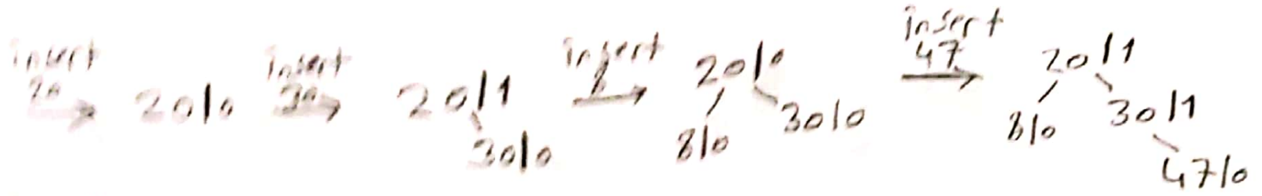
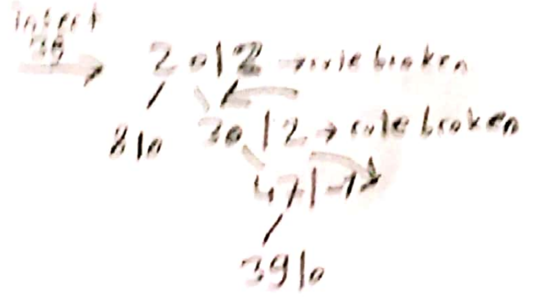
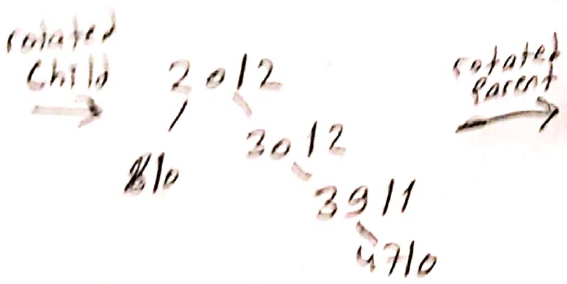
AVL Tree Add

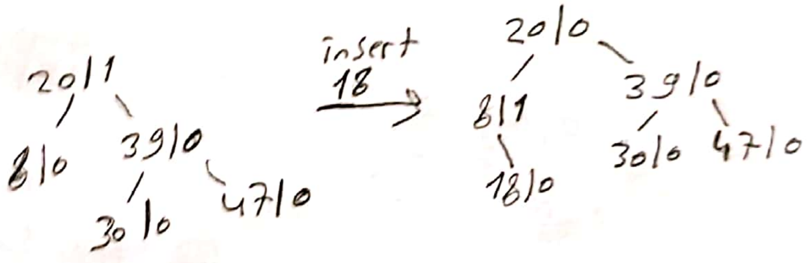
20, 30, 8, 47, 39, 18, 20, 4   Rule: $-1 \leq h_r - h_L \leq 1$

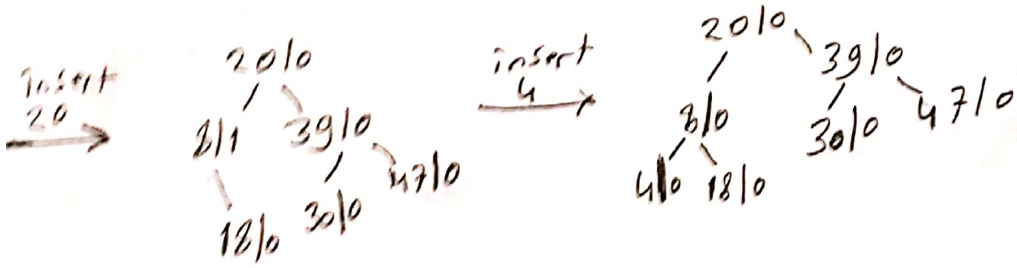




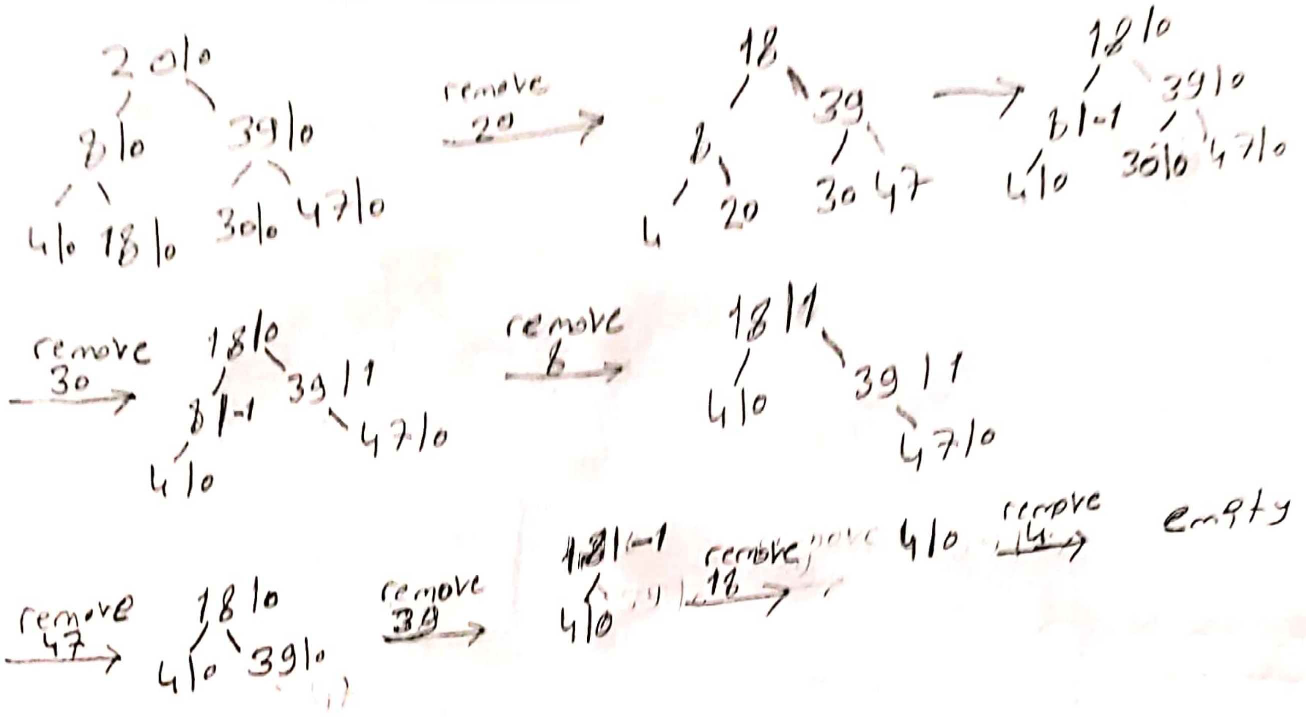
try to add rigt-left
so first we need to right rotation to child
then left rotation to parent







AVL Tree Remove

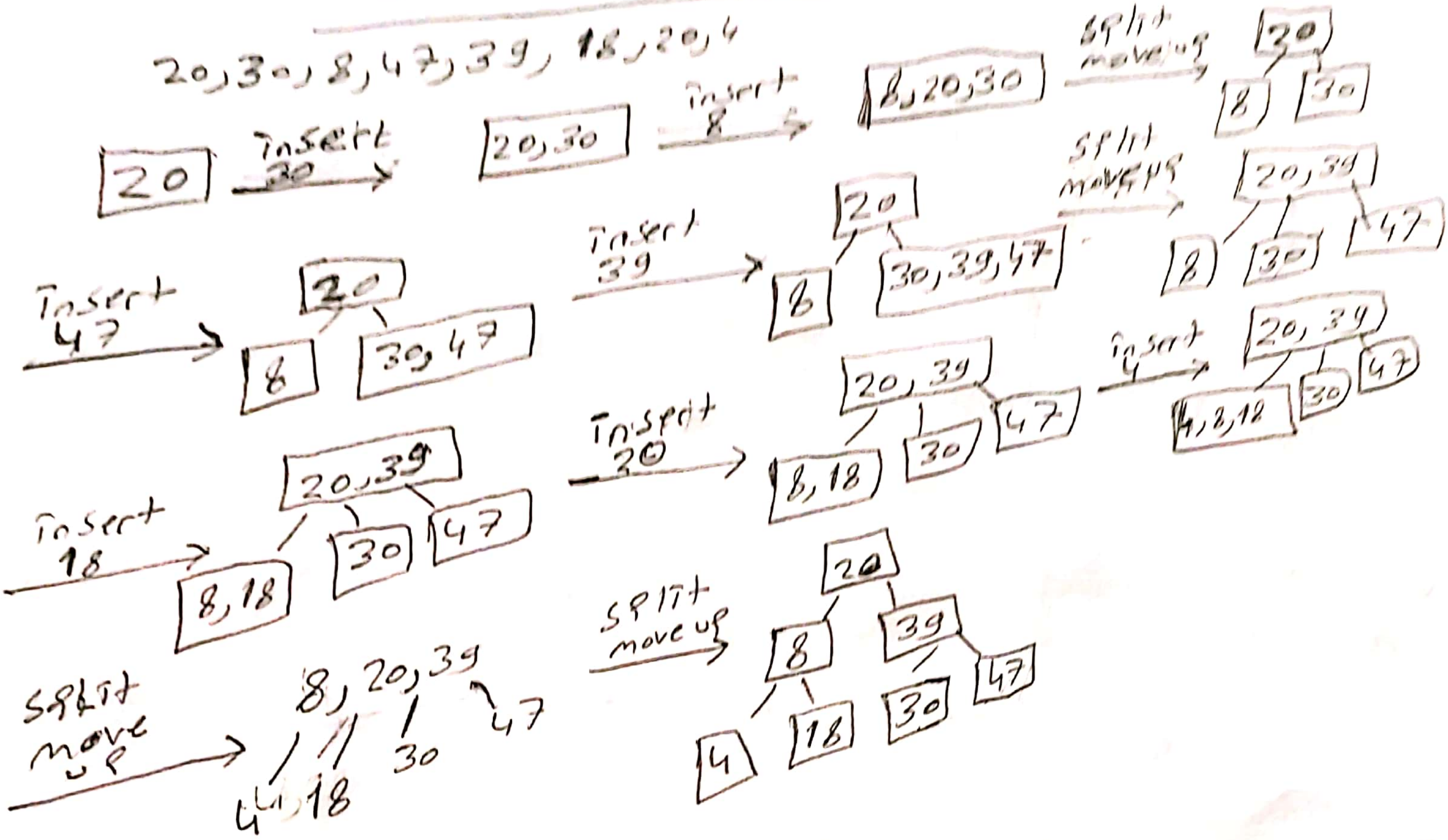


General algorith for remove:

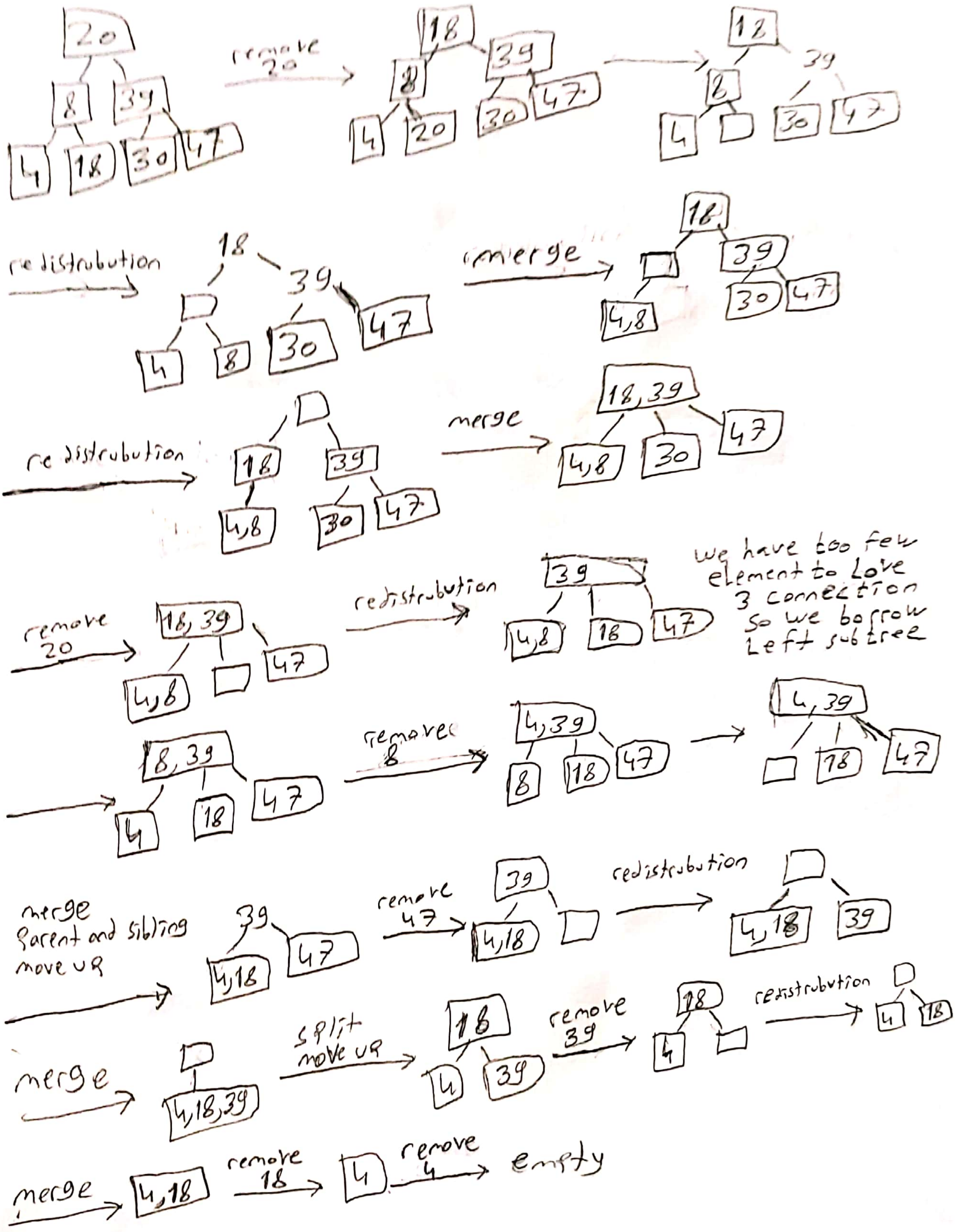
- Always delete from Leaf
- if you try to delete a leaf it is okay
- if you try to delete a Locol root and it has one child Connect parent to child and delete that node
- if you try to delete a Local root and it has two children find its Predecessor and replace them, than delete

2-3 Tree Add

20, 30, 8, 47, 39, 18, 20, 4



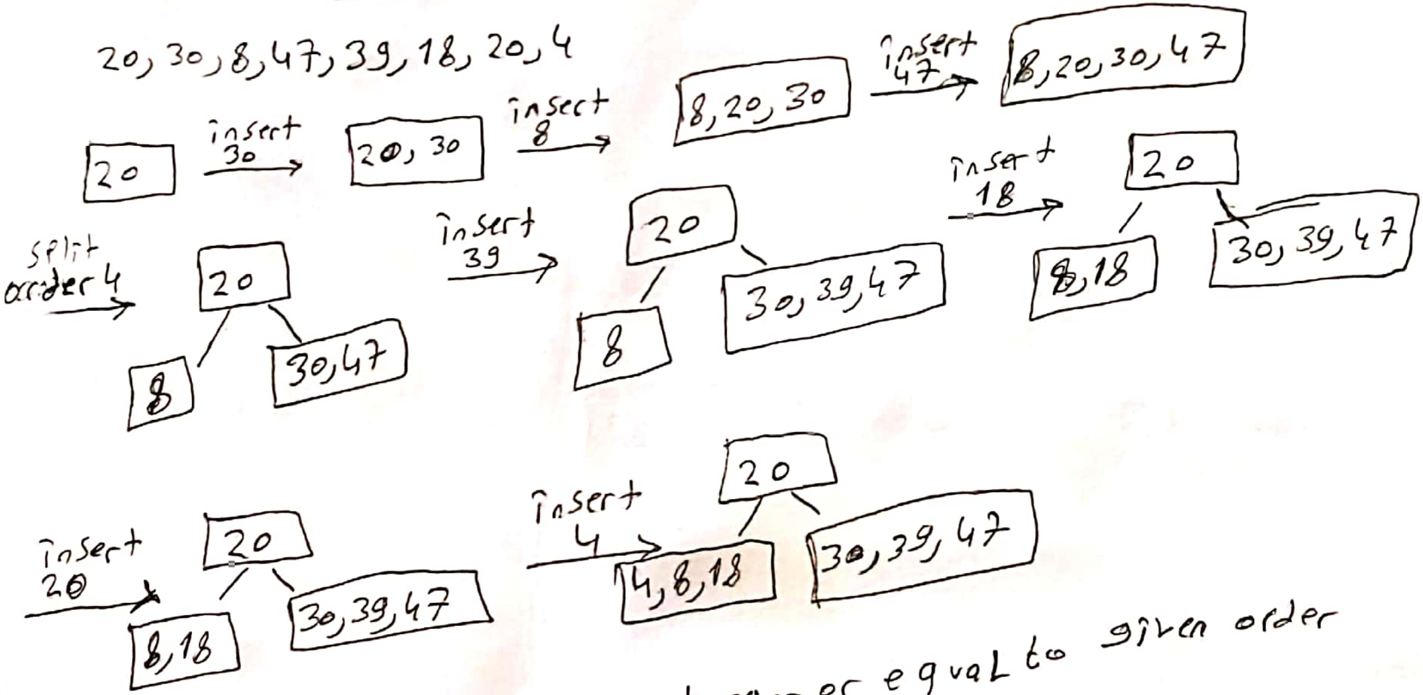
2-3 Tree Remove



we have too few element to have 3 connection so we borrow Left subtree

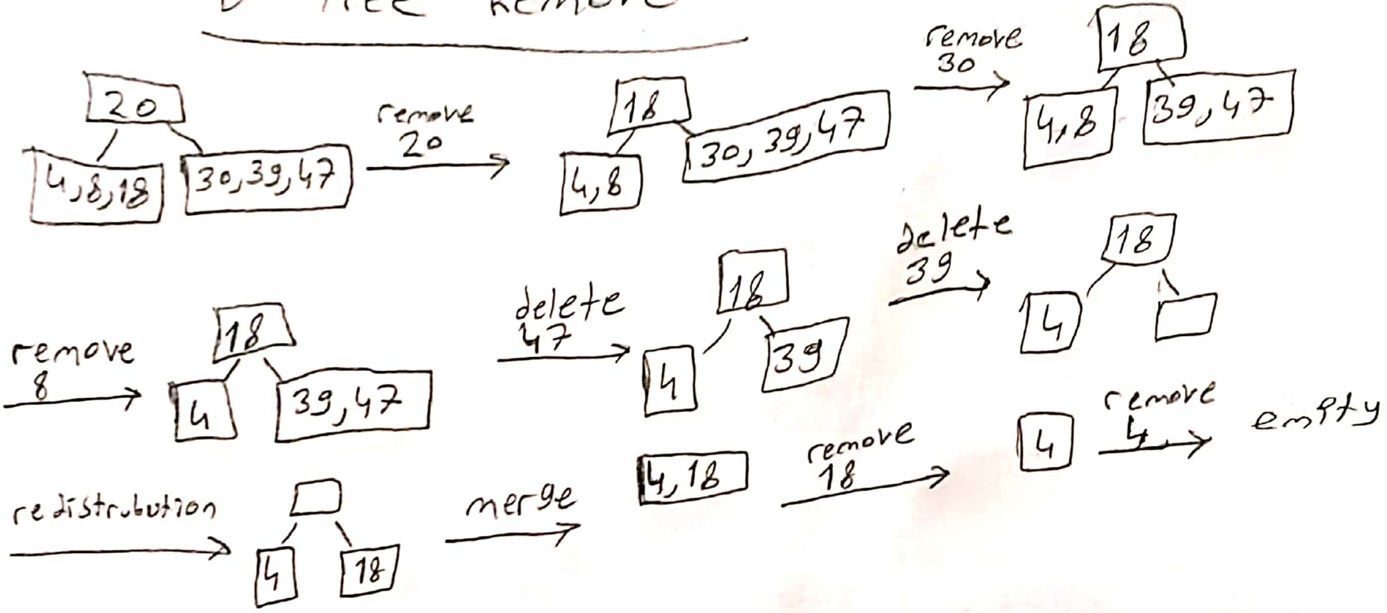
B-Tree Add

20, 30, 8, 47, 39, 18, 20, 4



rule is if a node's elements bigger or equal to given order split them

B-Tree Remove

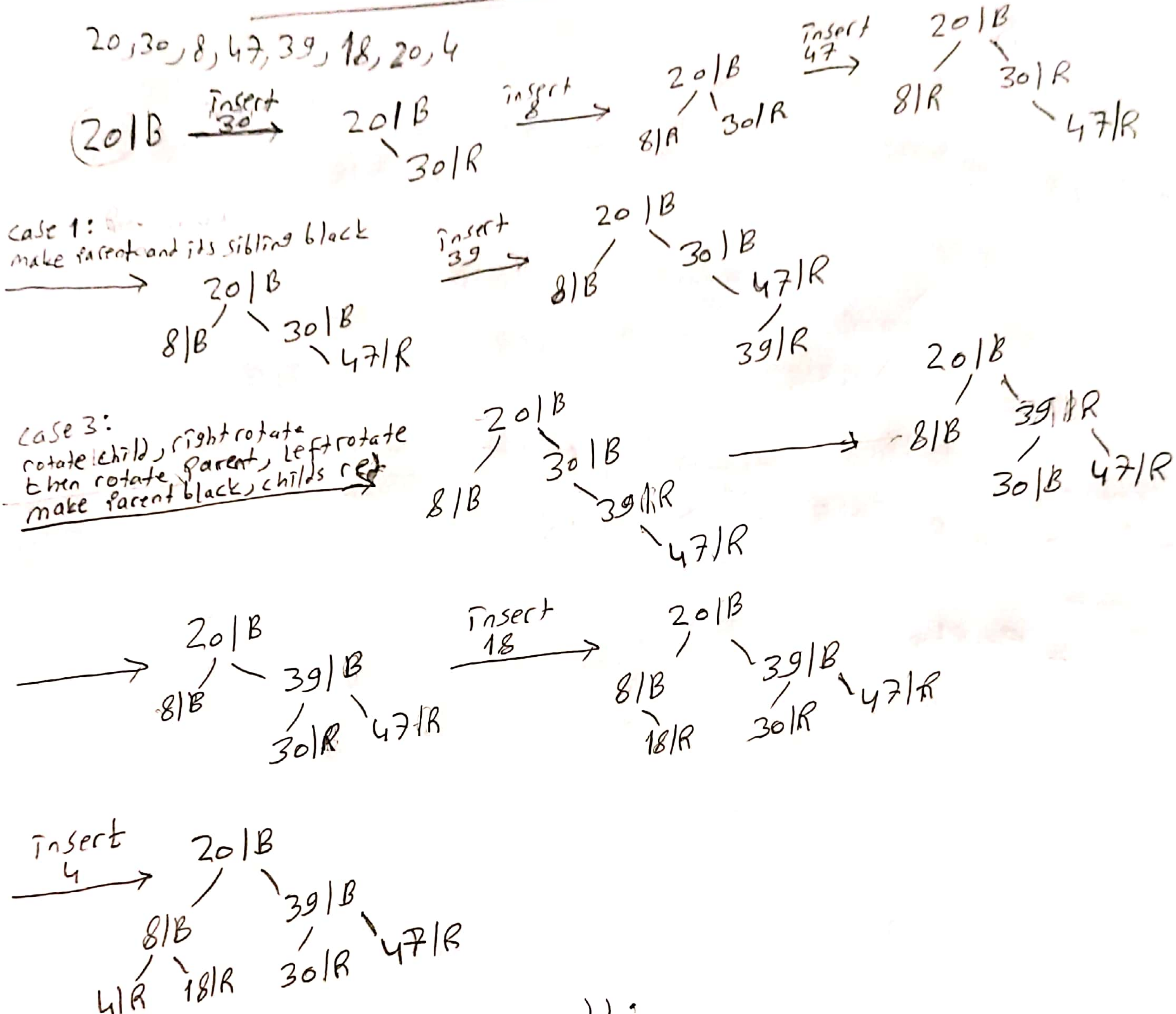


General algorithm for remove:

- All Leafs have to be on the same Level
- Always remove from a Leaf
- If a leaf empty, redistrubution from parent
- If a parent empty, merge childs

Red-Black Tree Add

20, 30, 8, 47, 39, 18, 20, 4



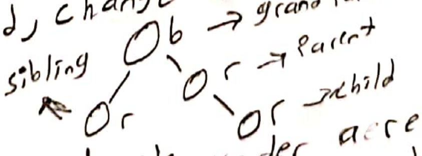
case 1:
make parent and its sibling black

case 3:
rotate child, right rotate
then rotate parent, Left rotate
make parent black, childs red

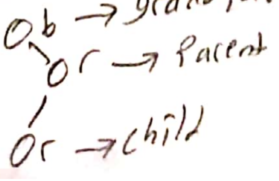
General algorithm for Red black add:

- root is always black
- red node cannot have a red child
- all path to Leafs should contain same amount black node

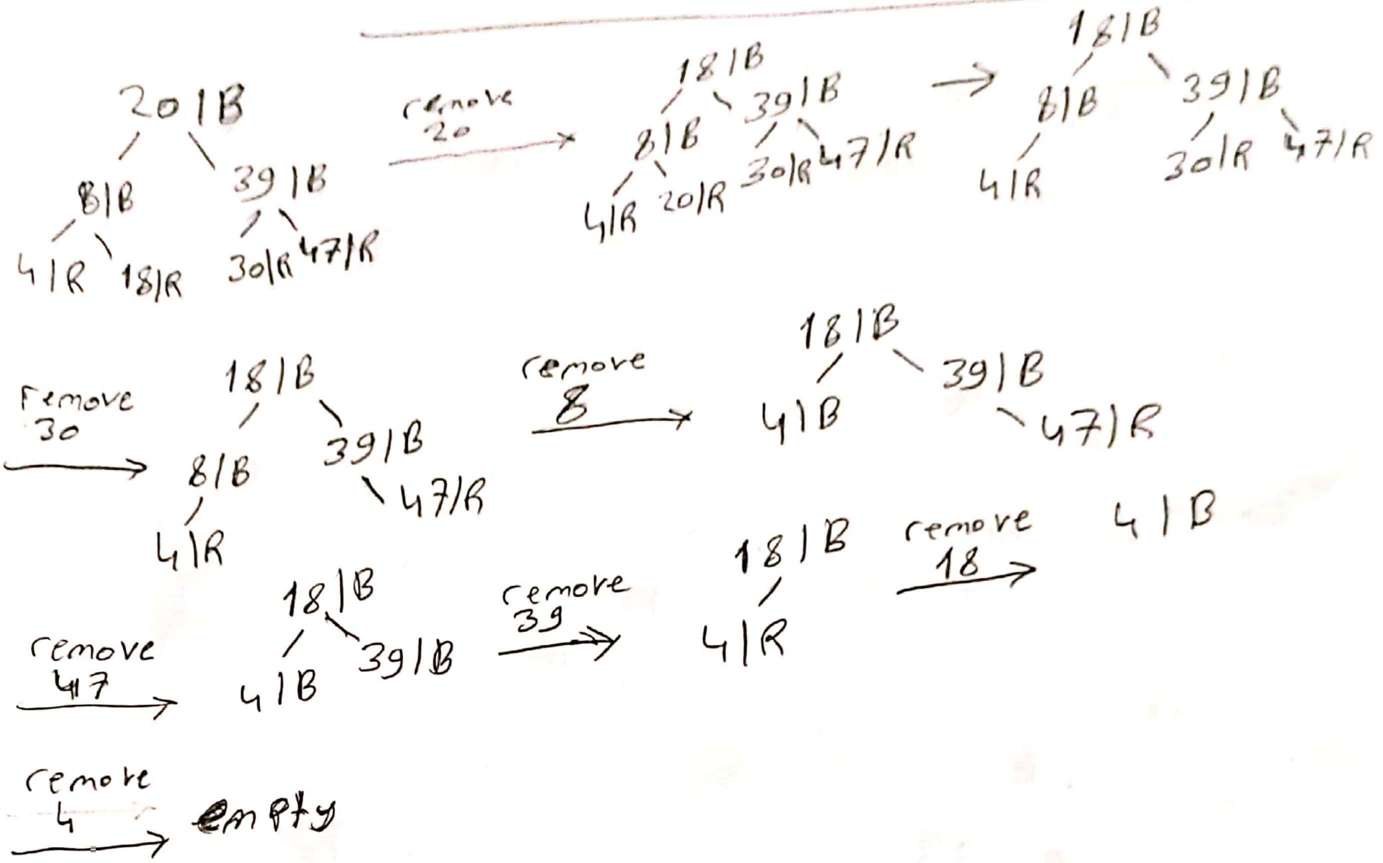
case 1: If try to Insert a red node under a red node has right child and parent's sibling is red, change parent and its sibling to black and grand parent to red



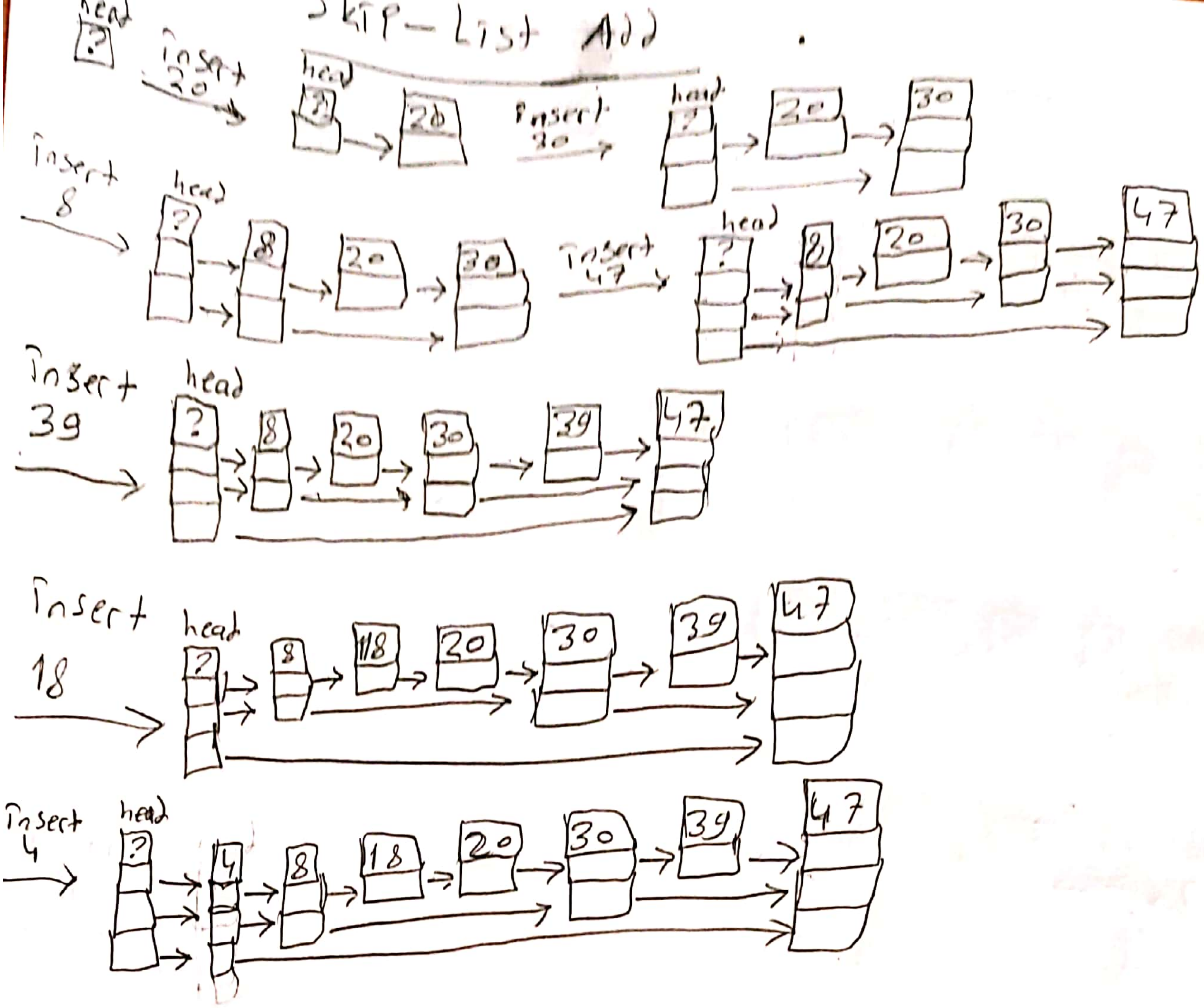
- Case 3: If try to insert a red node under a red nod as a left child and no sibling, make parent to black, grand parent to red and rotate parent to right rotate, rotate grandparent to Left rotate



Red-Black Tree Remove

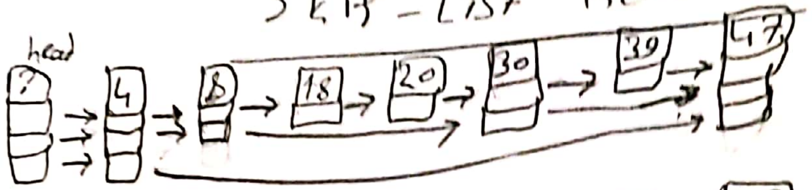


Skip-List Add

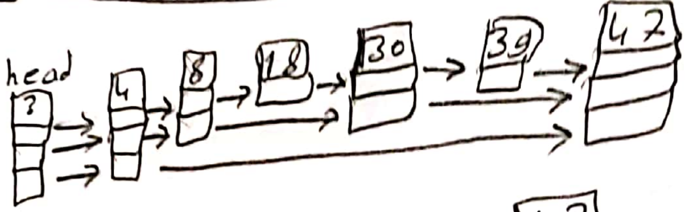


we add 20, 30, 8, 47, 39, 18, 20, 4 in order

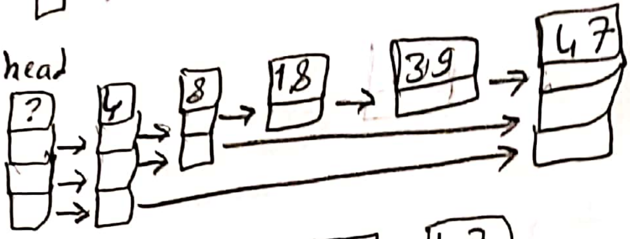
Skip-List Remove



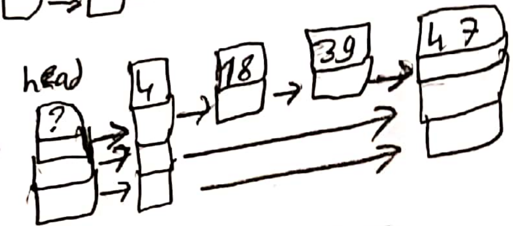
Remove 20 →



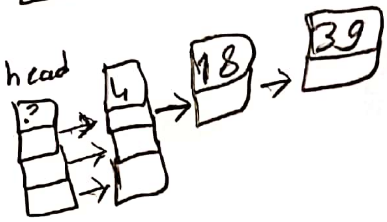
Remove 30 →



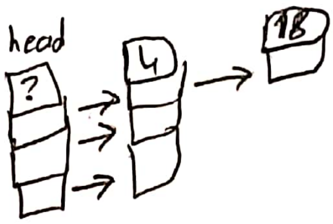
Remove 8 →



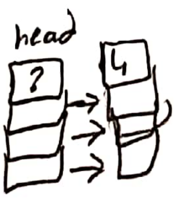
Remove 47 →



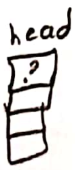
Remove 39 →



Remove 18 →



Remove 4 →



empty