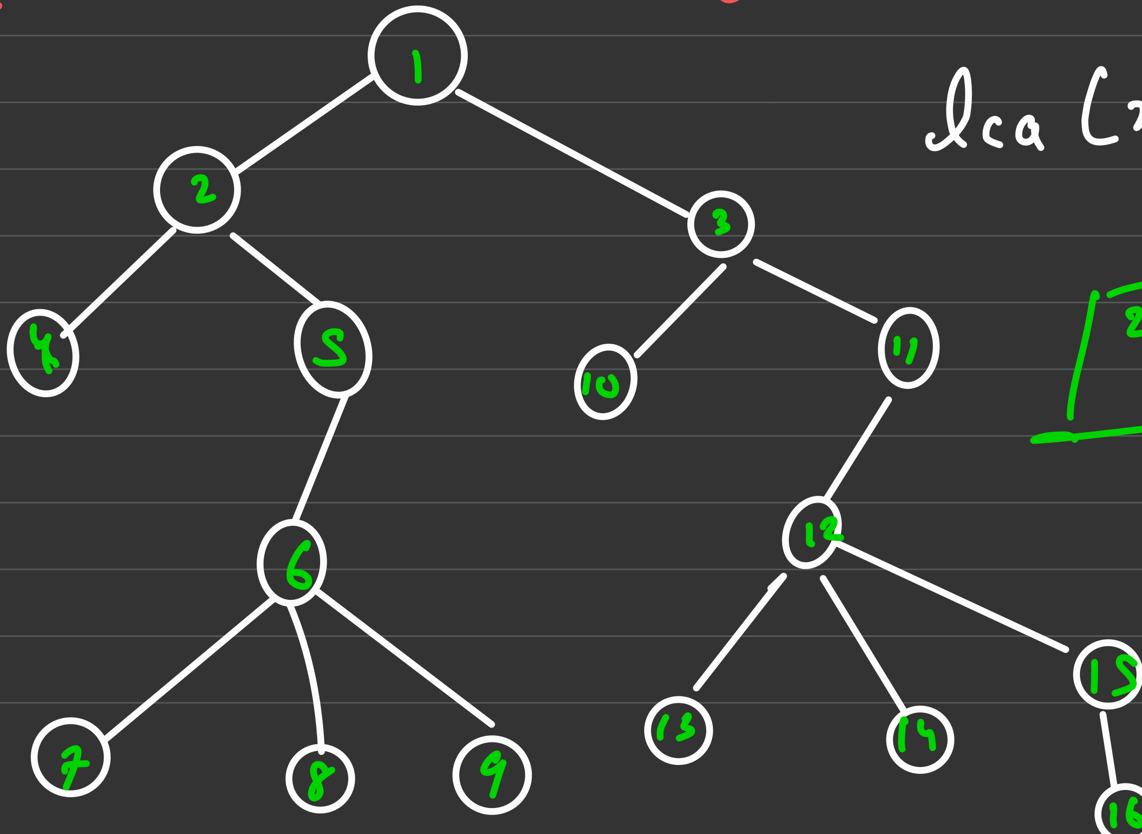
Basic DSA → LCA → (Lowest Common Ancestor)

TREE

lca (x, y)

2 nodes of a tree

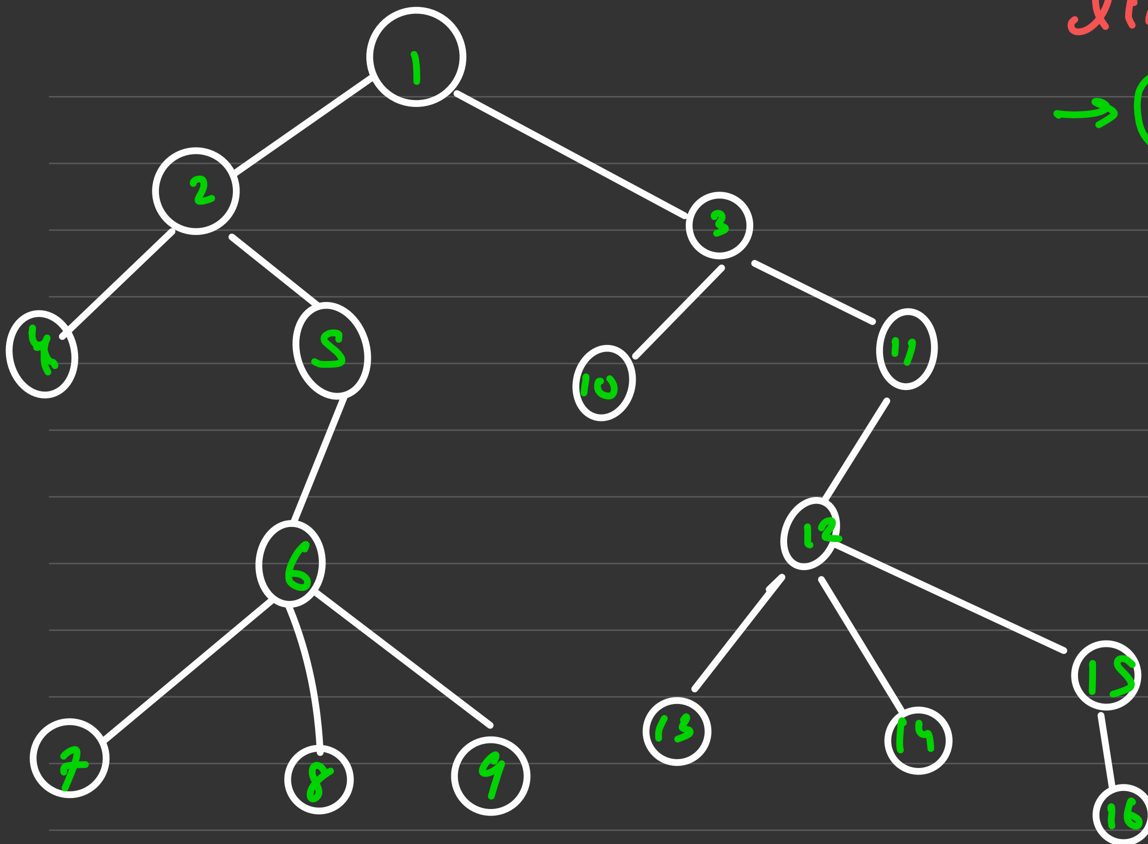
Brute force



lca(x, y)

→ 1 search x, y

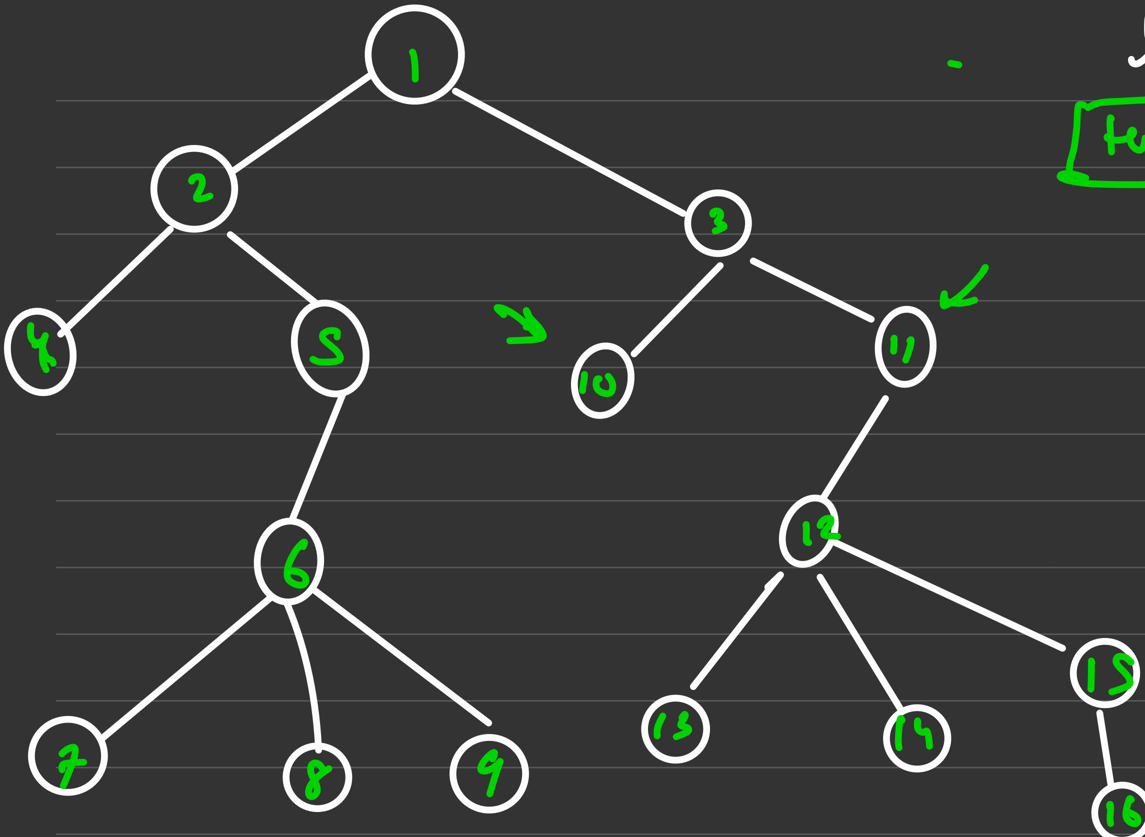
dfs



lca(10, 16)

[1, 3, 10]

[1, 3, 11, 15, 16]



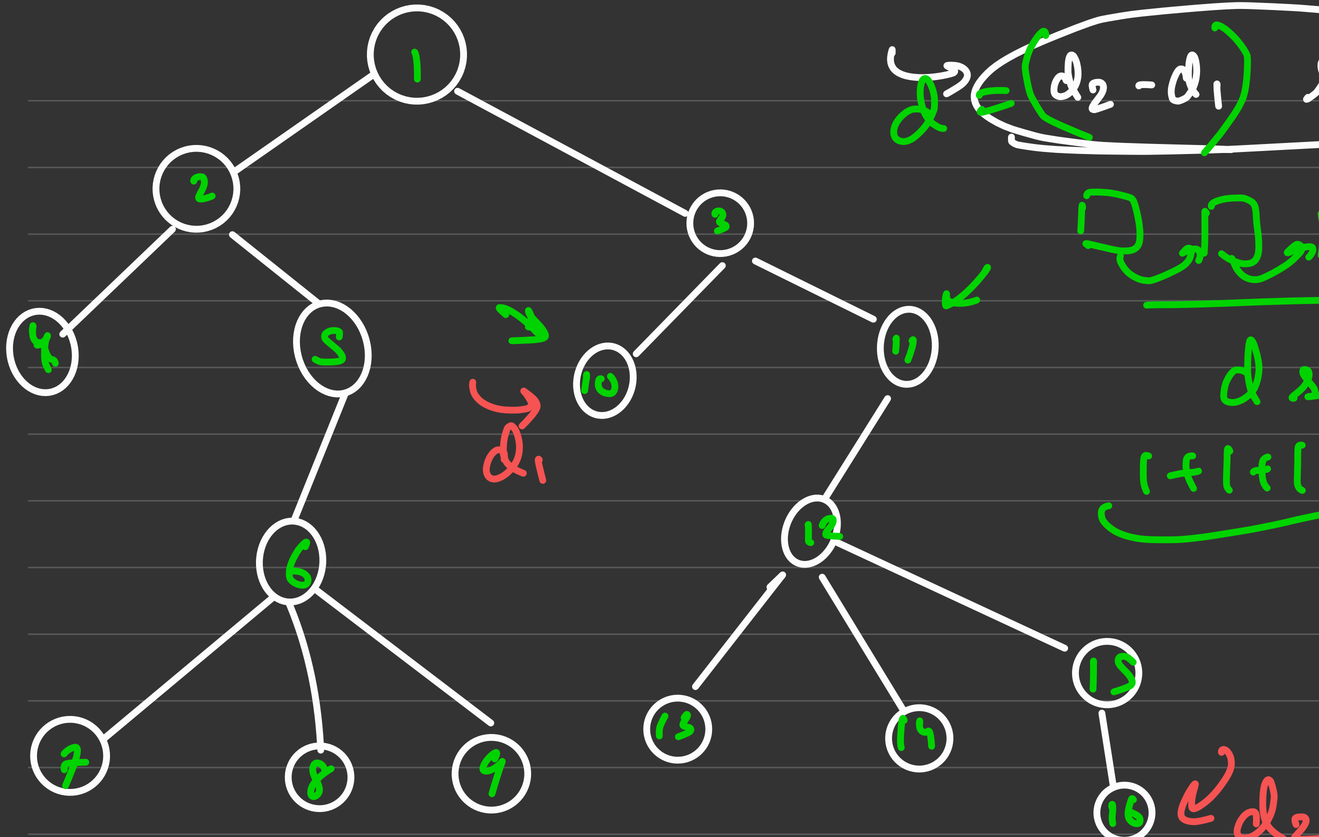
lca(10, 15)

$\boxed{\text{two pointers}}$

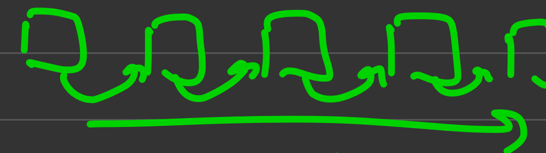
n-ary tree

graph

adj List



$d = (d_2 - d_1)$ steps



d steps

$$\underbrace{1+1+1+1- - - \rightarrow}_{} d$$

$$d = 2^x + 2^y + 2^z \cdots\cdots$$

$d = 13 = 1 + 4 + 8$

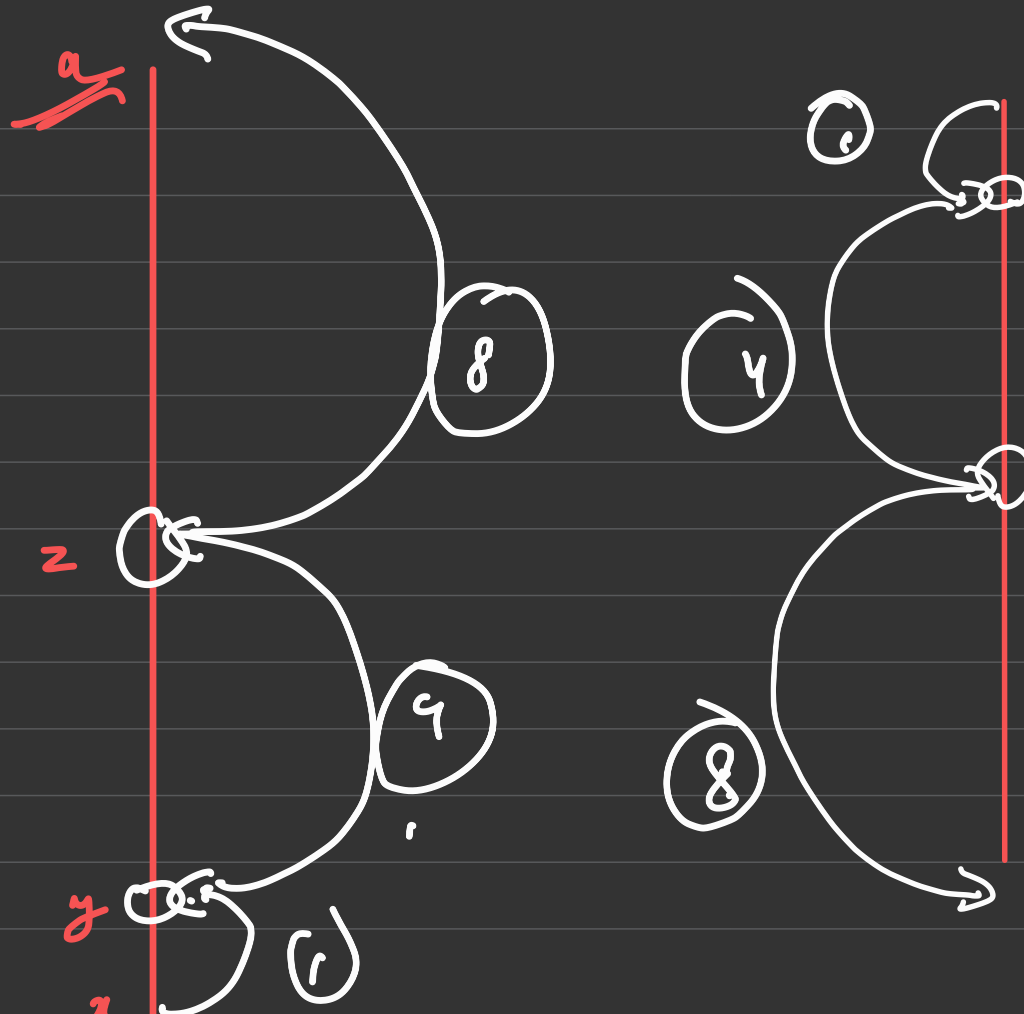
$\underbrace{2^0 + 2^2 + 2^3}$ → ladder

log

Parent array → par[x]

↓

immediate Parent of x



a
z
y
x
8
9
1
6
4
8

from every node instead of the immediate parent, we want some $2^{d\text{th}}$ parent.

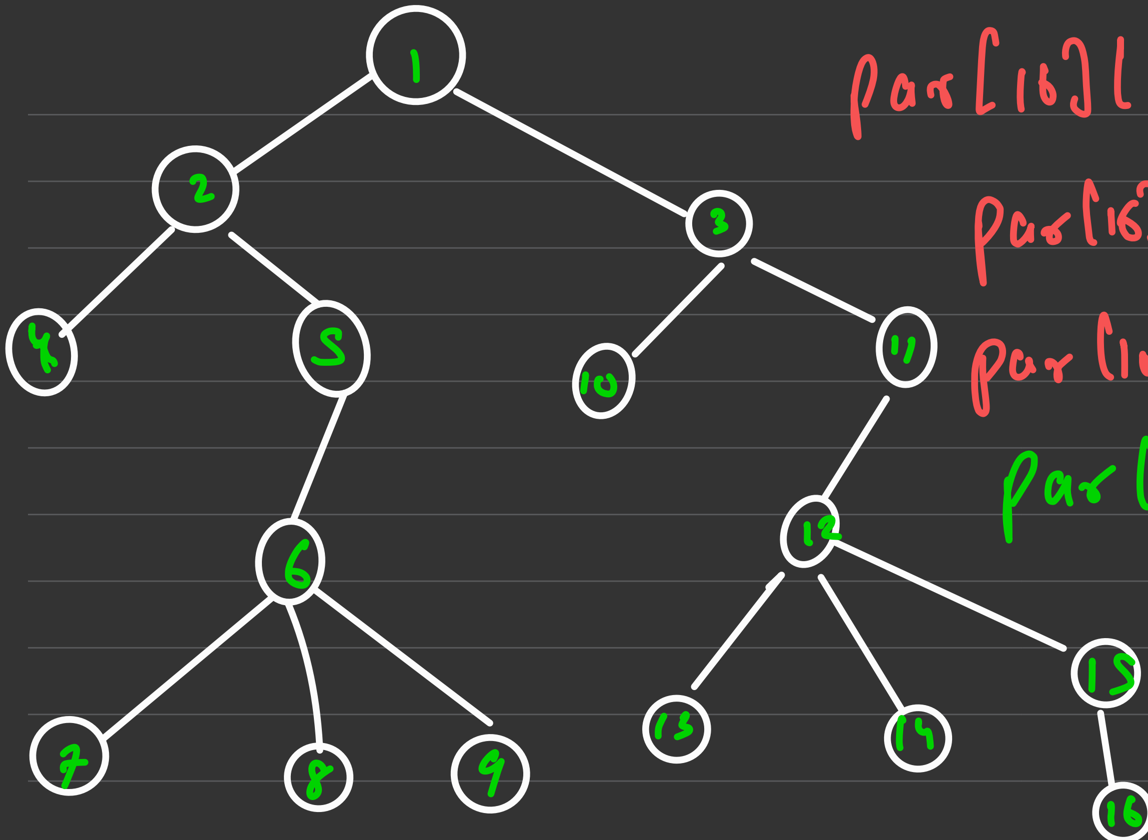
$f(\underbrace{x, 2^{d}}) \longrightarrow$ returns $2^{d\text{th}}$ parent of x

sparse matrix

We need sparse table of parent.

$par[i][j] \rightarrow$ for the i^{th} node it returns $2^{j\,th}$ parent

$f(i, 2^j)$

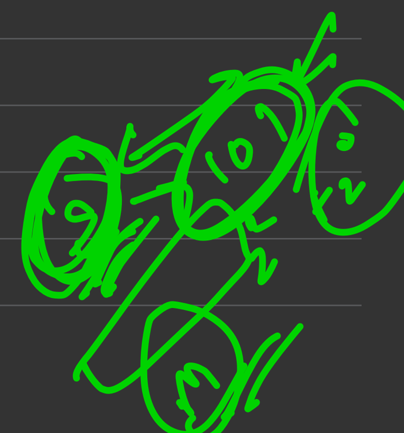


$par[16][0] \rightarrow 16, 2^0 \rightarrow 15$

$par[16][1] \rightarrow 16, 2^1 \rightarrow 12$

$par[16][2] \rightarrow 16, 2^2 \rightarrow 3$

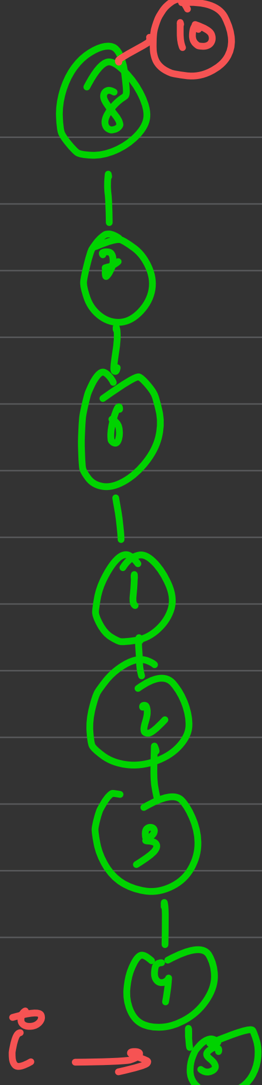
$par[16][3] \rightarrow 16, 2^3 \rightarrow 0$



matrix [i] [j]

$0 \leq i \leq n$ $\qquad$ $0 \leq j \leq \log n + 1$

$O(n \log n)$



$par[i][0] \rightarrow \underline{\underline{4}}$

$par[i][1] \rightarrow par[4][0]$

$par[i][2]$

$\rightarrow \underline{\underline{par[3][1]}}$

$par[i][3] \rightarrow par[par[i][2]][2]$

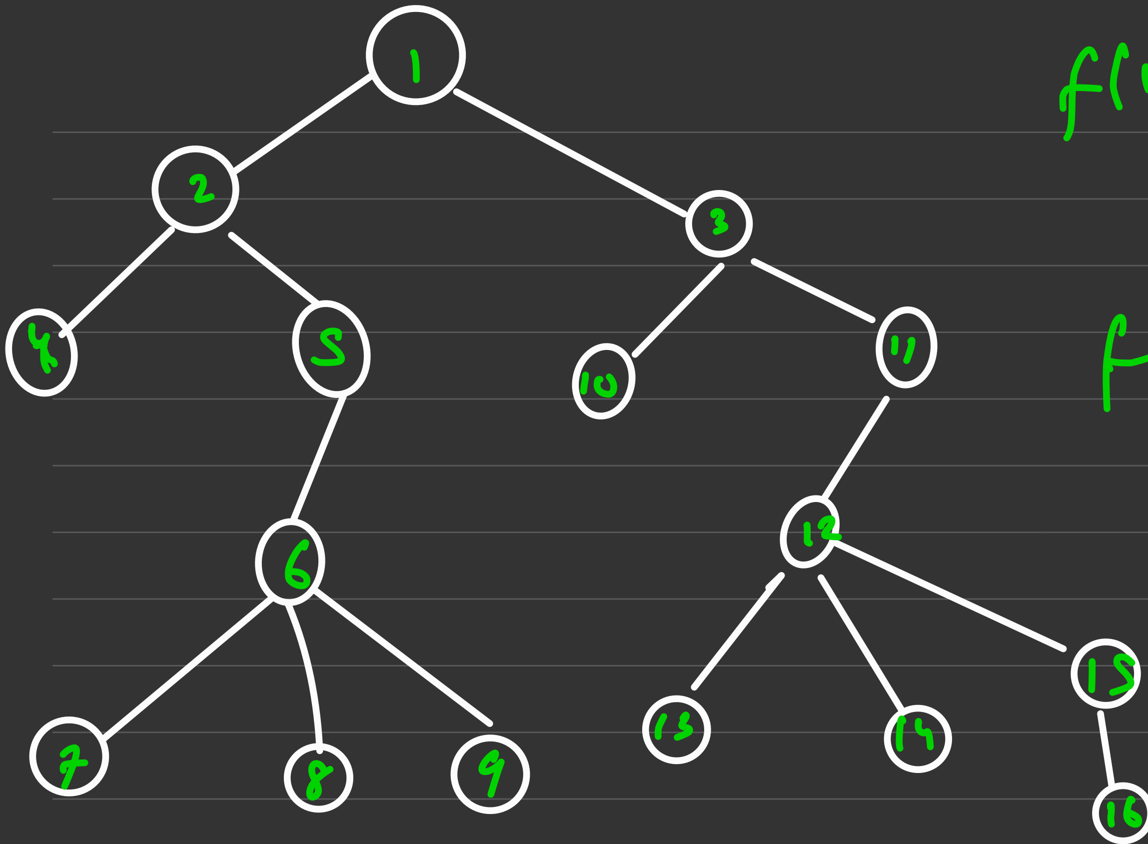
$par[i][j] \rightarrow par[\underline{\underline{par[i][j-1]][j-1]}}$

dp

(1) Bring both pointers to the same level

↳ $O(\log n \text{ steps})$

↳ $\underbrace{diff}$ = depth(x) - depth(y)



$f(13, 2^3) \quad f(14, 2^3)$

0

$f(13, 2^2) \quad f(14, 2^2)$

1

$f(13, 2^1) \quad f(14, 2^1)$

$f(13, 2^0) \quad f(14, 2^0)$

$12 \leftarrow$

$\alpha \rightarrow \underline{\log n}$ $\qquad$ $\log 10^5 \rightarrow \underline{\underline{22}}$

$f(11, 2^4)\ f(13, 2^4)$

$\downarrow$

0

$f(11, 2^3)\ f(13, 2^3)$

$\downarrow$

0

$f(11, 2^2)\ f(13, 2^2)$

$\downarrow \qquad \downarrow$

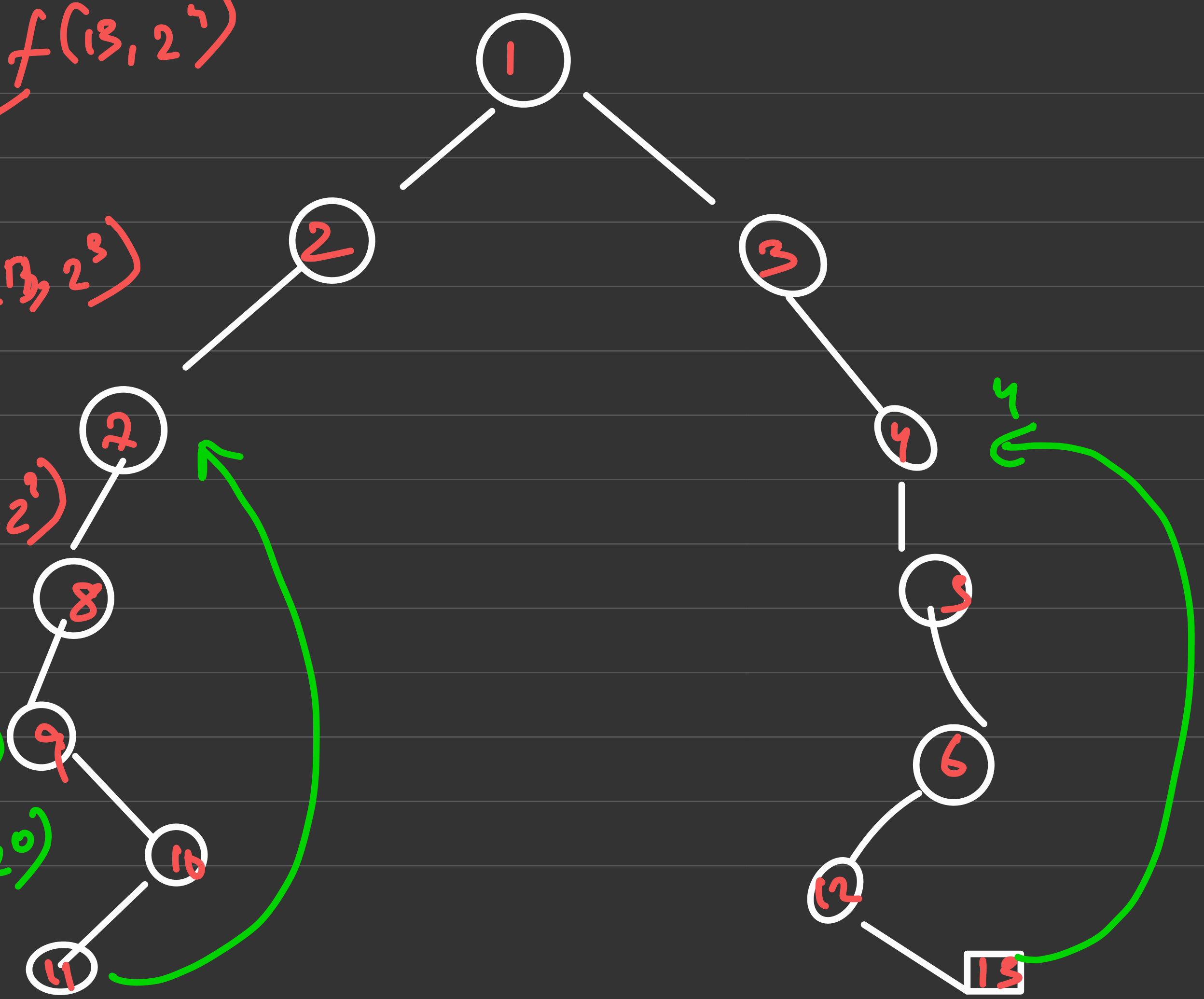
$7 \qquad 4$

$f(7, 2^1)\ f(4, 2^1)$

$f(7, 2^0)\ f(4, 2^0)$

$\downarrow \qquad \downarrow$

$2 \qquad 3$



Qn K^{th} ancestor

$K - 2^x + 2^y$ ———

Q-> Weighted tree → edges weight

x, y