

Overview: Which number is missing?

Description: Whoops! Agent Maria Hill is trying to break into Loki's computer system, which is not-very-intelligently protected by a number between 0 and  $n-1$ . Furthermore, one of Loki's minions foolishly left a file containing the other  $n-1$  numbers available on a different machine. Unfortunately, Maria is unable to directly access the other  $n-1$  numbers directly, because if she does so, Loki might discover her plots and change his password.

Instead, imagine that the  $n-1$  numbers between 0 and  $n-1$  are arranged randomly in an array; Maria is allowed to ask what the  $j$ th bit of the  $i$ th number in the array is. Using no more than 2500 of these queries, can she figure out which number is missing (and therefore Loki's password)?

Filename: adv54.{java, cpp, c, cc, py}

Input/Output: This is an interactive problem. This means that your program will receive input based on the output your program produces. When your program starts, you will be provided an integer  $n$  as specified above. Your program must then do one of the following:

1. Output two space separated integers  $i$  and  $j$ , which denote a query for the  $j$ th bit ( $0 \leq j < 32$ ) of the  $i$ th number ( $0 \leq i < n-1$ ), after which your program will be provided the  $j$ th bit of the  $i$ th number (either 0 or 1). This counts as 1 query.
2. Output a single integer  $k$ , indicating that the missing number is  $k$

You MUST output a new line character and flush the output stream after each output:

In C, use `printf("\n"); fflush(stdout);`

In C++, use `cout << endl << flush;`

In Java, use `System.out.println(); System.out.flush();`

In Python, use `sys.stdout.write("\n"); sys.stdout.flush();`

Assumptions:  $n$  is a power of 2

$2 \leq n \leq 1024$

bit indices are numbered from the right, i.e. the  $i$ th bit corresponds to  $2^i$

Sample Sequence #1: Hidden numbers: 3 1 2

```
COMPUTER 4
YOU      0 0
COMPUTER 1
YOU      0 1
COMPUTER 1
YOU      1 0
COMPUTER 1
YOU      1 1
COMPUTER 0
YOU      2 0
COMPUTER 0
YOU      2 1
COMPUTER 1
YOU      0
```

Sample  
Sequence #2: Hidden numbers: 2 0 1

COMPUTER	4
YOU	0 0
COMPUTER	0
YOU	0 1
COMPUTER	1
YOU	1 0
COMPUTER	0
YOU	1 1
COMPUTER	0
YOU	2 0
COMPUTER	1
YOU	2 1
COMPUTER	0
YOU	3