

# Indian National Olympiad in Informatics, 2012

Time: 3 hours

21 January, 2012

## Instructions

- (a) You will have to return this question paper at the end of the examination with relevant parts filled out.
- (b) There are two questions. You have to write working programs in Pascal, C or C++ to solve each of these questions.
  - *Only your source code will be submitted for evaluation. Your program will be recompiled and run on the evaluation computer.*
  - *Make sure your C/C++ programs compile with the GNU C compiler (**dev-cpp** or **djgpp**, under Windows). Programs written using Turbo C++ may not compile and run in the evaluation environment and may hence lose marks.*  
**If you work in C/C++, make sure you do not write `#include <conio.h>` in your program or use any functions defined in `conio.h`. If you do so, your program will not compile and you will get no marks.**
- (c) At the end of each question, there is a space to indicate the location of the source code file for your solution. Please fill up this information without fail. Otherwise, your solution cannot be evaluated.
- (d) All input for your programs will come from the keyboard. All output from your programs should be written to the screen.
- (e) Please fill out your contact details on the reverse of this page as completely as you can. Use your serial number as reported in the ZIO/ZCO results page as your roll number for INOI. If you qualified under multiple categories, use the ZIO serial number as your roll number. Ask your centre supervisor if you do not know your roll number.
- (f) At the beginning of each program, include a comment with your name, roll number and the problem number. For instance, if your name is Sachin Tendulkar, your roll number is 107 and the problem you are writing a C/C++/Pascal program for is Problem 1, add a comment of the form

```
/* Sachin Tendulkar, 107, Problem 1 */
```

at the top of your file.

*This will help us if files accidentally get mixed up when being sent from the exam centres to the evaluation centre.*

...P.T.O.

<b>Contact details</b>	
Roll Number:	
Name:	
Home Address:	
	PIN Code
Phone Number(s): (with STD code)	
Email address:	

## Question 1 Triathlon

The Republic of Tutaria is celebrating its 37<sup>th</sup> year of independence. To mark the occasion, the nation is organising a contest where all its  $N$  citizens take part. The event has three tracks, a COBOL programming competition, pole vault, and a doughnut-eating competition. Each citizen takes part in these three tracks in the same order—a citizen starts with the programming competition, continues with the pole vault as soon as his or her COBOL masterpiece is ready, and then starts gorging on doughnuts as soon as the pole vault is done.

The Supreme Leader of Tutaria closely monitors all citizens and knows the exact amount of time each citizen will take in each of the three tracks. She wants to schedule the event so that it will finish as early as possible. However, the Republic of Tutaria has only one computer, and, as a result, only one person can participate in the COBOL programming event at a time. However, any number of people may simultaneously participate in the pole vault and doughnut-eating competitions.

The event works as follows. The Supreme Leader fixes the order in which contestants get access to the computer. At time 0, the first citizen in the list starts writing his or her COBOL program, while the remaining citizens wait for the computer to be free. As soon as the first citizen is done, he or she proceeds to the pole vault, and the second citizen gets the computer for the programming round. In general whenever the computer becomes free, the next citizen gets to use it. Whenever a citizen is done using the computer, he or she proceeds to the pole vault immediately, regardless of what the other citizens are doing. Similarly, whenever a citizen is done with the pole vault, he or she proceeds to the doughnut-eating track immediately, independently of the others. The event ends as soon as all the citizens have finished all the three tracks of the event.

For example, suppose  $N = 3$ , and the time they need for the three tracks are as follows:

Citizen id	COBOL	Pole vault	Doughnut-eating
1	18	7	6
2	23	10	27
3	20	9	14

If the citizens start at time 0 and proceed in the order 1,2,3, then citizen 1 will finish at time  $18 + 7 + 6 = 31$ , citizen 2 will finish at time  $18 + 23 + 10 + 27 = 78$ , and citizen 3 will finish at time  $18 + 23 + 20 + 9 + 14 = 84$ . The event ends at time  $\max(31, 78, 84) = 84$ .

On the other hand, if the citizens proceed in the order 2,3,1, you can check that the event ends at  $\max(60, 66, 74) = 74$ . The Supreme Leader of Tutaria wants to fix the order in which the citizens proceed so that the event ends as early as possible. You can check that in this case 74 is the earliest time at which the event can end.

### Input format

The first line of input has a single integer,  $N$ , the number of citizens of the Republic of Tutaria. The next  $N$  lines contain 3 space-separated integers each: line  $i$  gives the time taken by the citizen  $i$  for COBOL programming, pole vault, and doughnut-eating respectively.

## Output format

The output should have a single line with a single integer, the earliest time at which the event can end.

## Test Data

The testdata is grouped into two subtasks with the following constraints on the inputs.

- **Subtask 1** [30 points] :  $1 \leq N \leq 3000$ .
- **Subtask 2** [70 points] :  $1 \leq N \leq 200000$ .

In both the subtasks, all the numbers in the input (except possibly  $N$ ) are in the range 1 to 10000, inclusive.

## Example

Here is the sample input and output corresponding to the example above.

### Sample input

```
3
18 7 6
23 10 27
20 9 14
```

### Sample output

```
74
```

## Time and memory limits

The time limit for this task is 2 seconds. The memory limit is 32 MB.

**Note:** Your program should not print anything other than what is specified in the output format. Please remove all diagnostic print statements before making your final submission. A program with extraneous output will be treated as incorrect!

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## Important

Indicate the location of the source code file for your solution to Question 1 in the box below.  
*If you fail to do this, your solution cannot be evaluated!*

**Source file:**

## Question 2 Table sum

You are given a table with 2 rows and  $N$  columns. Each cell has an integer in it. The score of such a table is defined as follows: for each column, consider the sum of the two numbers in the column; the maximum of the  $N$  numbers so obtained is the score. For example, for the table

$$\begin{array}{cccc} 7 & 1 & 6 & 2 \\ 1 & 2 & 3 & 4 \end{array}$$

the score is  $\max(7 + 1, 1 + 2, 6 + 3, 2 + 4) = 9$ .

The first row of the table is fixed, and given as input.  $N$  possible ways to fill the second row are considered:

$$\begin{array}{c} 1, 2, \dots, N \\ 2, 3, \dots, N, 1 \\ 3, 4, \dots, N, 1, 2 \\ \dots \\ N, 1, \dots, N - 1 \end{array}$$

For instance, for the example above, we would consider each of the following as possibilities for the second row.

$$\begin{array}{cccc} 1 & 2 & 3 & 4 \\ 2 & 3 & 4 & 1 \\ 3 & 4 & 1 & 2 \\ 4 & 1 & 2 & 3 \end{array}$$

Your task is to find the score for each of the above choices of the second row. In the example above, you would evaluate the following four tables,

$$\begin{array}{cccc} 7 & 1 & 6 & 2 \\ 1 & 2 & 3 & 4 \end{array} \quad \begin{array}{cccc} 7 & 1 & 6 & 2 \\ 2 & 3 & 4 & 1 \end{array} \quad \begin{array}{cccc} 7 & 1 & 6 & 2 \\ 3 & 4 & 1 & 2 \end{array} \quad \begin{array}{cccc} 7 & 1 & 6 & 2 \\ 4 & 1 & 2 & 3 \end{array}$$

and compute scores 9, 10, 10 and 11, respectively.

### Input format

The first line of the input has a single integer,  $N$ . The second line of the input has  $N$  integers, representing the first row, from left to right.

### Output format

The output should consist of a single line with  $N$  integers. For  $1 \leq k \leq N$ , the  $k^{\text{th}}$  number in the output should be the score when the second row of the table is taken to be  $k, k + 1, \dots, N, 1, \dots, k - 1$ .

## Test Data

The testdata is grouped into two subtasks with the following constraints on the inputs.

- **Subtask 1** [30 points] :  $1 \leq N \leq 3000$ .
- **Subtask 2** [70 points] :  $1 \leq N \leq 200000$ .

In both the subtasks, all the integers in the first row of the table are between 1 and 100000, inclusive.

## Example

Here is the sample input and output corresponding to the example above.

### Sample input

```
4
7 1 6 2
```

### Sample output

```
9 10 10 11
```

## Time and memory limits

The time limit for this task is 2 seconds. The memory limit is 32 MB.

**Note:** Your program should not print anything other than what is specified in the output format. Please remove all diagnostic print statements before making your final submission. A program with extraneous output will be treated as incorrect!

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## Important

Indicate the location of the source code file for your solution to Question 2 in the box below.  
*If you fail to do this, your solution cannot be evaluated!*

**Source file:**