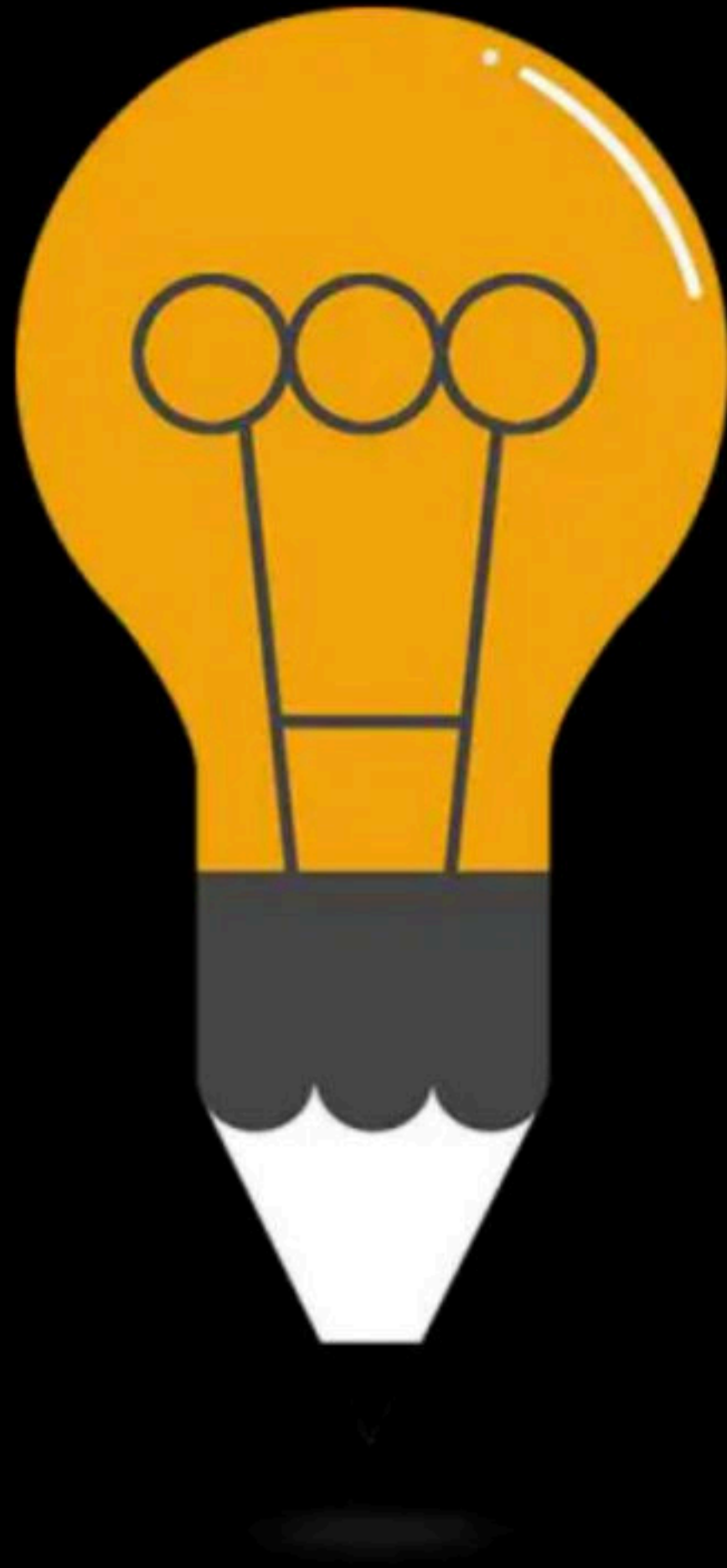


Doubt Clearing Session

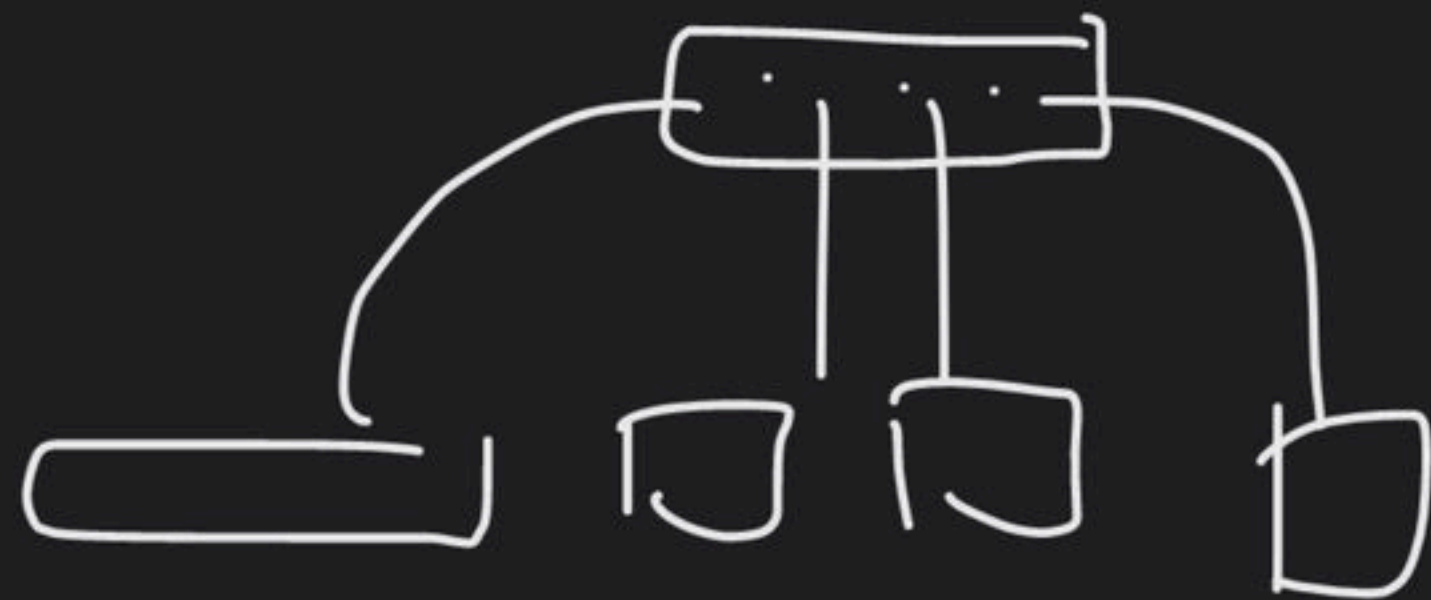
Complete Course on Database Management System



DBMS

Indexing: B+Tree

By: Vishvadeep Gothi



⋮



B+ Tree

Internal Node

- Keys
- Tree Pointer

Leaf Node

- Keys
- Record Pointer

B+ Tree

Order for Internal nodes (not root)

- Every internal node other than root should have atleast $\left\lceil \frac{p}{2} - 1 \right\rceil$ keys or $\left\lceil \frac{p}{2} \right\rceil$ pointers
- Every internal node can have maximum $p - 1$ keys or p pointers
- Every leaf node should have atleast $\left\lceil \frac{q}{2} \right\rceil$ keys and max q keys
- All leaves are on same level
- The leaves are connected using linked list (singly or Doubly)

B+Tree

What if order-4 B+ tree given in question?

Insertion in B+ Tree

Internal nodes order-3

Leaf nodes order-2

Insert 1, 2, 3, 4, 5

Using Node Splitting

Insertion in B+ Tree

Order-5

10, 14, 1, 18, 27, 39, 49, 12, 19, 21, 70, 64, 89, 75

Insertion in B+ Tree

Using Key Distribution

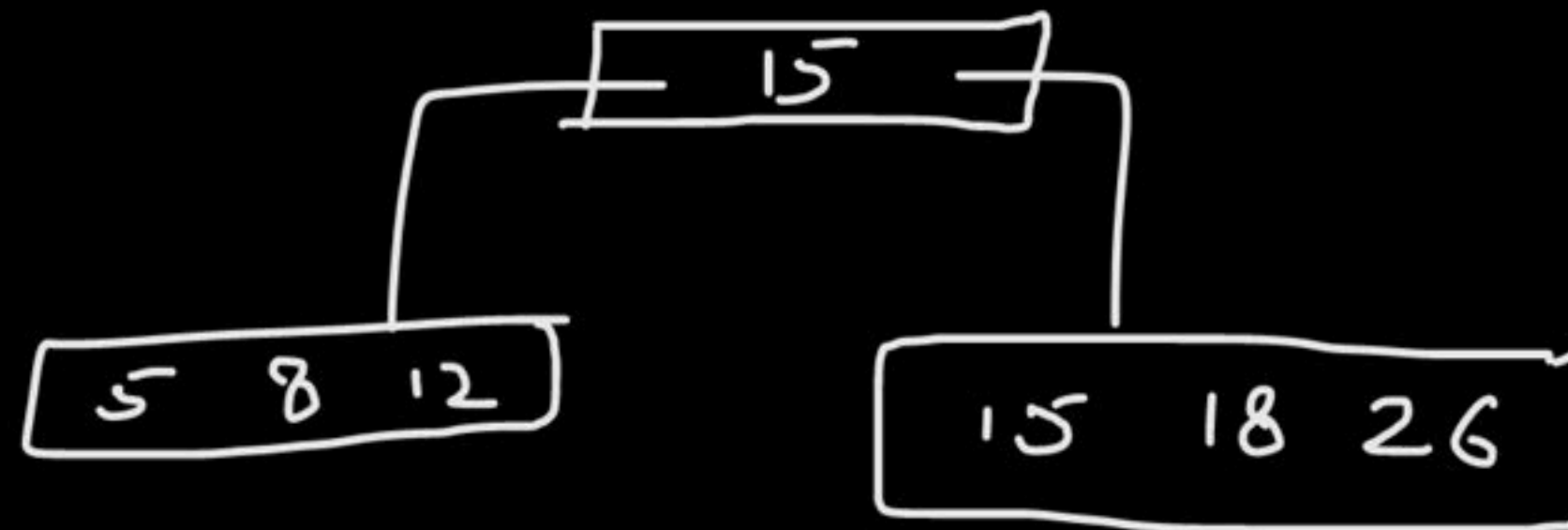
Deletion in B+ Tree

1. After deletion if no violation of min keys, then no changes in tree
2. If violation of min keys, then borrow key from sibling. *update anchor accordingly.*
3. If borrow from sibling can't be possible then merge the node with sibling. Either update the anchor key or pull down the anchor key from parent.

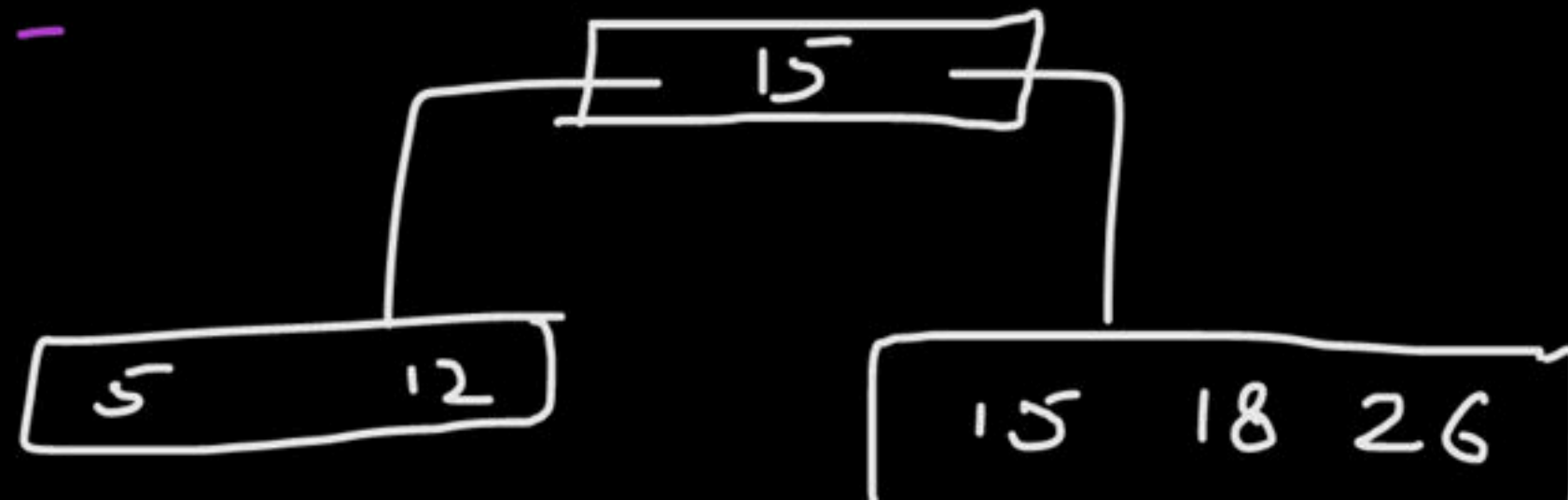
B⁺ tree order $\Rightarrow 5$

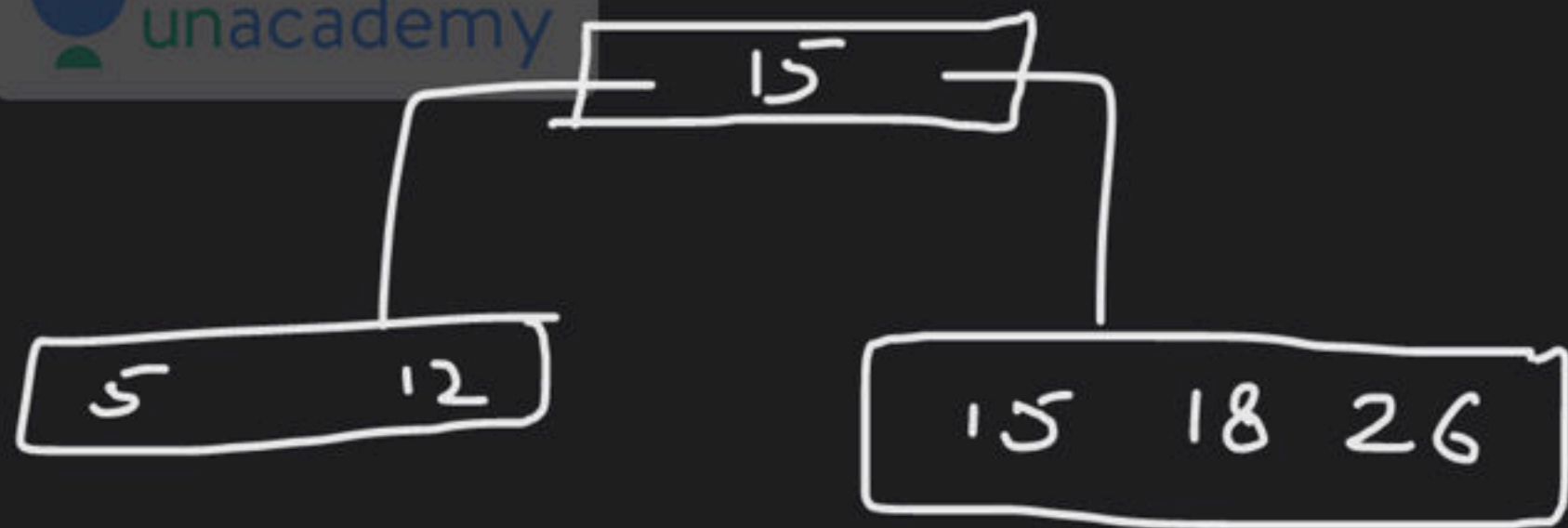
min keys $\Rightarrow 2$

max keys $\Rightarrow 4$

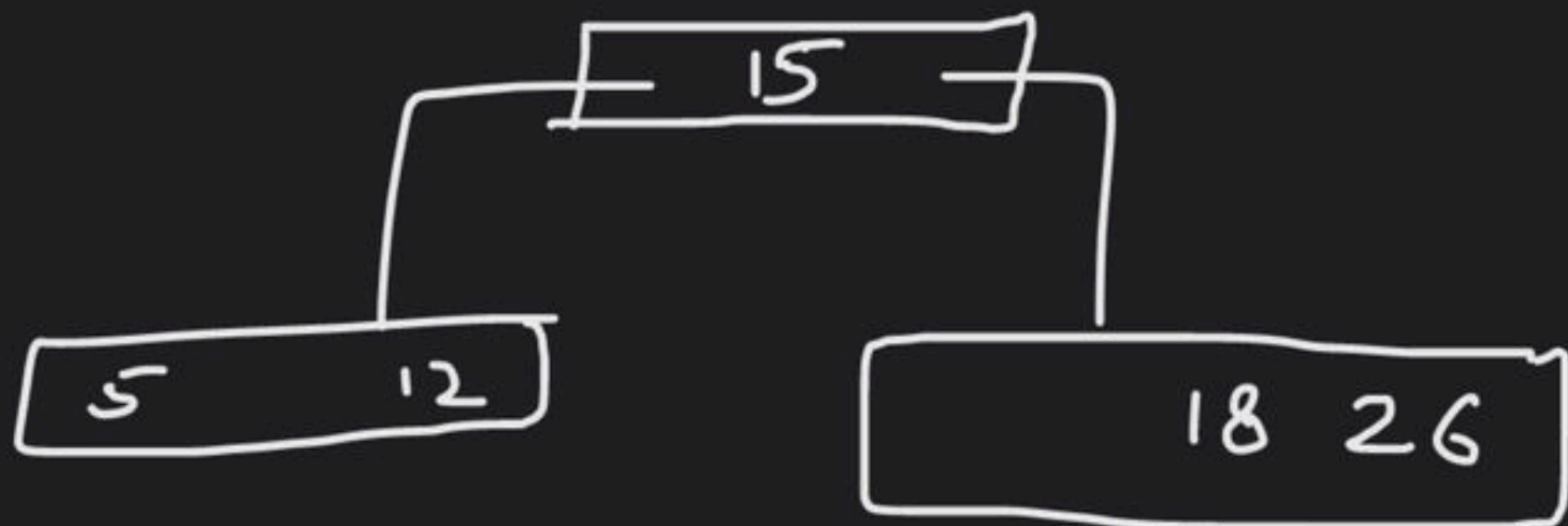


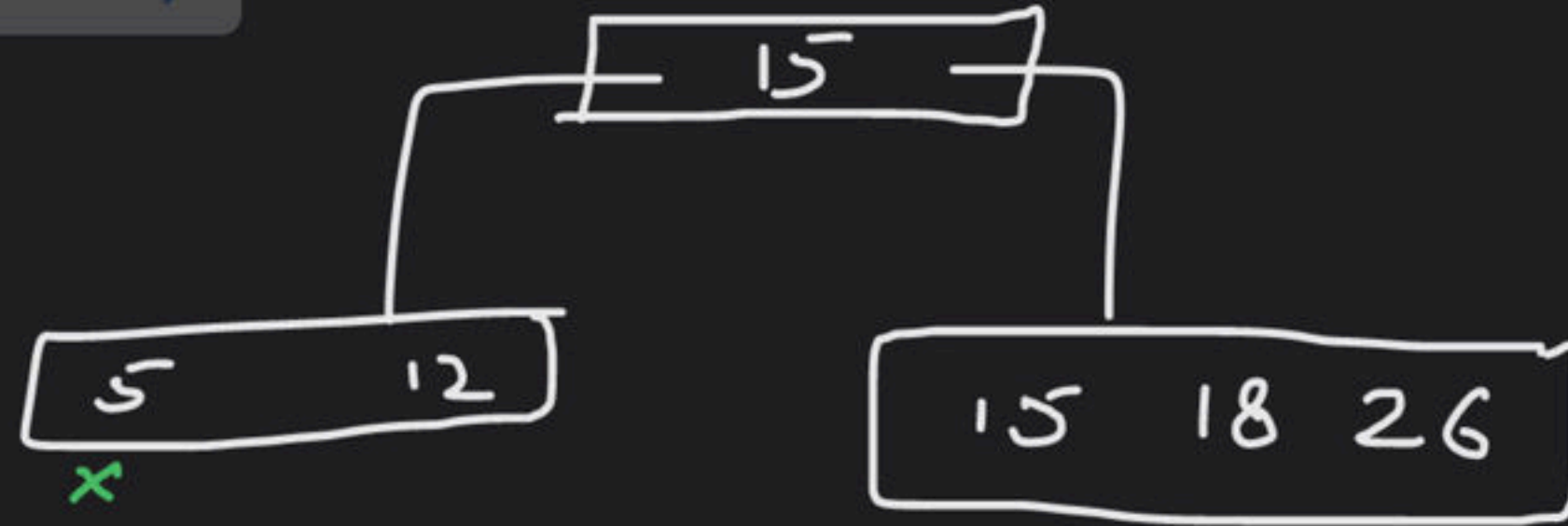
Delete 8 :-





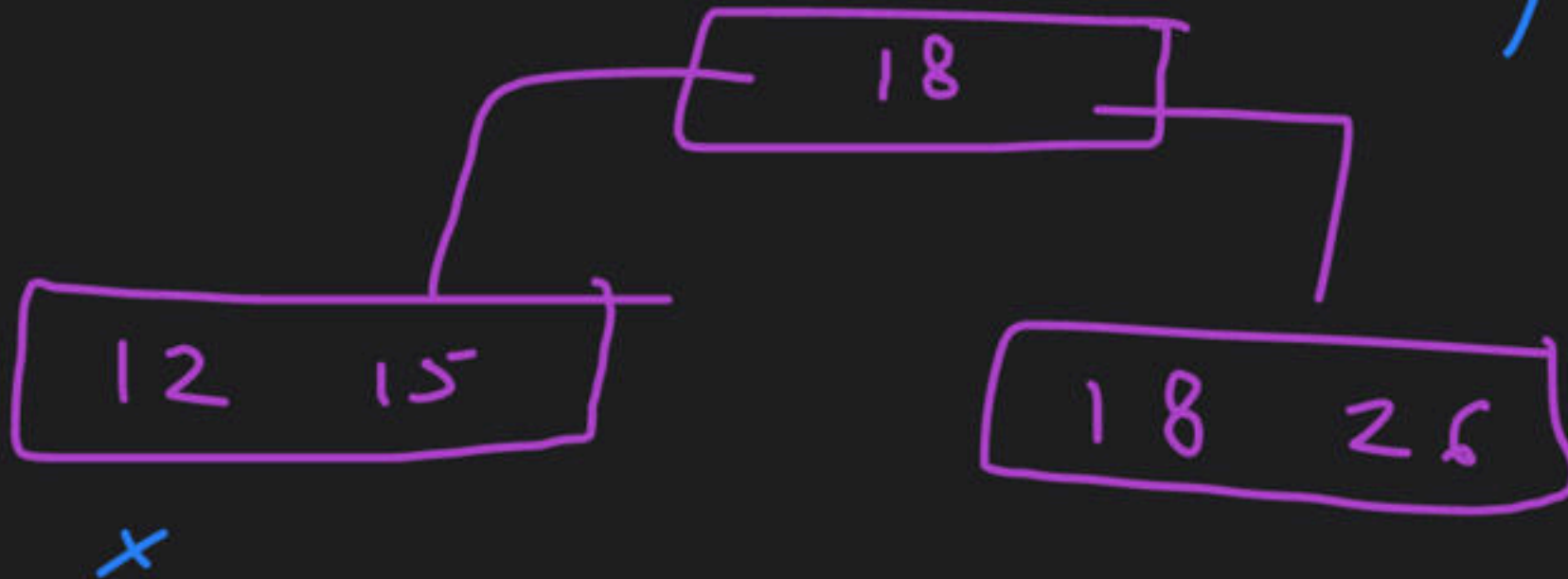
Delete 15:-





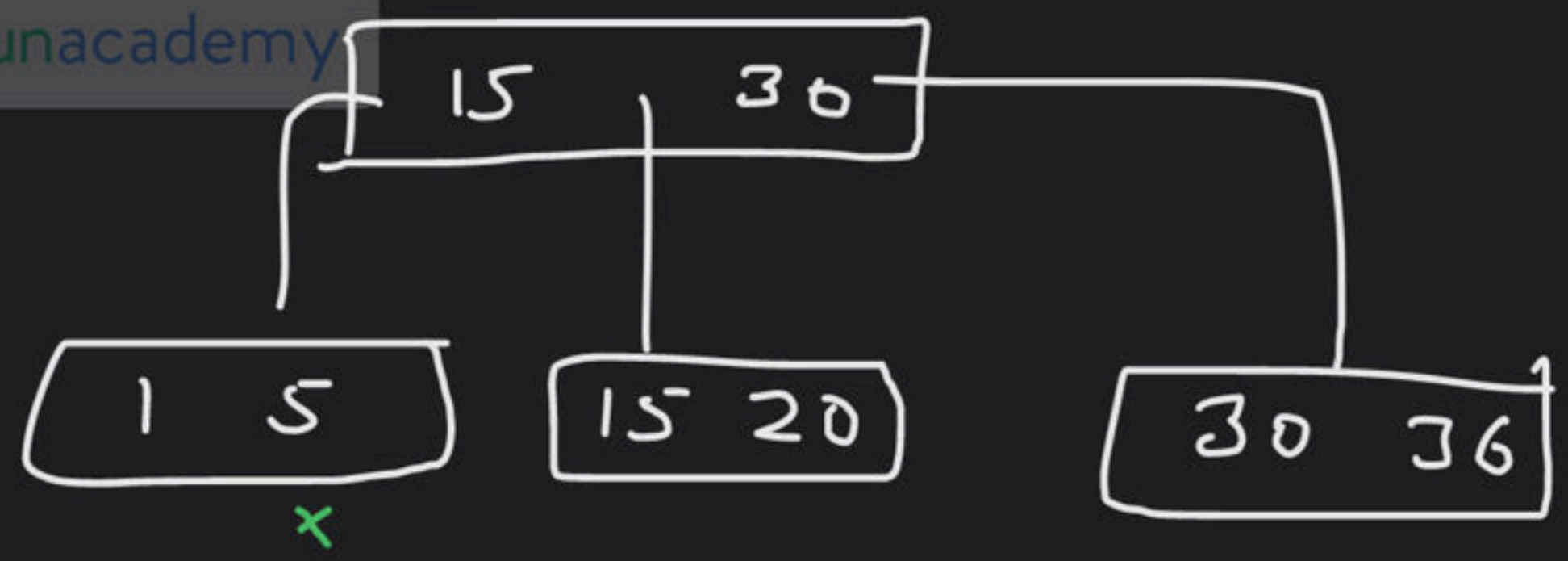
Delete 5 :-

borrow 15 from neighbour

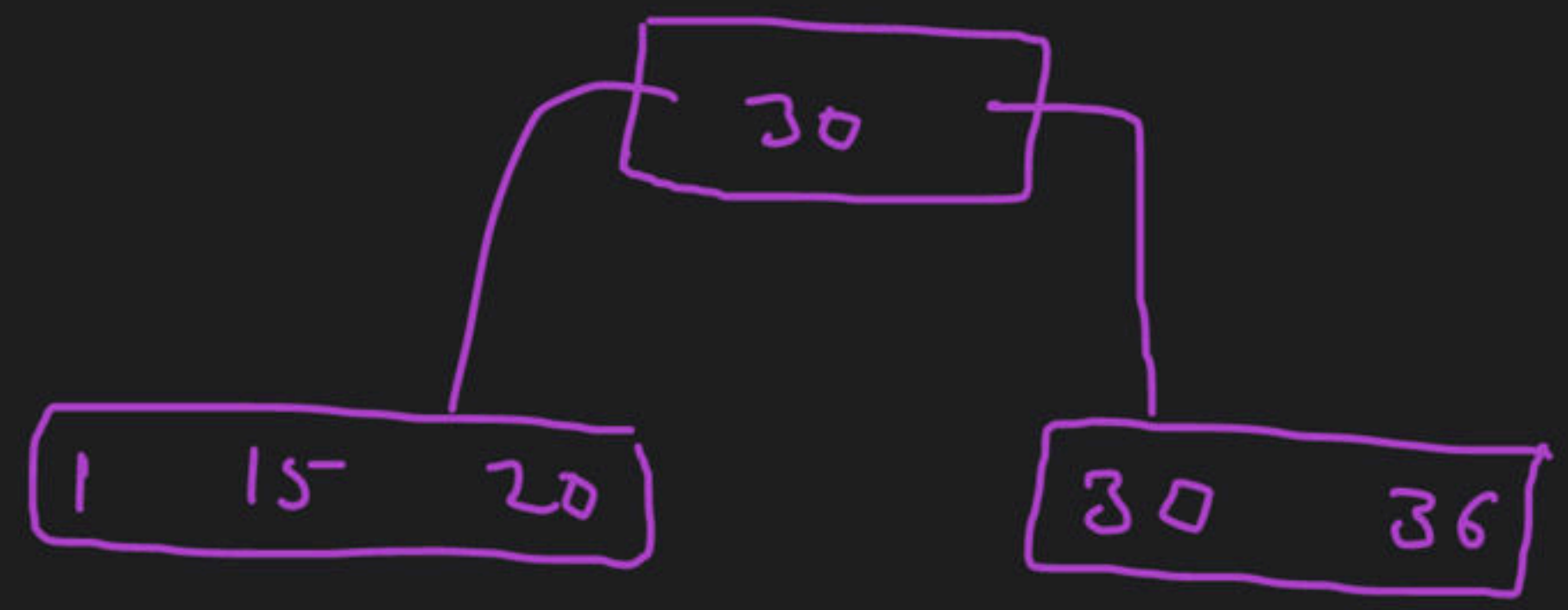


→ Delete 12 :-
Merge

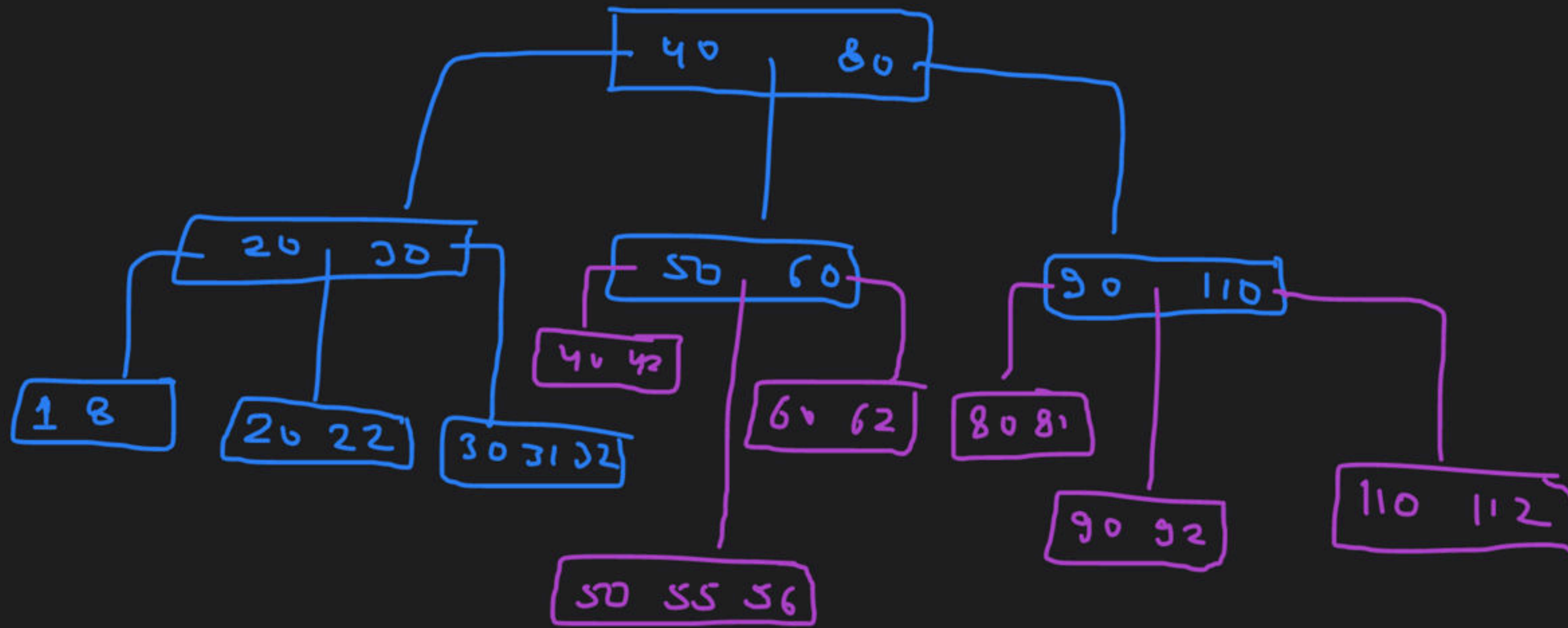




Delete 5:-

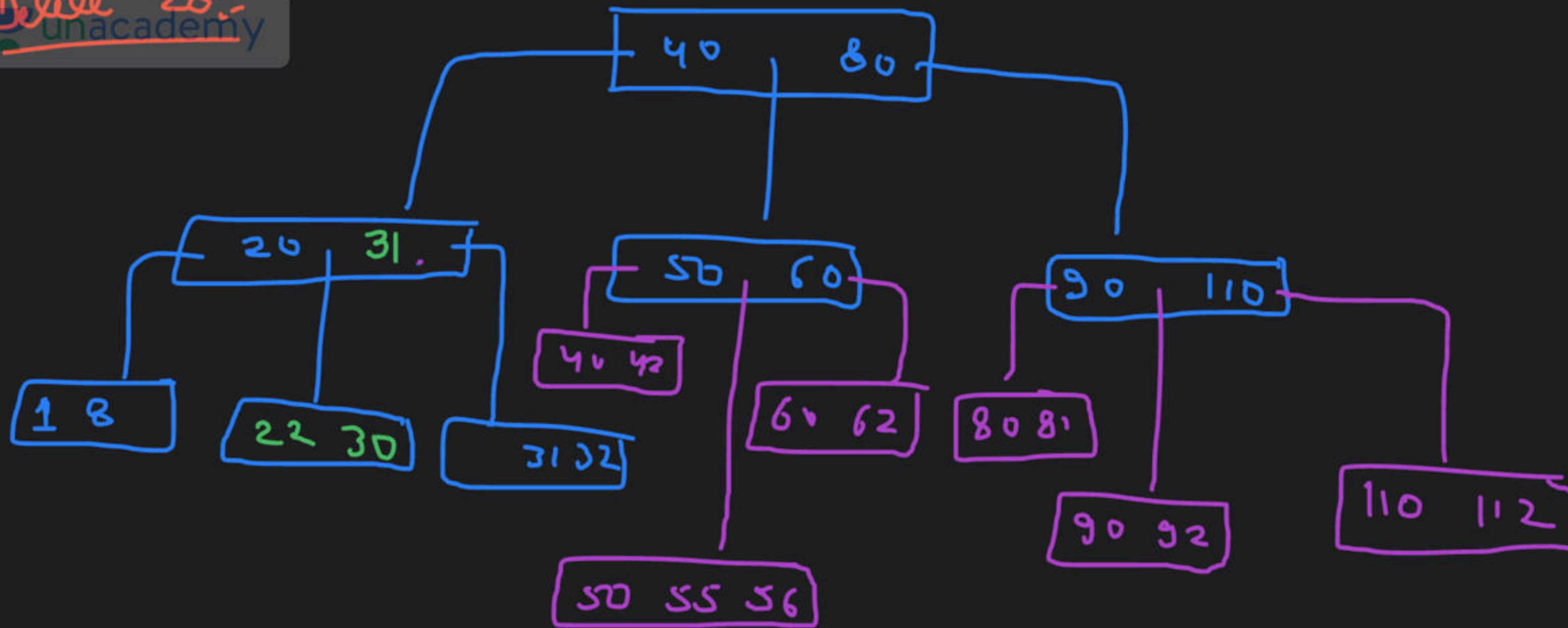


Ques) B⁺ tree with order 5

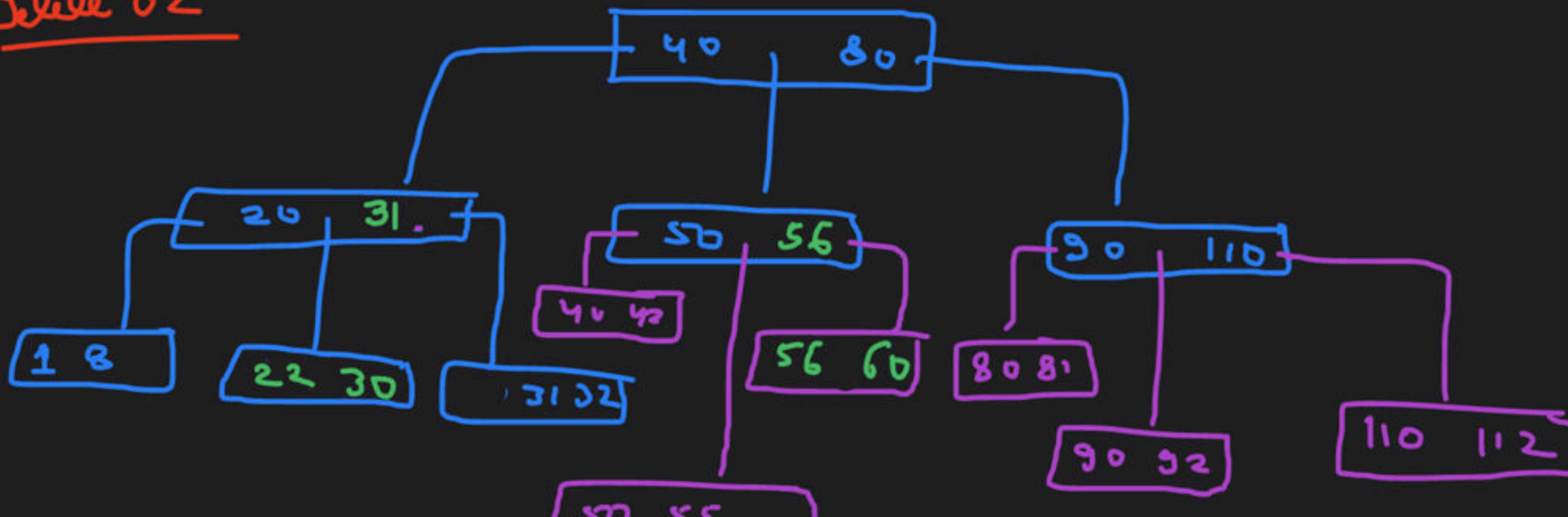


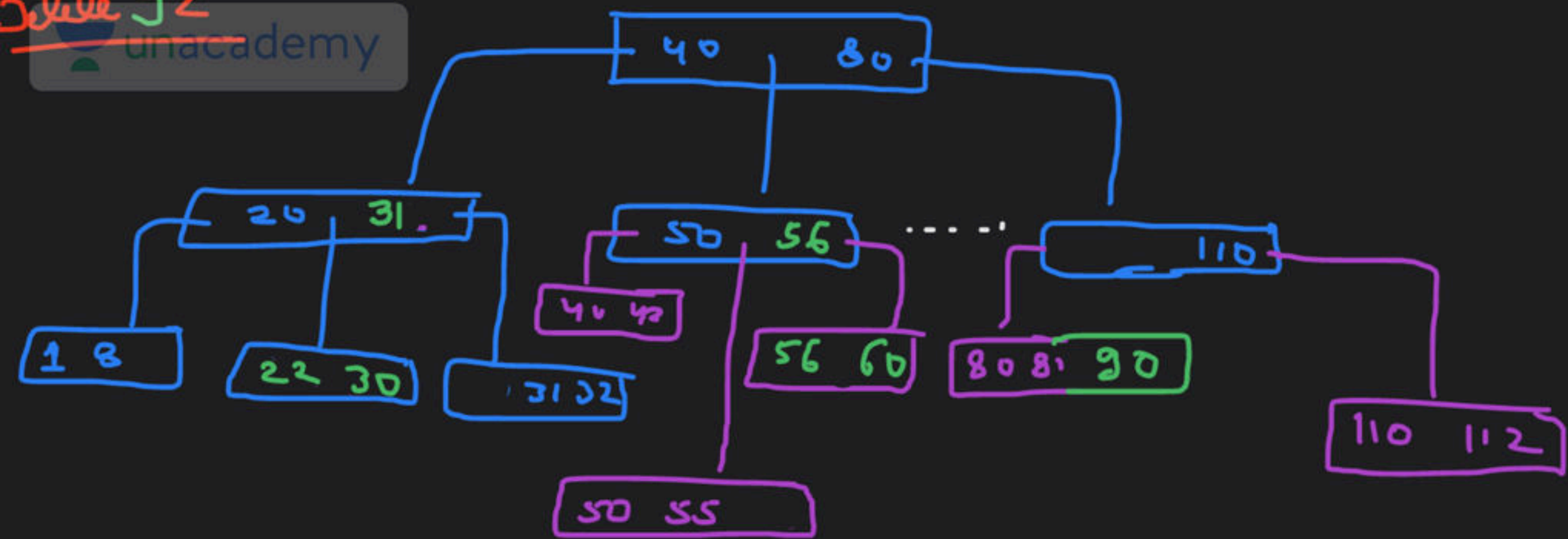
Delete 20, 42, 92, 112, 80, 60, 110, 22, 90

Delete 20:-

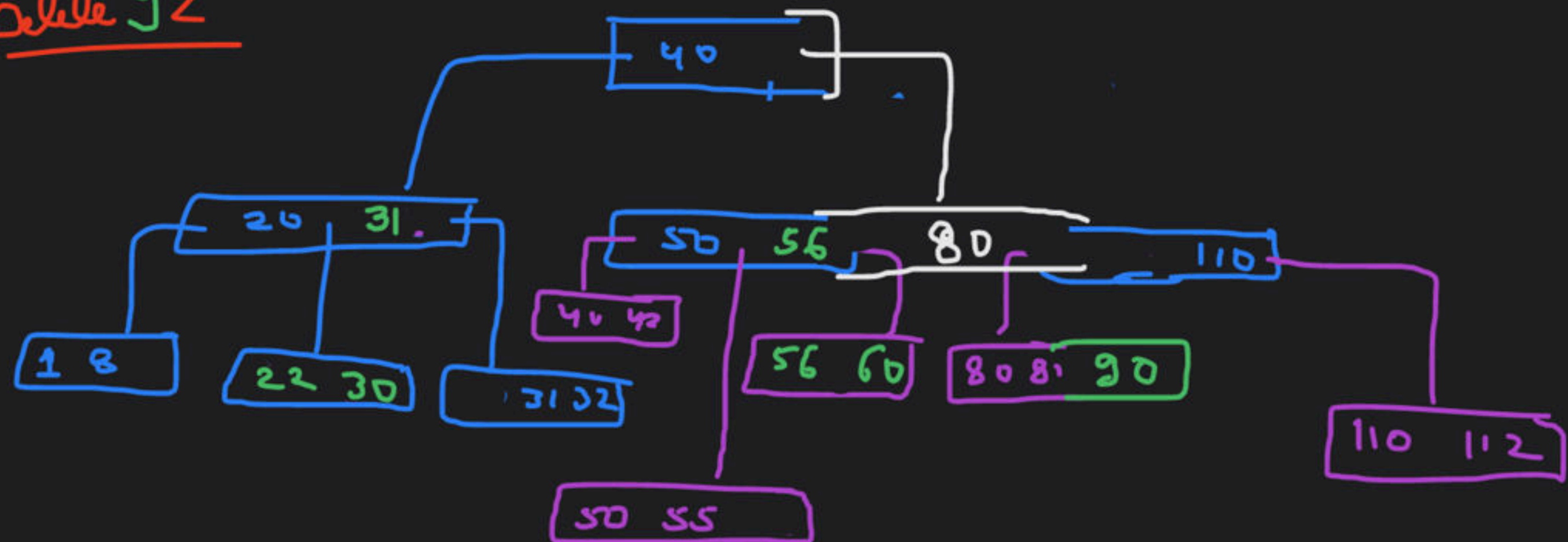


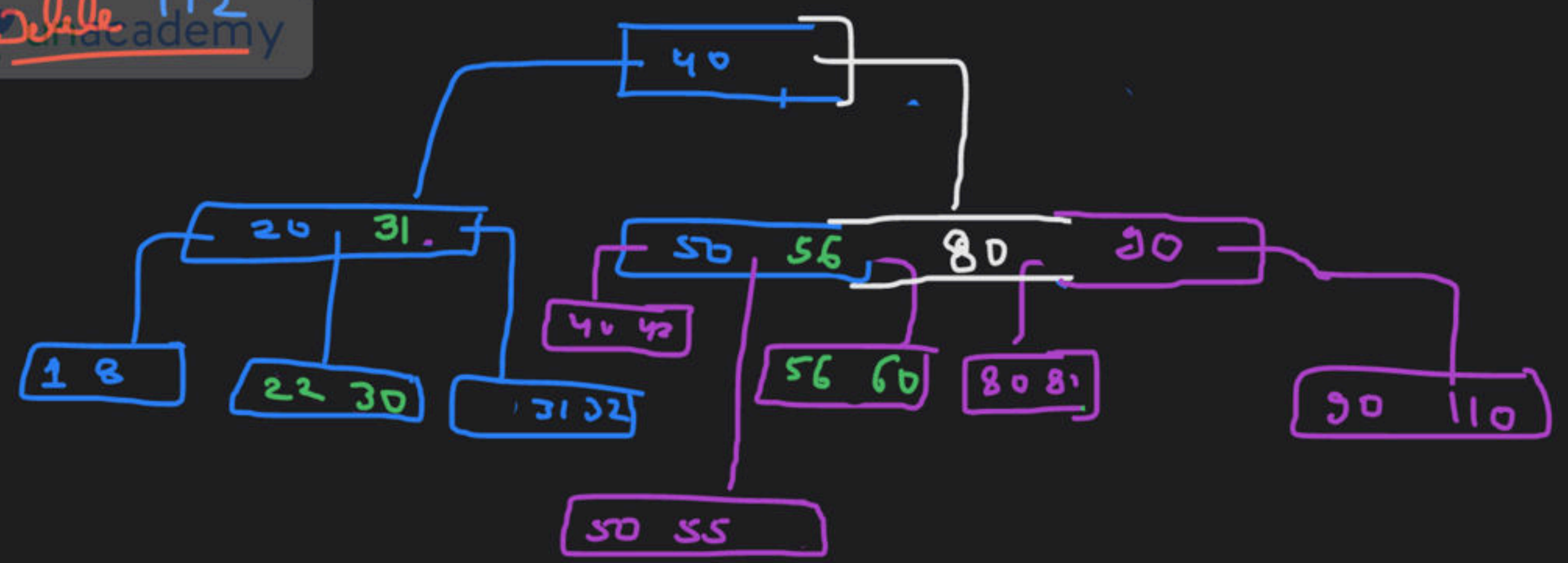
Delete 62



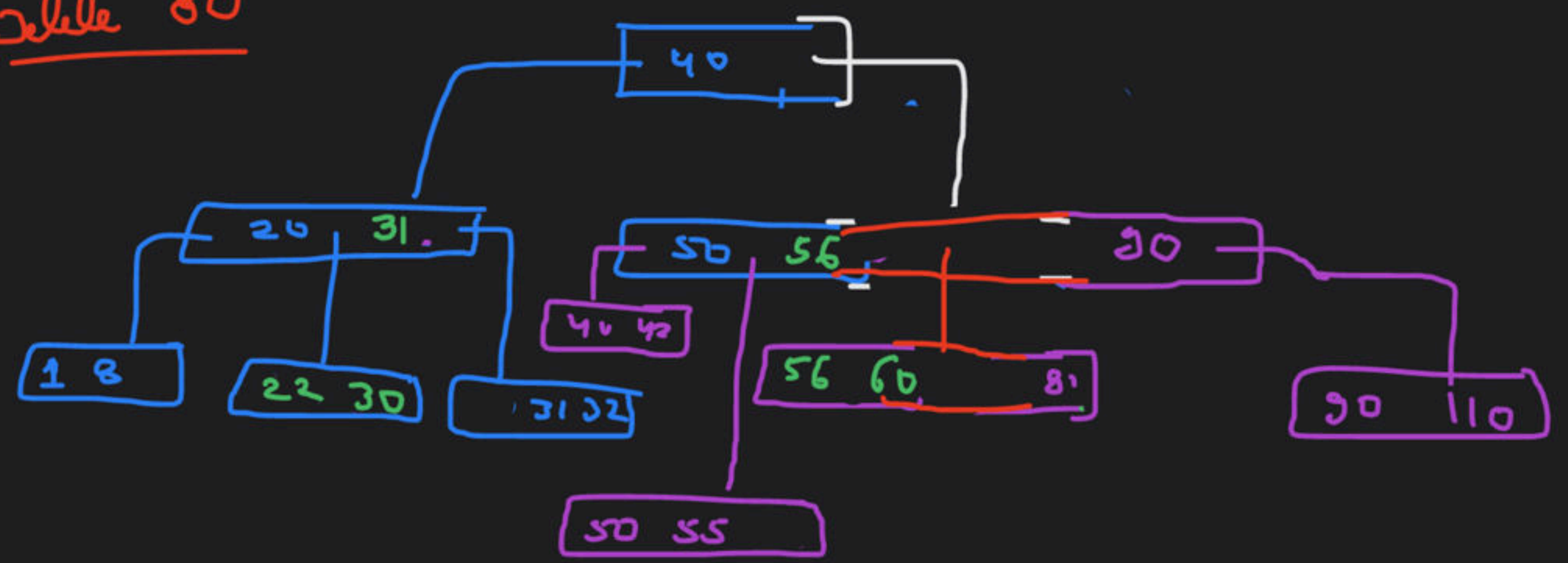


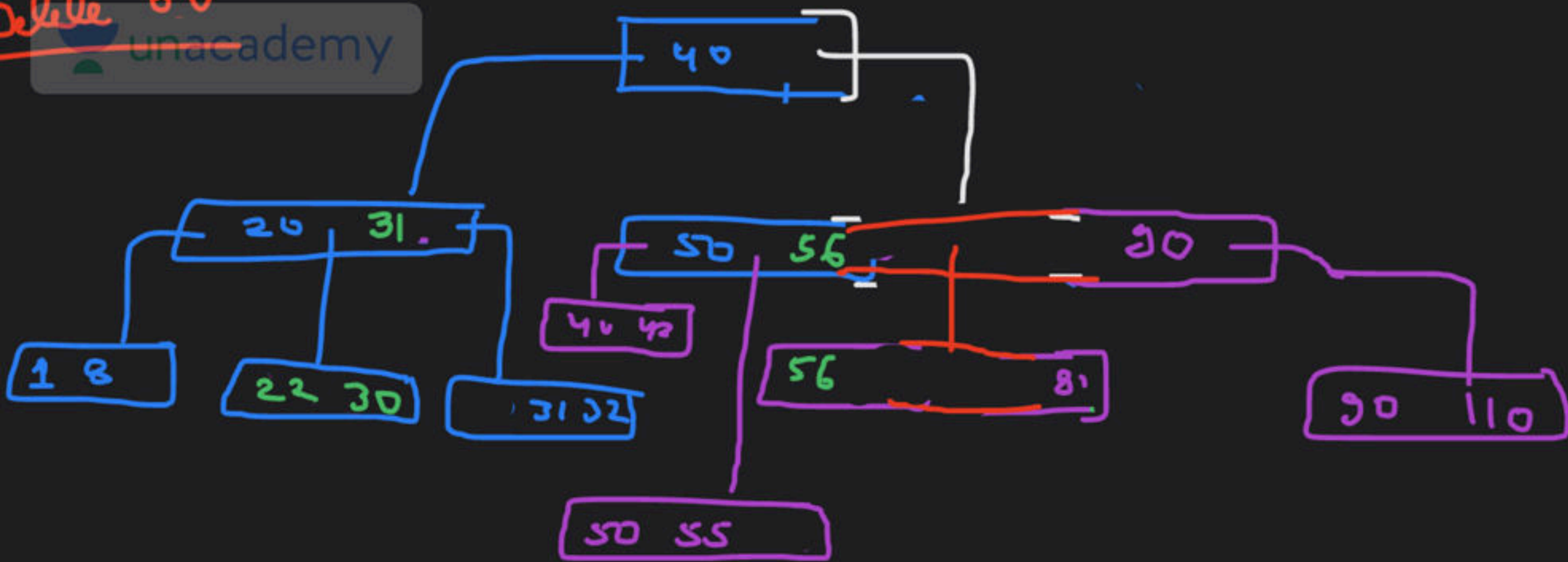
delete 92



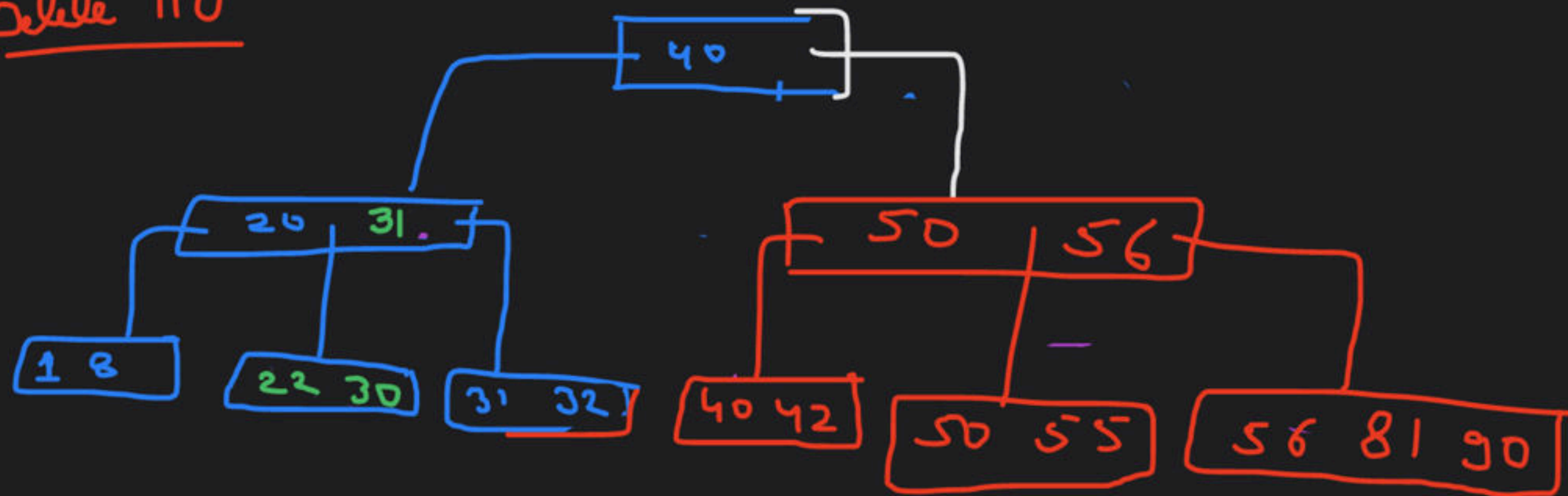


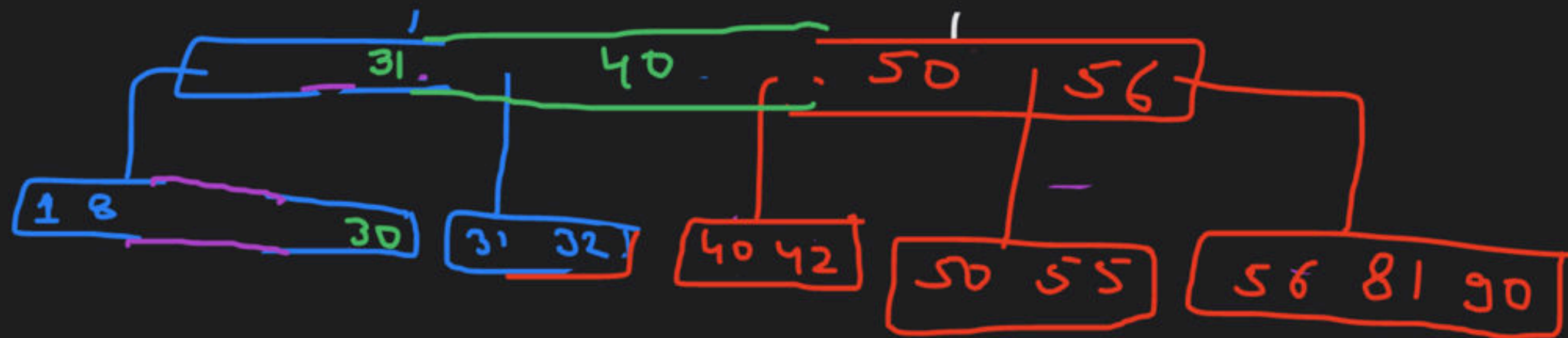
delete 80



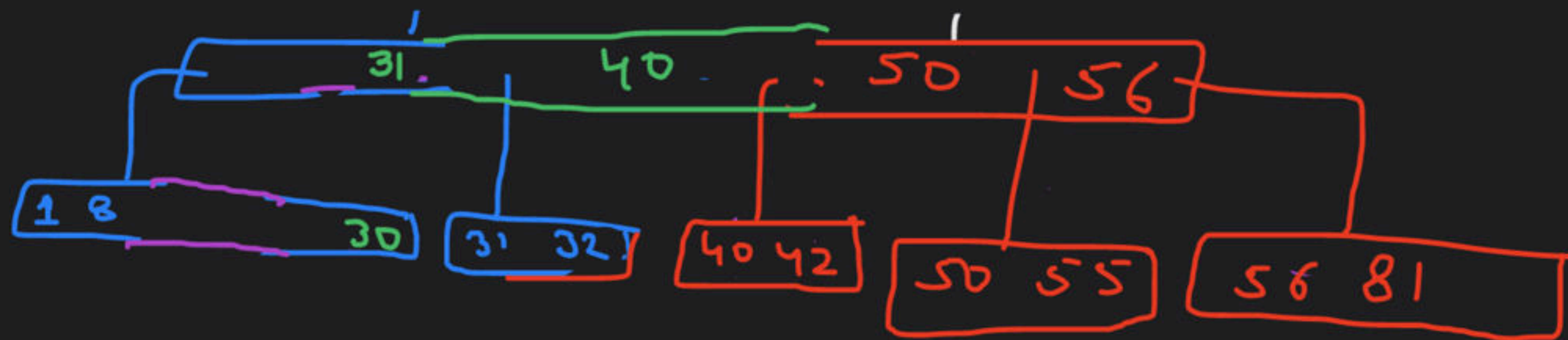


delete 110



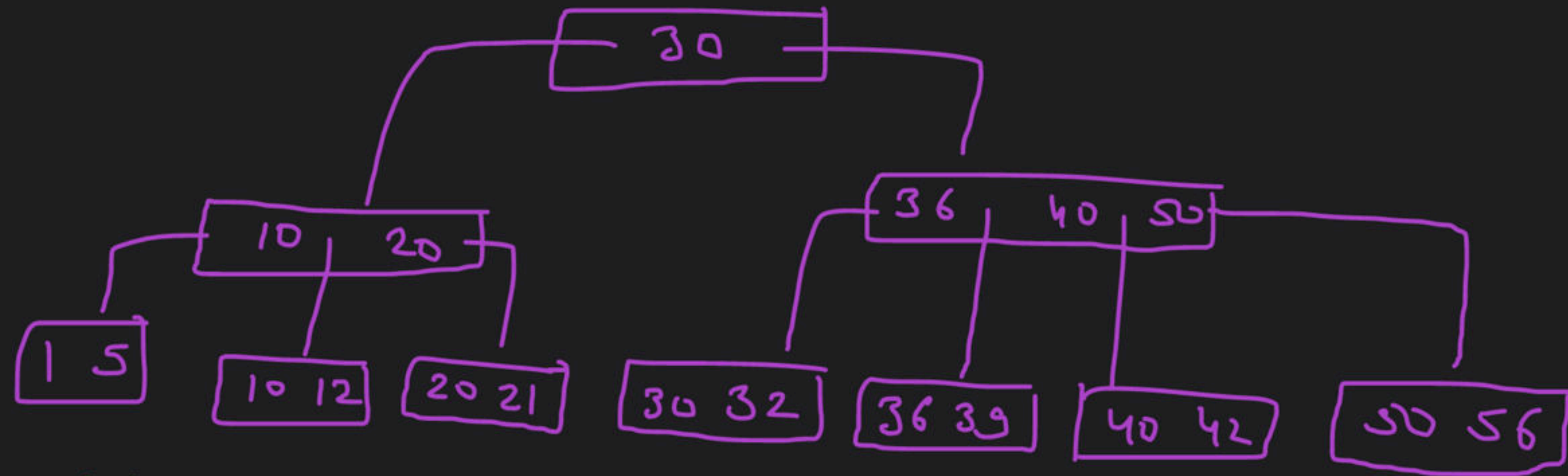


delete 90

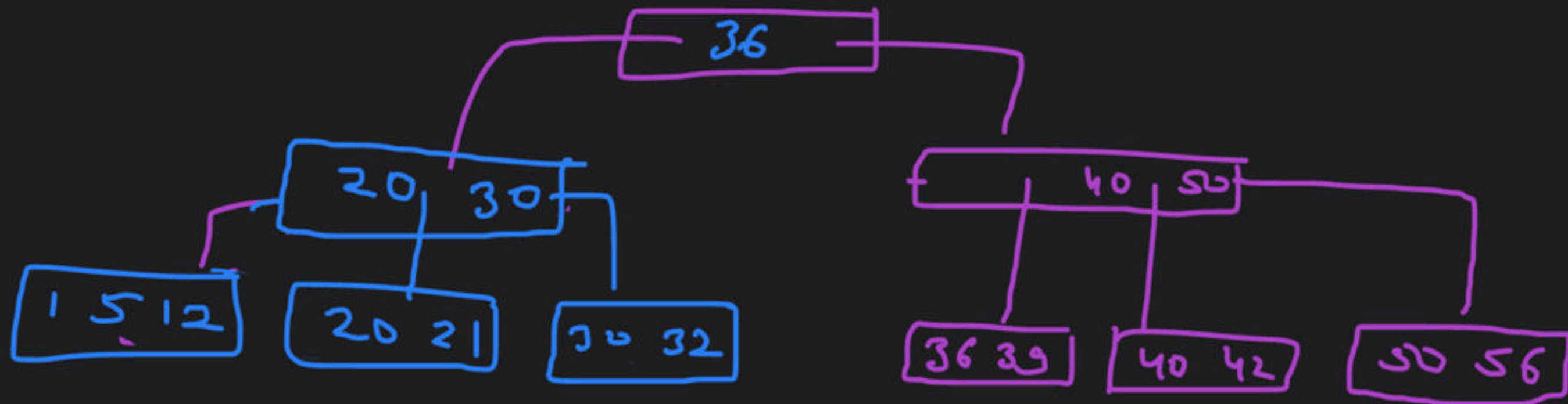


final tree

Ques) B⁺ tree of order 5



Delete 10 :-



Question GATE-2010

Consider a B^+ -tree in which the maximum number of keys in a node is 5. What is the minimum number of keys in any non-root node?

A. 1

B. 2

C. 3

D. 4

Order $\Rightarrow 6$

max keys $\Rightarrow 6 - 1 = 5$

$$\text{min keys} = \left\lceil \sqrt{\frac{6}{2}} - 1 \right\rceil = 2$$

B⁺ tree :-

Internal nodes

\Rightarrow keys & tree pointers

for order- p

max

$p-1$ keys,

p tree pointers
(block)

Leaf nodes

\Rightarrow

keys & record pointers, link

max

$p-1$ keys

$p-1$ record pointers

Question GATE-2015

Ans = 50

Consider a B+ tree in which the search key is 12 byte long, block size is 1024 byte, recorder pointer is 10 byte long and the block pointer is 8 byte long. The maximum number of keys that can be accommodated in each non-leaf node of the tree is _____.

key size = 12 bytes

block size = 1024 bytes

rec. pointer = 10 bytes

block pointer = 8 bytes

assume, B⁺ tree of order-p

$$(p-1)12 + p*8 \leq 1024B$$

$$12p - 12 + 8p \leq 1024$$

$$20p \leq 1036$$

$$p \leq 51.8$$

$$\text{max no. of keys} = p-1 = 51-1 = 50 \leftarrow p_{\text{max}} = 51$$

Question GATE-2016

B+ Trees are considered BALANCED because.

- ☒ A. The lengths of the paths from the root to all leaf nodes are all equal.
- ☐ B. The lengths of the paths from the root to all leaf nodes differ from each other by at most 1.
- ☐ C. The number of children of any two non-leaf sibling nodes differ by at most 1.
- ☐ D. The number of records in any two leaf nodes differ by at most 1.

Question GATE-2017

Ans $\Rightarrow \underline{\underline{52}}$

In a B⁺ Tree, if the search-key value is 8 bytes long, the block size is 512 bytes and the pointer size is 2 B, then the maximum order of the B⁺ Tree is ____

key $\Rightarrow 8\text{B}$ block $\Rightarrow 512\text{B}$ pointer $\Rightarrow 2\text{B}$ non-leaf node

$$p \times 2 + (p-1) \times 8 \leq 512$$

$$2p + 8p - 8 \leq 512$$

$$10p \leq 520$$

$$p \leq 52$$

$$p_{\max} = 52$$

leaf node

$$2 + (p-1) \times 2 + (p-1) \times 8 \leq 512$$

↑

12

pointer

$$p \leq 52$$

$$p_{\max} = 52$$

Happy Learning.!

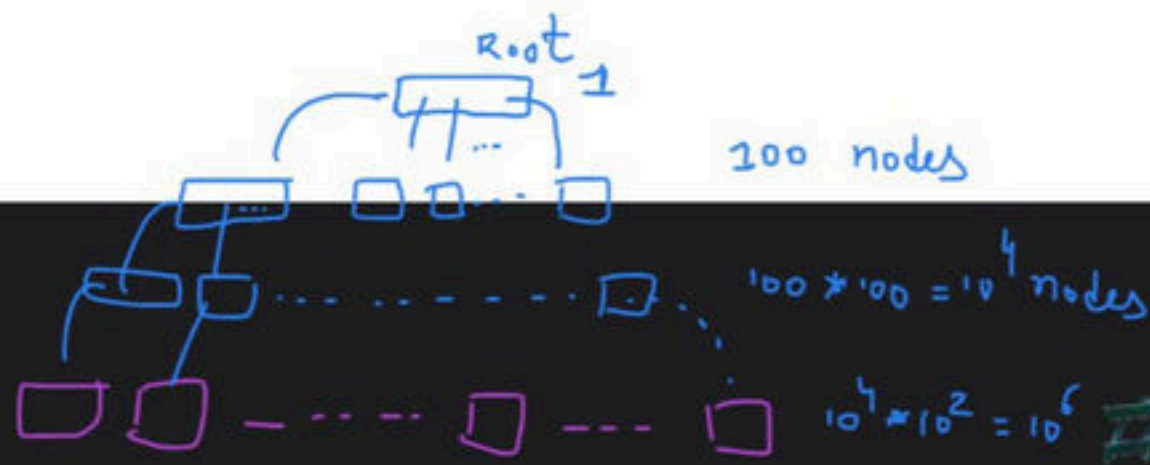


▲ 1 • Asked by Shreyas

Sir maximum of no access toh tbh hoga na jbh hum height of tree + leaf nodes ko sequentially access krna pdhe pr yaha toh bss height kiya

in a file which contains 1 million records and the order of the tree is 100, then what is the maximum number of nodes to be accessed if B+ tree index is used?

- a. 5
- ☒ b. 4
- c. 3
- d. 10



▲ 1 • Asked by Aritra

Please help me with this doubt

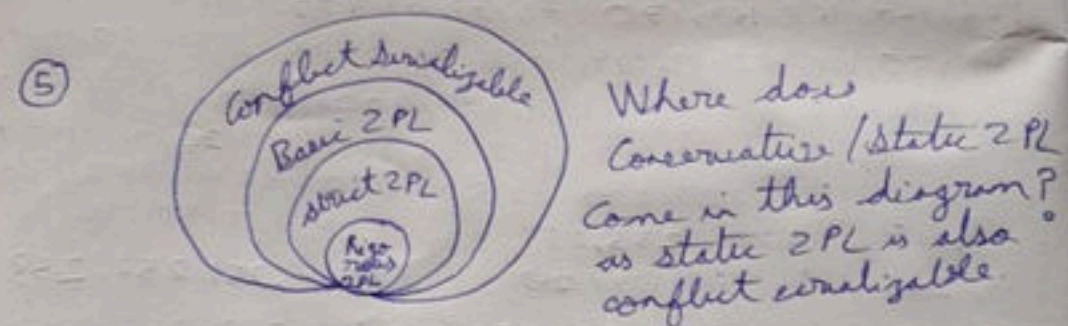
Doubts (VDSir)

① I know TRC and DRC but what is safe TRC & safe DRC. Please explain sir. ✗

② Sir share Test required? ✗

③ Sir please explain blind write & its relation with view serializability

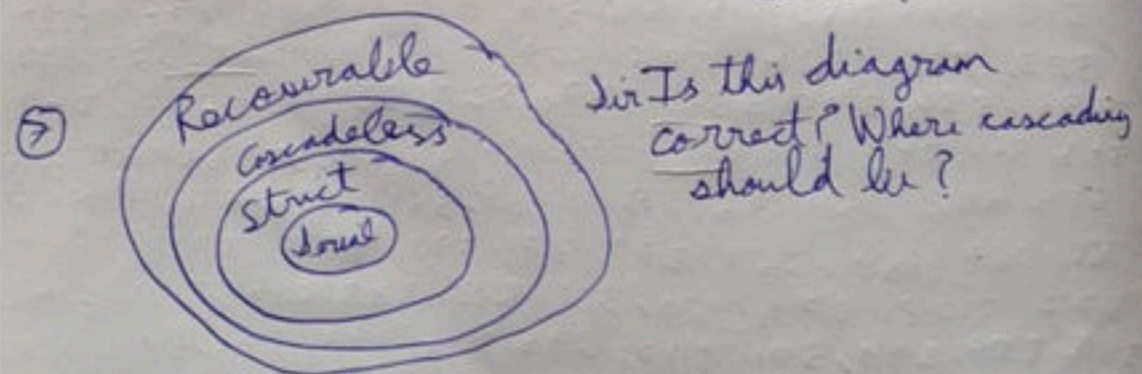
④ Sir what is Transaction Recovery Manager & Checkpoint protocol. I saw some PYQs. ✗



⑥ Sir is this a rule?

$$\begin{matrix} A \rightarrow C \\ B \rightarrow C \end{matrix} \Rightarrow AB \rightarrow C$$

Is the reverse also true?



⑧ PYQs doubts in next page

⑨ In indexing question by default is unspanned?