Note

Émetteur(s) :	Sopra Battle Team
Destinataire(s) :	
Copie(s) :	
Objet :	**Exercices**

0. Introduction

Welcome to Sopra's first international Battle. The following subjects can be undertaken in whichever order you choose and are independent of one another.

It falls on you to find relevant and sturdy solutions to solve the given problems. Be watchful, the referees are specialists of advanced exception testing and will give you interesting test sets.

More the exercise is difficult, more you can earn points when you finish it. Be careful to the "bonus" and "malus" that differs depending the exercise.

The table below summarize points, bonus and malus based on each exercise:

N°	Exercise	Point	Bonus	Malus
1	Pyramids and Barrels	10	3	2
2	Pythagore	5	2	1
3	Numbers and letters	15	3	3
4	Smallest Integer	4	1	2
5	In or Out ?	20	4	5
6	Two circles	15	3	3
7	Code breaker 1	10	3	2
8	Code Breaker 2	40	6	10
9	A little planning	7	2	1
10	Linux and mackerel	30	5	7
11	Needles race	4	1	2
12	Marathon	5	2	1
13	Triangle	15	3	3
14	Tangent	20	4	5
15	SopraPhone	10	3	2

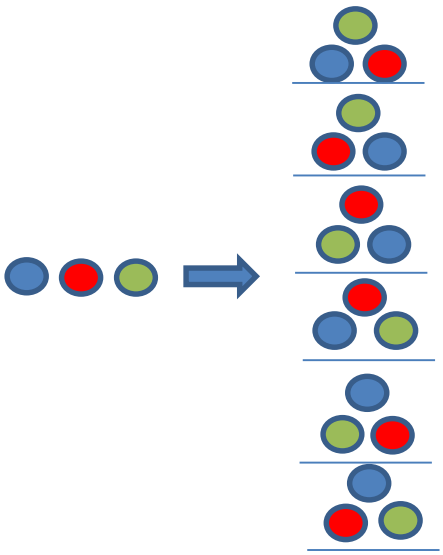
1. Pyramids and Barrels

You have at your disposal several barrels, each one a different color, and you must put them together to form a pyramid just like the one on the following picture.

As a reminder, numbers that can be put together as a pyramid observe the formula that follows (t_n : t is the size and n the number of barrels) :

$$\forall n \in \mathbb{N}^* \quad t_n = \frac{n(n+1)}{2}.$$

If you're given 3 barrels, you can make 6 different pyramids:



Keeping in mind you are working with the highest possible pyramid (the pyramid that uses the most barrels),

a/ how many different ones can you make with 10 barrels?

b/ how many different ones can you make with 11 barrels?

2. Pythagore

Everyone knows the famous Pythagorean theorem ($a^2+b^2= c^2$), but which numbers a, b and c comply with both: $a^2+b^2= c^2$ and $a+b+c=X$?

a/ When X = 1000 ?

b/ When X = 1500 ?

3. Numbers and letters

A dictionary of the French words is attached to the present document (dictionnary.txt, encoded in ISO-8859-1).

The television game show "Des chiffres et des lettres" (literally "numbers and letters") has been a famed institution on French TV for over 40 years. In this game there is a "letter round". Contestants are given 10 letters (one particular letter can appear several times) and they must make the longest possible French word using as much letters as they can.

Of course, only basic characters appear, the character "e" can be used as all its accented variations "é", "è", "ê", "ë" (this applies to all other characters : ç, à, ù, î, ô, …). Finally compound words (the ones including a "-") are allowed, the hyphen counts for zero character.

For example,

- the following draw [aetdurejlm] gives:
  - adultéré
  - adultère
  - délateur
  - deleatur
  - délutera
  - demeurât
  - mudéjare
- the following draw [etecao] gives:
  - à-côté
  - actée
  - cotée
  - écoté

Your turn to design the algorithm to find the longest words that can be assembled from the letters of a this draw : smarinousz ?

4. Smallest Integer

What is the smallest integer that can be divided by all the integers from 1 to X ?

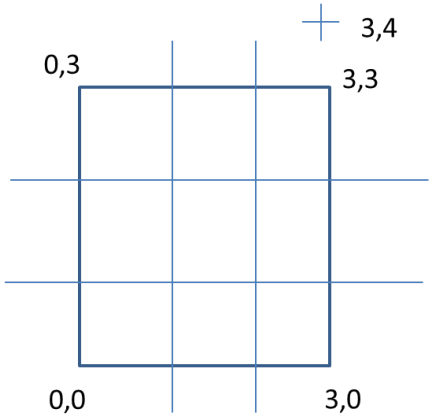
a/ When X = 5 ?

b/ When X = 10 ?

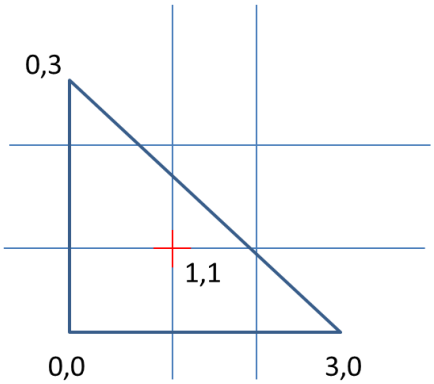
5. In or Out ?

Given a set of points with (x,y) coordinates constituting a polygon (the last given point is connected to the first by a straight line), show if a point (x,y) is inside or outside the figure ?

Example : for the points illustrated below, the algorithm should answer "out".



For the next figure, the algorithm should answer "in":



a/ Given the polygone constituate by the points below, is the point (3,1) “in” or “out” ?

- (0,0)
- (6,0)

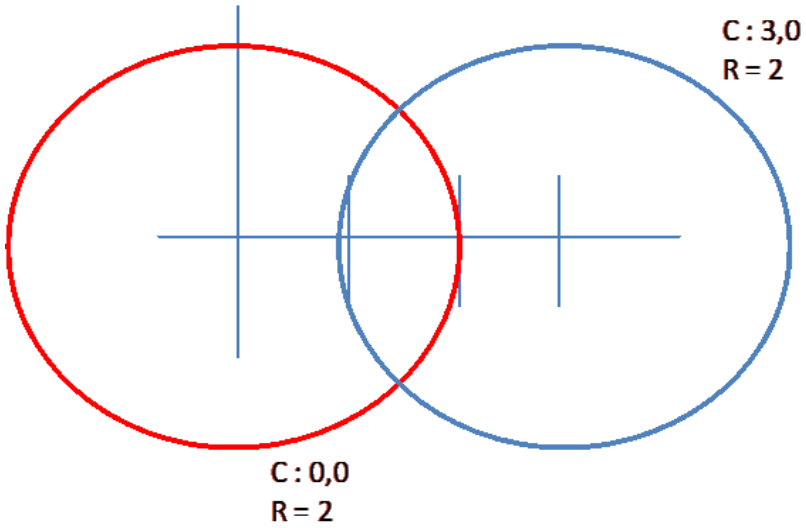
- (0,3)

b/ Given the polygone constituate by the points below, is the point (4,2) “in” or “out” ?
- (0,0)
- (5,1)
- (6,0)
- (3,2)
- (3,5)
- (2,5)
- (1,4)
- (0,3)

6. Two circles

Given 2 circles, formulated as the coordinates (x,y) of each one's center and its radius, indicate the number of intersections of the two circles : 0, 1, 2 or infinity.

For example, in the setup below:



There is 2 intersections.

Implement an algorithm which say the number of intersections.

a/ Number of intersections with the configuration below ?

- Circle C1 : 0, 0 et R = 3
- Circle C2 : 0, 1 et R = 2

b/ Number of intersections with the configuration below ?

- Circle C1 : 1, 0 et R = 2
- Circle C2 : 1, 3 et R = 1

7. Code Breaker 1

Decrypt the file "textCypher1.txt".

8. Code Breaker 2

Decrypt the file "textCypher2.txt".

9. A little planning

Our clients' imagination knows no bounds. As part of a big project, our client asks of us that we use the "Headache" calendar.

Each month of the Headache calendar has a number of days equal to the number of days on the Gregorian calendar but:

If that month has an even number of days you must subtract twice the number of the month

If that month has an uneven number you must subtract twice the number of the month and add 3

Example:

- January has 31 days (uneven) and is the month number 1 so in the Headache calendar, it has:

31 – (2 x 1) +3 = 32 days

- February has 28 days (even) and is the month number 2 so in the Headache calendar, it has:

28 – (2 x 2) = 24 days

  - But in case of leap years, February has 29 days (uneven) and is the month number 2 so in the Headache calendar, it has: 29 – (2 x 2) + 3 = 28 days

- March has 31 days (uneven) and is the month number 3 so in the Headache calendar, it has:

31 – (2 x 3) + 3 = 28 days

In this calendar, how many days have gone by between the two dates below (The first day and the last are excluded from the count, we want the number of days in between) ?

- a/ Le 2014/01/01 et le 2014/06/01 ?
- b/ Le 2010/01/01/ et le 2014/09/01 ?

10. Linux et mackerel

On an ice shelf, a brave little penguin named Linux needs fishes to get going. Each fish eaten can make him move of 1 km. There are S fishes on the starting point, and Linux can take a maximum of T fishes with him. Linux can only eat the fishes he has on him. A fish is considered eaten when Linux starts moving.

Given the values of S and T, how far can Linux go from the starting point?

For example, if there are 6 fishes in stock and Linux can take a maximum of 3 fishes with him, Linux could move 4km away from the starting point. Indeed, Linux takes 3 fishes with him, moves of 1km, puts one fish down and comes back to the starting point thanks to the last fish he's holding. He then takes the last 3 fishes, moves of 1 km, picks up the fish he left behind, and eats the 3 fishes on the 3 next kilometers.

What is the maximum distance when S = 12 et T = 6 ?

11. Needle race

On a clock, the hands cross on a regular basis. Given a starting and an ending time, how many times do the hour and minute hands cross paths? Time is set as HH:MM ($00 \leq H \leq 23$). The difference between starting and ending time can't exceed 24 hours.

How many times the needles will be superimposed between 11h12 and 18h53?

12. Marathon

A race is taking place around a 1km long track. Three runners are running at a speed of:

- Runner 1 : 2 km/h
- Runner 2 : 4 km/h
- Runner 3 : 6 km/h

The algorithm has to be able to give the time elapsed between the beginning of the race and when they first cross the line together, whatever the speed and the number of runners.

There are always 3 runners. Their speeds are the only parameter in this case.

13. Triangle Route

Given a triangle of numbers:

```
   3
  7 4
 2 4 6
8 5 9 3
```

Starting on the top of the triangle (number 3), you can only move downwards on one of the two numbers adjacent your current position.

What is the maximum sum of numbers you can obtain moving as described?

For example, the maximum sum on this triangle is 23, using the following path:

```
   3
  7 4
 2 4 6
8 5 9 3
```

The triangle is given in a file to ease marking (be cautious with the number of layers). The triangles are given on attached files. The numbers are aligned to the left.

This triangle

```
   3
  7 4
 2 4 6
8 5 9 3
```

is given like this :

```
3
7 4
2 4 6
8 5 9 3
```

a/ What is the maximum obtained with the standard triangle (15 lines) ?

b/ What is the maximum obtained with the big triangle (100 lines) ?

14. Tangent

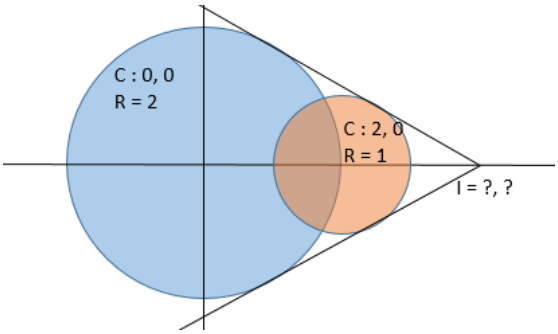
Given two circles of centre (x,y) and radius r, indicate the coordinates of the intersection point of their 2 common tangents.

What are the coordinates of the intersection point when there are the two circle below ?

C1 : (x=0, y=0), r=2

C2 : (x=2, y=0), r=1

Intersection point is : x = ?, y = ?



15. SopraPhone

You are being given the responsibility of developing the SopraPhone contact list.

The phone number(s) matching the first pressed figures are to be displayed nearly instantaneously to the user. The first figures the numbers have in common are not to be duplicated in memory. Thankfully, the requirements show the diagram bellow to help you:

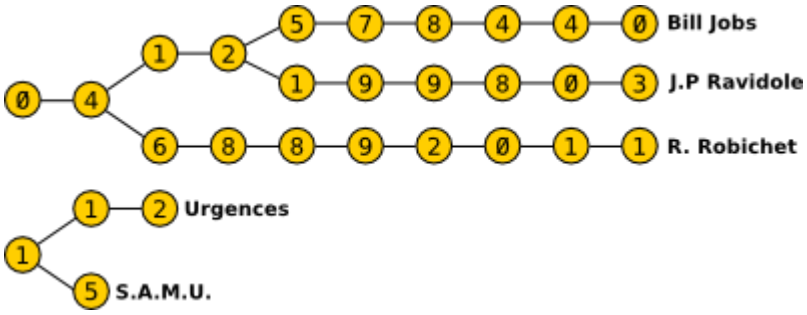


Fig 1. Data structure to store SopraPhone phone numbers

The graph above shows the **28 items**, which make up the list of the five numbers below:

```
Entrée :
0412578440
0412199803
0468892011
112
15
```

Your mission: Write a program which displays the number of figures needed to store a list of phone numbers using the structure above.

IN:

Line 1 : Number N of phone numbers.

N next lines : Each line is a phone number of maximum length L. The phone numbers are only made of figures from 0 to 9 without space.

OUT:

The number of figures stored by the structure.

CONTRAINTES :

$0 \leq N \leq 10000$

$2 \leq L \leq 20$

a/ How many items do you get for the list below?

```
Entrée :
2
0123456789
0123
```

b/ How many items do you get for the list below?

```
Entrée :
2
0123456789
1123456789
```