

Degree represents the lower bound

on the no. of children i.e. the minimum number possible.

whereas the order represents the upper bound on the no. of children i.e. the maximum no. possible.

Note:

B tree node can contain more than one key values whereas BST node contains only one.

There are lower bound & upper bounds on the number of keys a node can contain.

Degree

Every node other than root must have at least $t-1$ keys. Every internal node other than root has at least t children.

Every node contains at most $2t-1$ keys. internal node can have at most $2t$ children. Node is full for $2t-1$ keys.

Order

All internal nodes except the root have at most m nonempty children and at least

$\lceil m/2 \rceil$ non empty children

B-tree of order 5 (m)

$\lceil \frac{m}{2} \rceil - \text{ceil value}$

$$m = 5$$

$$\text{max no. of keys} = 4 (m-1)$$

$$\text{min no. of keys} = \left(\lceil \frac{5}{2} \rceil - 1 \right) = 3 - 1 = 2$$

$$\text{max. no of children} = 5 \quad m$$

$$\text{min no. of children} = \lceil \frac{5}{2} \rceil = 3 \quad \lceil \frac{m}{2} \rceil$$

B-tree of degree 5 (~~m~~) (t)

$$\text{max no. of keys} = \frac{2t-1}{2} (5-1)$$

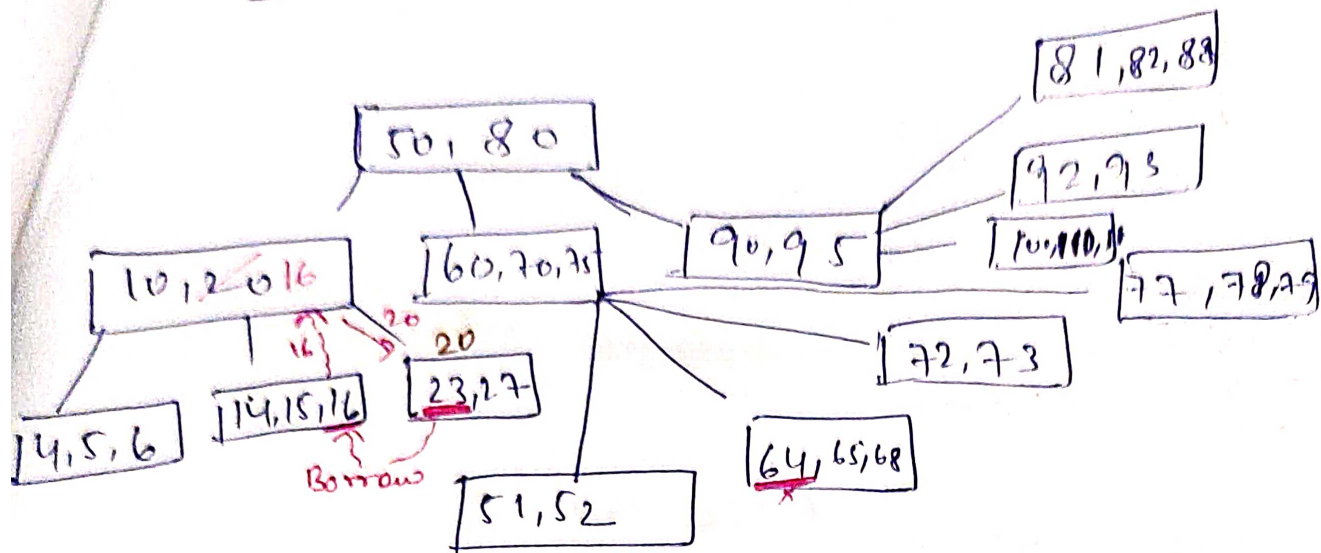
$$\text{min no. of keys} = \frac{t-1}{2} (5-1)$$

with L and U parameters ; with lower upper bound on no. of children inner node is supposed to have.

$$L = 3, U = 6$$

2-5 keys per node. (both degree or n)

Deletion in B-tree



Order $(m) = 5$

min child $= \lceil m/2 \rceil = 3$

max child $= 5$

min keys $= \lceil m/2 \rceil - 1 = 2$

max keys $= m - 1 = 4$

1) if target key is in leaf node

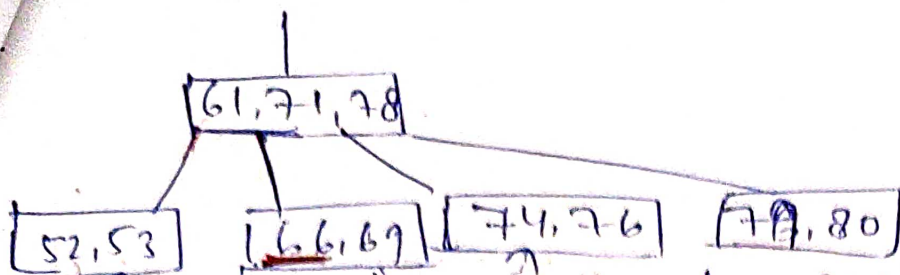
1. leaf contains more than min no. of keys.

2. leaf contain min no. of keys.

delete, ~~64~~ ✓

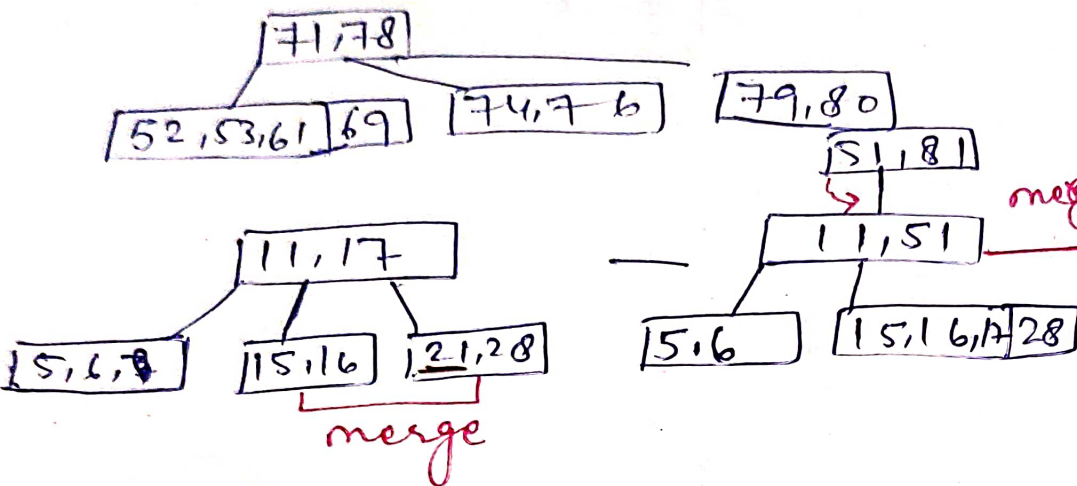
23 (less than min key, borrow from immediate left node (sibling))

Borrow from right sibling (node)
Neither left or right sibling has more than 2 keys.



// not more than 2 keys

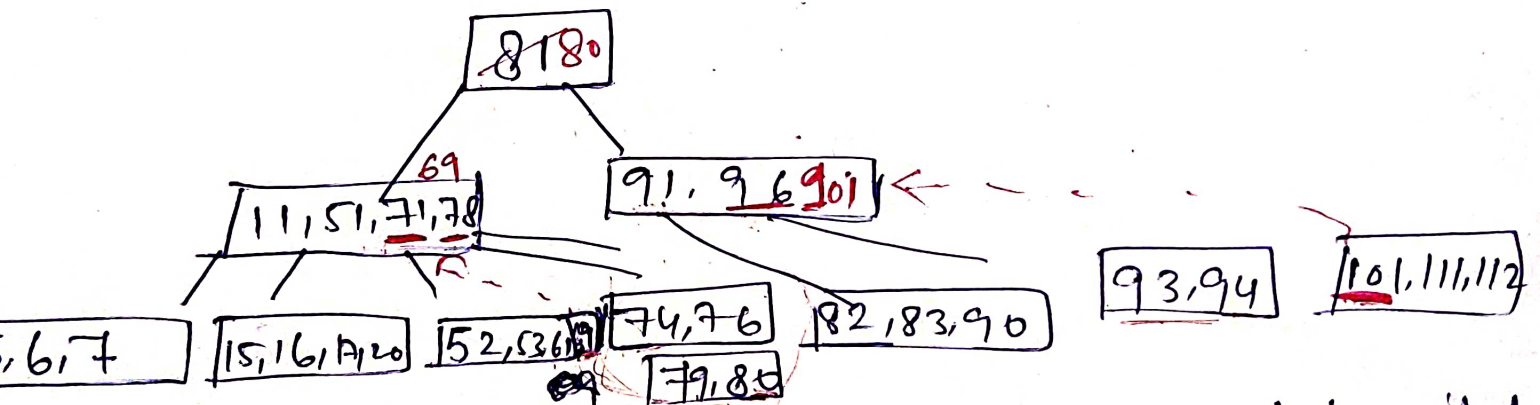
61 will come down and merge nodes



merge next

// wrong, 11 can't live alone
so 11, will ask to root for help

if target key is in Internal node.
(non leaf node)



delete 71 (replace 69 or 74), 74 not possible (min - 2 keys)
inorder Prede Inorder Succ.

delete 96. (94, 100)

delete 78 (merge)

delete 81, root (replace 80 or 111), 80