



## Problem K. XOR and LCA

Input file:       standard input  
Output file:      standard output

Yuki has a tree with  $2^n$  nodes, labeled from 0 to  $2^n - 1$ . The  $i$ -th edge connects node  $u_i$  and node  $v_i$ . Let  $\text{lca}_r(u, v)$  denote the lowest common ancestor of nodes  $u$  and  $v$  when the tree is rooted at node  $r$ . You need to help Yuki calculate:

$$\bigoplus_{0 \leq u < v < 2^n} \text{lca}_{u \oplus v}(u, v)$$

where  $\oplus$  denotes the bitwise XOR operation.

### Input

This problem contains multiple test cases.

The first line contains a positive integer  $t$  ( $1 \leq t \leq 10^4$ ), representing the number of test cases.

For each test case:

- The first line contains a positive integer  $n$  ( $1 \leq n \leq 21$ ).
- The next  $2^n - 1$  lines each contain two integers  $u_i, v_i$  ( $0 \leq u_i, v_i < 2^n$ ,  $u_i \neq v_i$ ).

It is guaranteed that the input forms a tree, and the sum of  $2^n$  over all test cases does not exceed  $2^{21}$ .

### Output

For each test case, output a single line containing an integer representing the answer.

### Example

standard input	standard output
4	1
1	2
0 1	0
2	4
0 1	
1 2	
2 3	
3	
0 1	
0 2	
0 3	
0 4	
0 5	
0 6	
0 7	
3	
4 5	
2 6	
3 7	
0 2	
1 5	
2 7	
6 4	



## Note

For the first test case:

- When the tree is rooted at node 1, the lowest common ancestor of nodes 0 and 1 is node 1, so the answer is  $\text{lca}_1(0, 1) = 1$ .

For the second test case:

- We calculate  $\text{lca}_{u \oplus v}(u, v)$  for all pairs  $(u, v)$ :
  - $(0, 1)$ :  $0 \oplus 1 = 1$ ,  $\text{lca}_1(0, 1) = 1$ .
  - $(0, 2)$ :  $0 \oplus 2 = 2$ ,  $\text{lca}_2(0, 2) = 2$ .
  - $(0, 3)$ :  $0 \oplus 3 = 3$ ,  $\text{lca}_3(0, 3) = 3$ .
  - $(1, 2)$ :  $1 \oplus 2 = 3$ ,  $\text{lca}_3(1, 2) = 2$ .
  - $(1, 3)$ :  $1 \oplus 3 = 2$ ,  $\text{lca}_2(1, 3) = 2$ .
  - $(2, 3)$ :  $2 \oplus 3 = 1$ ,  $\text{lca}_1(2, 3) = 2$ .
- The XOR sum is  $1 \oplus 2 \oplus 3 \oplus 2 \oplus 2 \oplus 2 = 2$ .