

Evaluate Division : Graph BFS

Given a list of equations of form

$$\frac{a}{b} = \text{value},$$

answer queries of form $\frac{x}{y} = ?$

if no ans possible / not enough info,
return -1

sample

$$\frac{a}{b} = 2, \quad \frac{b}{c} = 3 \quad \text{equations}$$

$$\frac{a}{c} = ? \quad \frac{b}{a} = ? \quad \frac{a}{b} = ? \quad \frac{a}{a} = ? \quad \text{queries}$$

$$\frac{x}{x} = ?$$

$$6, \quad 0.5, \quad -1, \quad 1, \quad -1 \quad \text{answers}$$

(you'll not be asked queries that will
force div by 0

(ex) $\frac{a}{c} = 0, \quad \frac{b}{c} = 2$ won't ask
 $\left(\frac{b}{a}\right)$

solution :

* create a graph from equations data



if $\text{val} = 0$, don't add $1/\text{val}$ edge

* write a function

$f(\text{single query}) \rightarrow \text{answer}$

* map f to list of queries

* for f , if query is $\frac{x}{y} = ?$

* if x or $y \notin \text{graph}$, return -1

* elif $x = y$, return 1

* otherwise do

dfs starting with x .

for each edge,

maintain
parent

$\text{parent}[c]$
 $= (p, \text{value})$

parent = p
value
child c

if y is visited during bfs,

retrace path $y \longrightarrow x$

via parent dict and multiply

edge values in the path

and return that.

complexity analysis

$$f \leftarrow O(N)$$

$N = \#$ of equations
graph

$2N$ edges

$\leq 2N$ vertices

so if Q queries, $O(QN)$

improvements:

→ add query data to graph

sequentially?

might increase
complexity of bfs
though

→ if query set is all pairs of
variables, build graph in steps

$$\frac{a}{b} = 2 \Rightarrow a \xrightarrow[1/2]{2} b$$

then process equations involving b or a

so



at each step,

answer all queries related to variables in graph

adding a new variable



$$\frac{a}{d} = \frac{a}{c} \cdot \frac{c}{d}$$

\Leftarrow 2 multiplications only --

(what about O_s ? ...)

if $Q \leftarrow O(N^2)$, then will $\sim O(N^2)$

prev approach $\sim O(N^3) \dots$