; output just one of them). The $i$th line contains either a 1 (one) to indicate that weight $i$ should be put on the scale, or a 0 (zero) to indicate that it should be omitted.

### Sample output

```
1
1
1
0
```

## Constraints

- $1 \leq N \leq 40$
- $1 \leq C < 2^{30}$
- $1 \leq$ each weight $< 2^{30}$

### 50% constraints

- $1 \leq N \leq 20$

## Time limit

1 second.

## Scoring

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

# The Knights of Ni

## Author

Carl Hultquist

## Introduction

Arthur is in a sticky situation: he needs to pass through the woods that are guarded by the Knights of Ni. In order to pass through safely, the knights have demanded that Arthur bring them a shrubbery. Time is of the essence, and Arthur must bring them a shrubbery as quickly as possible. You must help him do this.

## Task

Arthur has given you a map of Camelot, which is divided into square grid blocks. The map shows where Arthur and his party are at the moment, where the Knights of Ni are, and where all the shrubberies of the land are. It also shows which areas of the map can be used (some grid blocks are impassable because of swamps, cliffs and killer rabbits). In order to make sure that they follow the map correctly, Arthur and his party can only move North, East, South or West, and whenever they do so they move exactly one grid block on the map. Moving from a grid block to a neighbouring grid block in this way takes exactly 1 day. Your task is to determine the quickest way for Arthur to obtain a shrubbery and then take it to the Knights of Ni. Furthermore, until Arthur has a shrubbery he may not pass through the grid block where the Knights of Ni are (for if he does, they will surely kill him).

## Example

Suppose the map of the land is as shown in Figure 1.

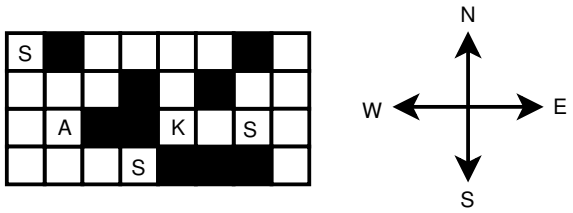


Figure 1: Example map of Camelot

$A$ indicates where Arthur and his party are, $K$ indicates where the Knights of Ni are, and $S$ indicates the position of a shrubbery. Solid black blocks are impassable, and all the white blocks can be traversed by Arthur and his party. In this example, the quickest way for Arthur to obtain a shrubbery and take it to the Knights of Ni is to travel in the following directions: North, West, North, South, East, East, North, East, East, South, South. This will take him 11 days. Note that he could also have first travelled West and also reached the Knights of Ni in 11 days; if there is more than one best solution like this then you only need to find one of the solutions, and it does not matter which one you output.

## Input (ni.in)

The first line of input will contain 2 space-separated integers, $W$ and $H$, which are the width and height respectively of the map in grid blocks. The next $H$ lines will each contain $W$ space-separated integers that describe the map. The integers in the map description have the following meanings:

- 0 — block that Arthur and his party **can** travel through
- 1 — impassable block that Arthur and his party **cannot** travel through
- 2 — starting location of Arthur and his party
- 3 — location of the Knights of Ni
- 4 — location of a shrubbery

Arthur and his party can travel through grid blocks marked with 0, 2, 3 or 4 (with the one exception that they can only travel through the grid block marked 3 — where the Knights of Ni are — once they have collected a shrubbery). There will always be at least one shrubbery in the map description.

### Sample input

```
8 4
4 1 0 0 0 0 1 0
0 0 0 1 0 1 0 0
0 2 1 1 3 0 4 0
0 0 0 4 1 1 1 0
```

## Output (ni.out)

The first line of output must contain a single integer, $D$, which is the number of days it will take Arthur and his party to complete their quest. The next $D$ lines of output will describe the path taken by Arthur and his party: each line must contain a single character — N, E, S or W — indicating the direction that they travel in.

### Sample output

```
11
N
W
N
S
E
E
N
E
E
S
S
```

## Constraints

- $1 \leq W, H \leq 1000$

### 50% constraints

- $1 \leq W, H \leq 20$
- $1 \leq$ number of shrubberies on map $\leq 10$

## Time limit

8 seconds.

## Scoring

For any test-case, if

- Your output is not formatted as specified above
- The path you specify takes Arthur and his party off the map
- The path you specify does not pass through a grid block containing a shrubbery
- The path you specify does not finish at the grid block occupied by the Knight of Ni
- The path you specify passes through an impassable grid block
- The path you specify passes through the grid block occupied by the Knight of Ni before collecting a shrubbery

then you will score 0% for that test-case. Otherwise, you will have found a solution that takes Arthur and his party $D$ days. Suppose the best solution takes $B$ days. Then you will score

$$100e^{\frac{B-D}{B}}\%$$

for that test-case.