Problem G. Binary Tree

Time limit:	1 second
Memory limit:	1024 megabytes

This is an interactive problem.

Given a binary tree with n vertices, your task is to find a special vertex s in the tree with at most $p = \lfloor \log_2 n \rfloor$ queries. That is to say, p is the largest integer such that $2^p \le n$.

Each query consists of two different vertices u and v. The interactor will output an integer t ($0 \le t \le 2$) as the answer. Let $d(a, b)$ be the number of edges on the simple path from vertex a to vertex b.

- If $t = 0$, then vertex u is nearer to the special vertex. That is, $d(u, s) < d(v, s)$.
- If $t = 1$, then the distances from u and v to the special vertex are the same. That is, $d(u, s) = d(v, s)$.
- If $t = 2$, then vertex v is nearer to the special vertex. That is, $d(u, s) > d(v, s)$.

Note that the interactor is adaptive, meaning that the answer for each test case is not pre-determined. The interactor can determine the special vertex according to your queries, as long as its answer does not conflict with the previous queries and answers.

Input

There are multiple test cases. The first line of the input contains an integer T indicating the number of test cases. For each test case:

The first line contains an integer n ($2 \le n \le 10^5$) indicating the number of vertices in the binary tree.

For the following n lines, the i-th line contains two integers x_i and y_i ($0 \le x_i, y_i \le n$), indicating the left and right child of the i-th vertex. If $x_i = 0$, then the i-th vertex has no left child; if $y_i = 0$, then the i-th vertex has no right child.

It is guaranteed that the sum of n for all test cases will not exceed 2×10^5.

Interaction Protocol

To ask a query, output one line. First output `?` followed by a space, then print two different integers u and v ($1 \le u, v \le n$) separated by a space. After flushing your output, your program should read a single integer t indicating the answer to your query.

If you want to guess the special vertex, output one line. First output `!` followed by a space, then print an integer s ($1 \le s \le n$) indicating the special vertex. After flushing your output, your program should continue processing the next test case, or exit immediately if there are no more test cases. Note that your guess does not count as a query.

To flush your output, you can use:

- `fflush(stdout)` (if you use `printf`) or `cout.flush()` (if you use `cout`) in C and C++.
- `System.out.flush()` in Java.
- `stdout.flush()` in Python.

Example

standard input	standard output
2 5 0 0 1 5 2 4 0 0 0 0 1 0 2 0 2 0 0 2	 ? 5 1 ? 1 4 ! 2 ? 2 1 ! 1