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ICPC Programming Competition

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Let's put it on our calendars!

NAQ Problem D: Colorful Trees

■ Given tree with colored vertices, report for each edge the # pairs of vertices with same color that have that edge on path between them

■ Input:
- n ($2 \leq n \leq 10^5$): # of nodes in tree
- next n lines contain integer color c ($1 \leq c \leq n$).
- next n−1 lines contain integers a and b ($1 \leq a < b \leq n$), denoting an undirected edge from node a to node b.

■ Output
- n−1 lines, each with # number of pairs with same color that have that edge on the path between them

Basic Idea

- **Assume only one color**
- **For every edge e in the tree**
  - You only need to know how many vertices are on either side of the edge (say, l_e and r_e)
  - The number of paths using edge e is then $l_e \times r_e$
- **If you have multiple colors, simply keep track of how many vertices are on either side of the edge for each color c.**
  - # of paths $= \sum_c l_{e,c} \times r_{e,c}$

Image from Lecture

$n = 11$

$[4, 4., 3]$ 24

b r 9

$10: \begin{bmatrix} 2, 3, 2 \end{bmatrix}$ 2×2 $O(nc)$
$\quad b \quad r \quad 9$ $+$
$\quad \begin{bmatrix} 2, 1, 1 \end{bmatrix}$ $3 \times 1 = 9$
$\qquad\qquad\qquad +$
$\qquad\qquad\quad 2 \times 1$

$3+3+2=8$

$[1,1,1] \cdot 3$

$[2,3,2]$

$[1,1,1]$

$[0,0,1]$

$[0,1,0]$ $[0,0,1]$ $[0,1,0]$

Unrooted trees

$1-11$
$10-6$
$3-5$
$7-5$
$9-11$
$2-6$
$8-6$
$7-11$

Unresolved issue

■ If # of colors = c

■ Then, running time = $O(nc)$

- This may be too large