

# Black Panthers

Type	Time limit	Memory limit
Batch (interactive)	3 seconds	128 MB

## Statement

As a member of the most infamous organisation of thieves, the *Pink Panthers*<sup>1</sup>, you have managed to infiltrate a rival thief organisation, the *Black Panthers*. Intelligence has told you the following information about the organisational structure of the *Black Panthers*:

- There are  $N$  members in the *Black Panthers*, with ID numbers from 0 through  $N - 1$ .
- Each member except **the Boss** has 1 supervisor, such that the hierarchy forms a rooted binary tree structure if you consider the members as nodes, and the parent of each node is its supervisor, if any.
- That is, each member supervises at most 2 members, and the tree is rooted at the boss's node.

You wish to determine the supervisor of each member on the organisation, as well as who the Boss is. Your contact in a intelligence unit can answer your questions of the form “For two members  $a, b$  what is the ID of the lowest common ancestor (LCA) of  $a$  and  $b$  on the hierarchy?” However, your intelligence contact does not want to be suspected for espionage, so you may only ask at most 22000 questions.

## Implementation

You **must not** implement a main function. Instead, you should include the line in your code `#include "panther.h"` and implement the functions:

```
vector<int> supervisors(int N, int S);
```

where:

- $N$  is the number of members.
- $S$  is the subtask number (see below).
- `supervisors` should return a vector  $A$  of  $N$  values where  $A[i]$  is the member who is the supervisor of member  $i$ . If member  $i$  is the Boss, then  $A[i] = -1$ .

The grader will have implemented the function which may be called:

```
int query(int a, int b);
```

where:

- $a, b$  are the member IDs you wish to query.
- `query` will return the member ID that is the answer of the question.

When judging, `supervisors` will be called exactly once at the beginning.

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<sup>1</sup>See Selection Exam 2017, *White Collar*

## Experimentation

The source files `panther.h` and `grader.cpp` are provided for you to experiment on your machine. Please note that the grader used for judging may have different behaviour to the provided grader.

Compile your solution with:

```
g++ -std=c++11 -O2 -Wall -static panther.h sol.cpp grader.cpp -o panther
```

## Sample Grader

The sample grader reads the input in the following form:

**Line 1:**  $N$   $S$

**Line 2:**  $P_0$   $P_1$  ...  $P_{N-1}$

Here  $P_i$  is the supervisor of member  $i$ , and if  $i$  is the boss then  $P_i = -1$ .  $S$  is the subtask number. The sample grader will then execute the aforementioned interaction procedure and print 2 lines:

**Line 1:** The number of queries used.

**Line 2:** The values of the vector returned by supervisors  $A[0] \dots A[N-1]$ .

## Subtasks and Constraints

For all subtasks:

- $1 \leq N \leq 10^3$
- $1 \leq S \leq 5$  (see below)
- The organisational structure forms a binary tree

## Subtasks

Number	Points	Max $N$	Other Constraints
1	20	200	None
2	20	1000	$P_i \neq P_j$ for $i \neq j$
3	20	1000	$P_i < i$ for all $i$ and $P_0 = -1$
4	20	600	None
5	20	1000	None

## Scoring

For each test case, your program shall be awarded 100% of the points if the correct answer is returned for every function call, and 0% otherwise. For each subtask you will get points equal to the lowest scoring testcase.

## Sample Grader Input and Sample Session

The sample grader reads from standard input:

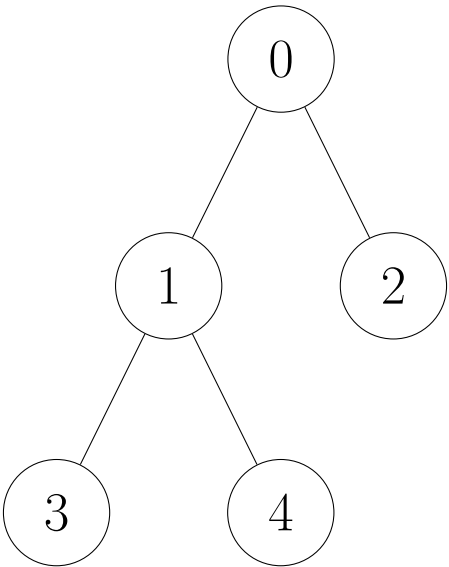
```
5 1
-1 0 0 1 1
```

The sample grader writes to standard output:

```
3
-1 0 0 1 1
```

Grader	Program	Description
supervisors(5, 1)		The grader calls the function.
returns 0	query(0, 1)	Member 0 is supervisor of member 1.
returns 1	query(3, 4)	Member 1 supervises members 3 and 4
returns 0	query(4 2)	Member 0 supervises member 2. Member 1 is leader of member 4.
Ends interaction	Returns [-1,0,0,1,1]	

Here is what the sample input looks like:



## Notes

You may find on CMS a zipped package containing:

- A stub implementation of your function.
- Files for the sample grader and `panther.h` as well as compile command.
- 3 more sample inputs, adhering to subtasks 2,3,4 respectively.

You may assume the grader is adaptive, and will take no more than 1 second of runtime.