Title: Balanced Search Trees

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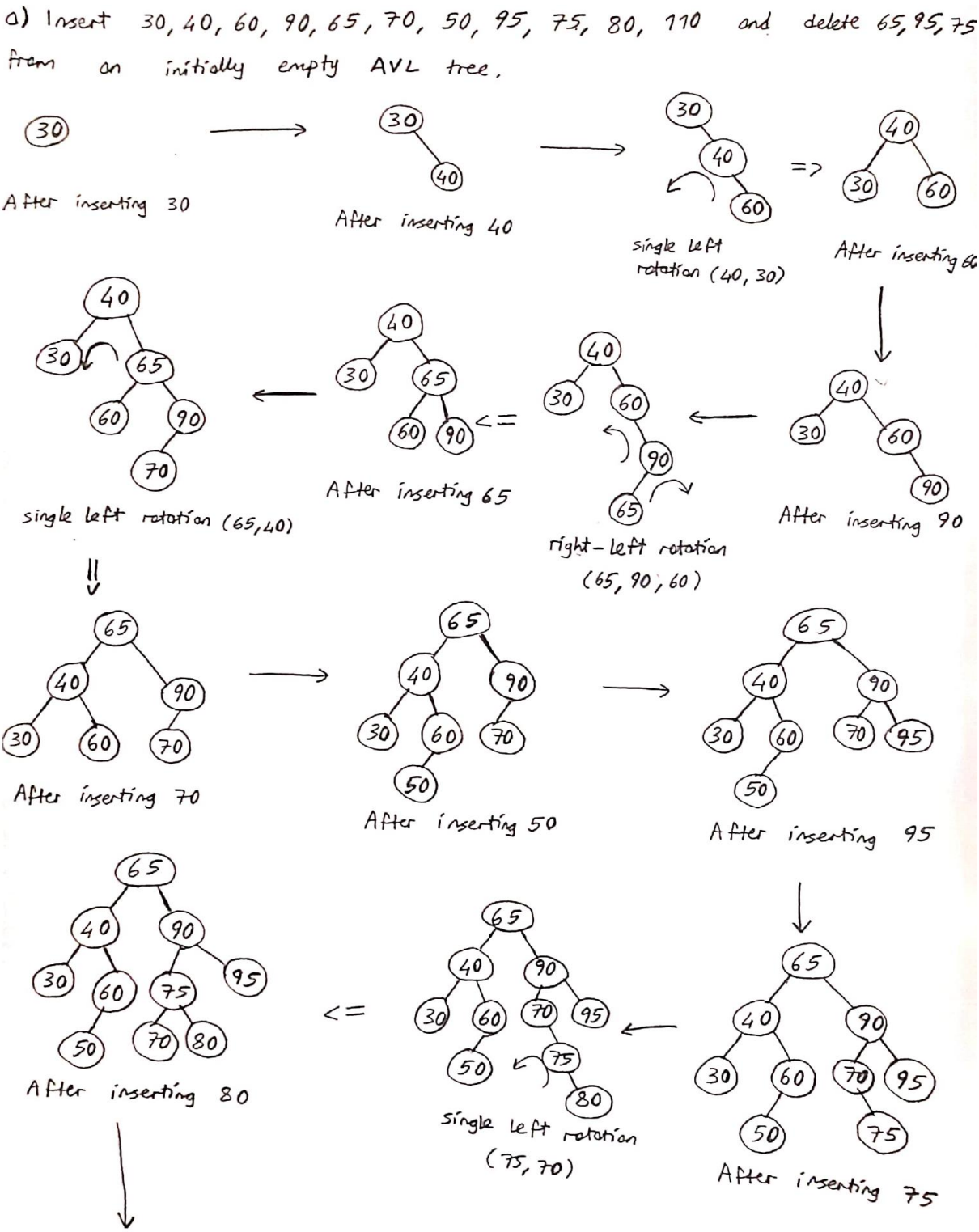
Section: 1

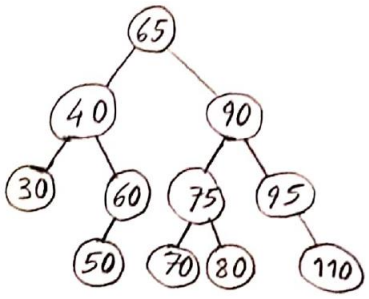
Assignment: 4

Description: HW4 Report

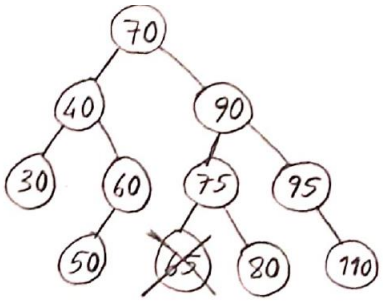
Question 1:

a) AVL tree

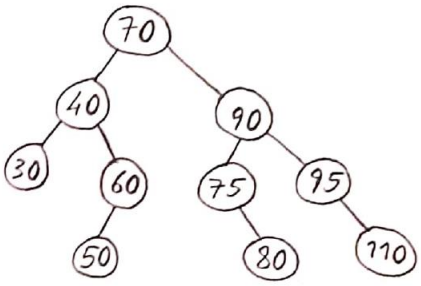




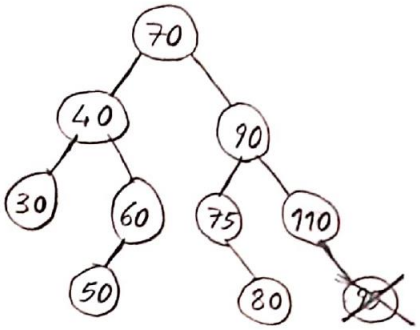
After inserting 110



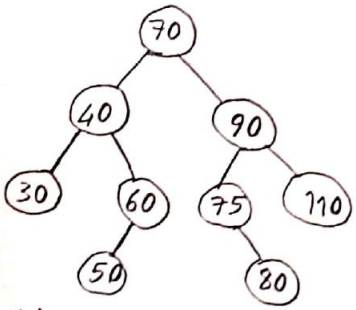
No rotation



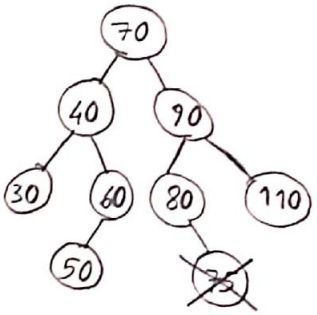
After deleting 65 (inorder successor = 70)



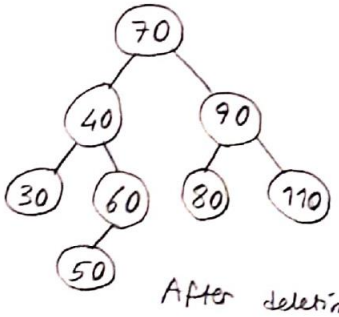
No rotation



After deleting 95

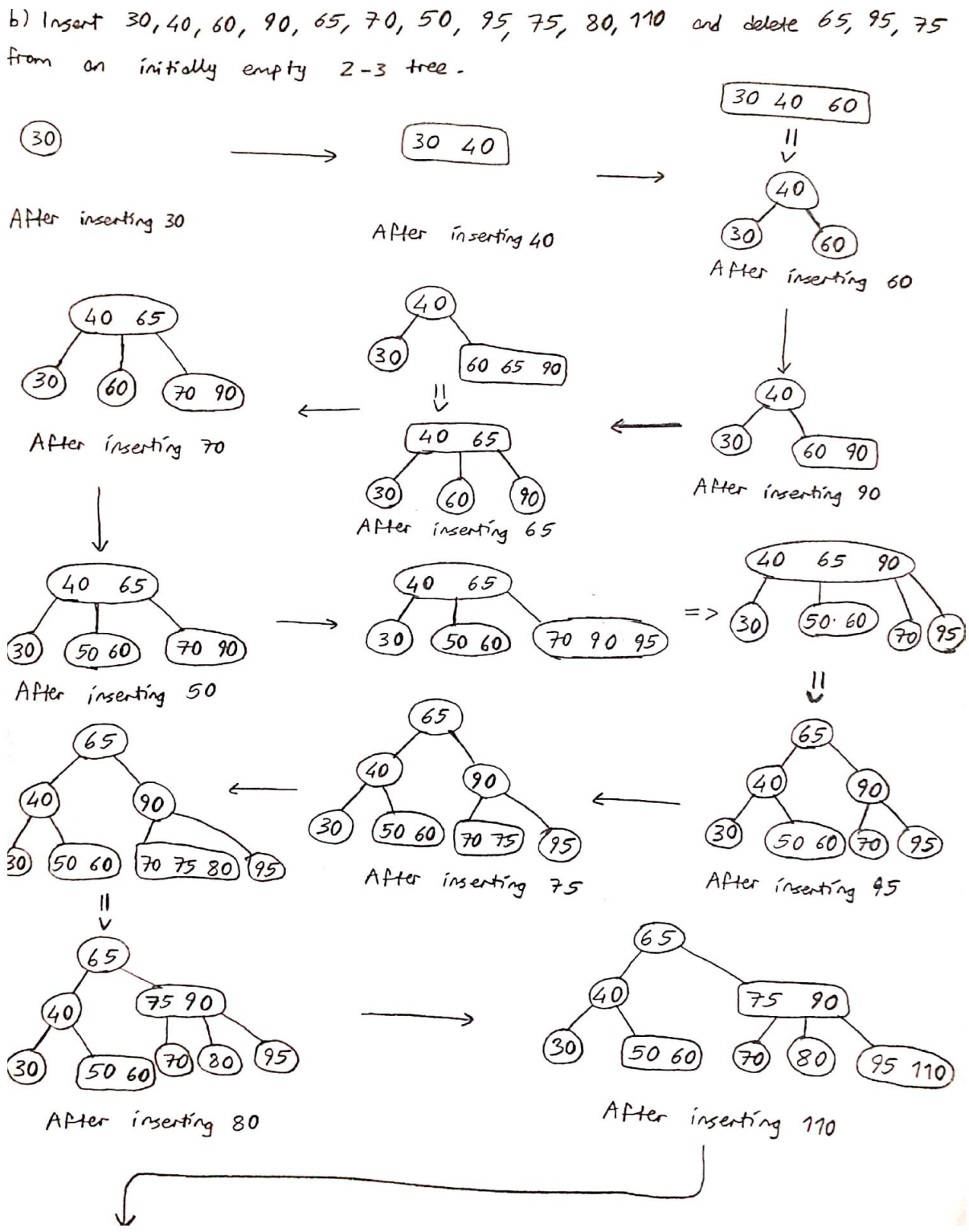


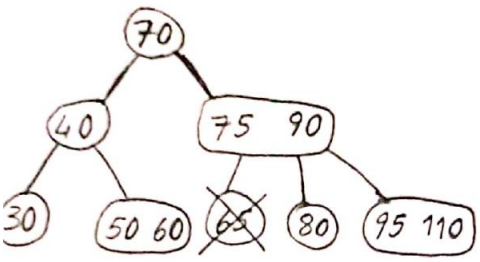
No rotation



After deleting 75

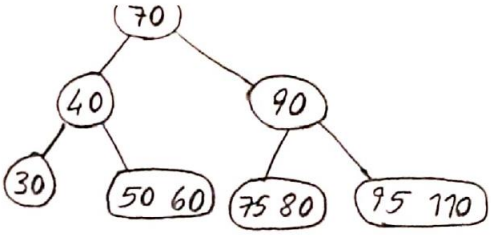
b) 2-3 tree


b) Insert 30, 40, 60, 90, 65, 70, 50, 95, 75, 80, 110 and delete 65, 95, 75 from an initially empty 2-3 tree.
30
After inserting 30
30 40
After inserting 40
30 40 60
40
30 60
After inserting 60
40
30 60 90
After inserting 90
40
30 60 65 90
40 65
30 60 90
After inserting 65
40 65
30 60 70 90
After inserting 70
40 65
30 50 60 70 90
After inserting 50
40 65
30 50 60 70 90 95
=>
40 65 90
30 50 60 70 95
65
40 90
30 50 60 70 75 95
After inserting 75
65
40 90
30 50 60 70 95
After inserting 95
65
40 90
30 50 60 70 75 80 95
65
40 75 90
30 50 60 70 80 95
After inserting 80
65
40 75 90
30 50 60 70 80 95 110
After inserting 110

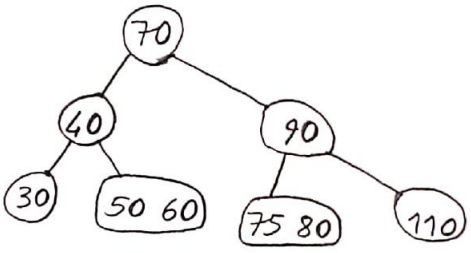


inorder successor = 70

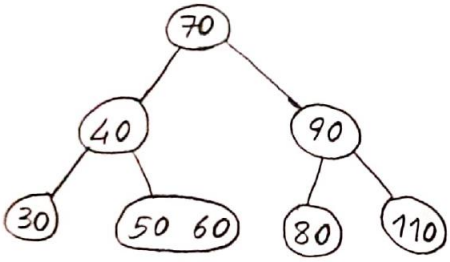
=>



After deleting 65

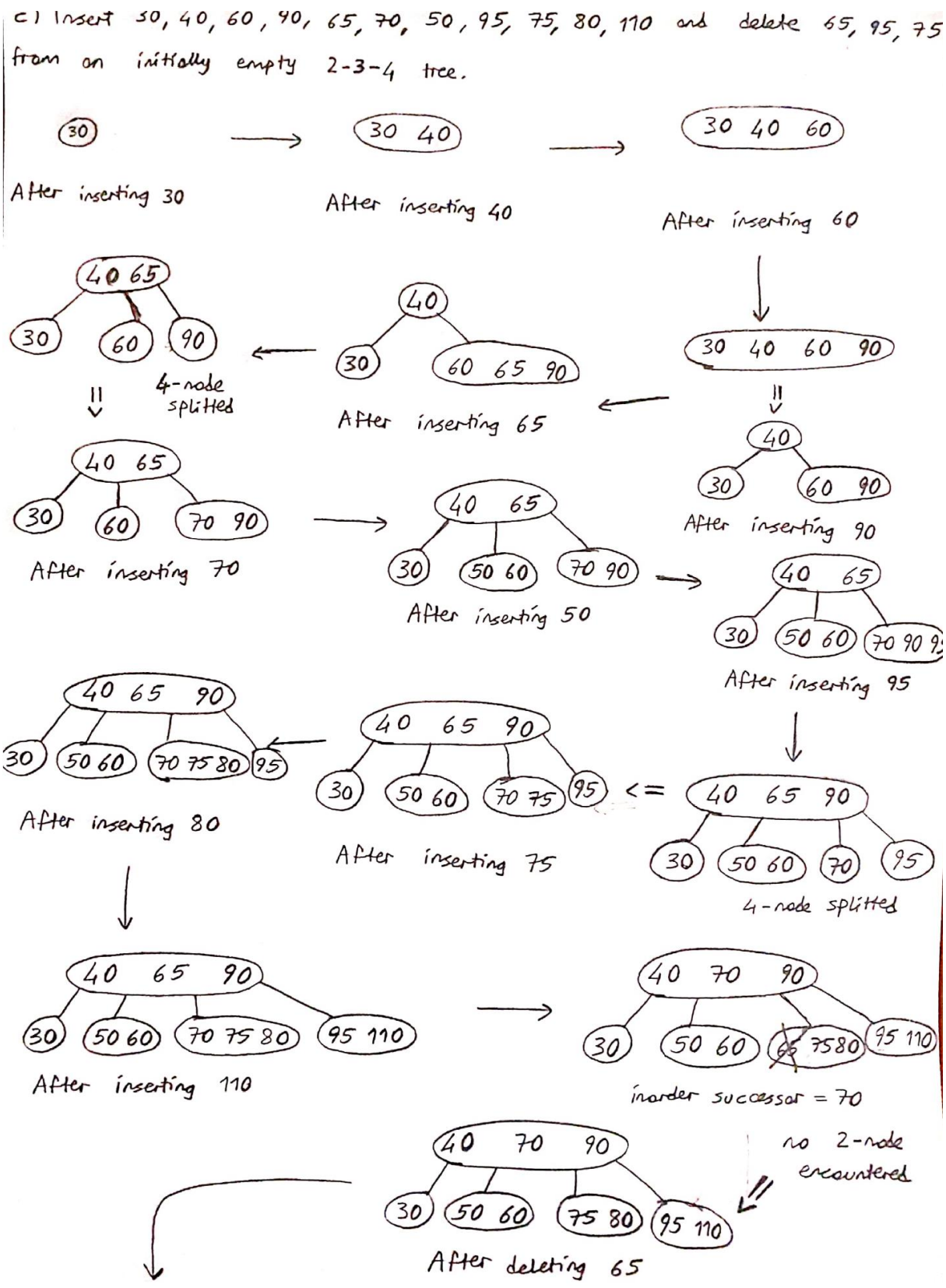


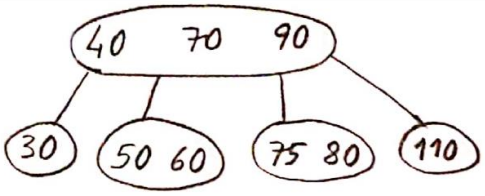
After deleting 95



After deleting 75

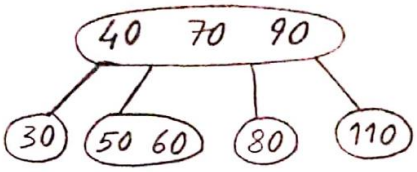
c) 2-3-4 tree


c) Insert 50, 40, 60, 90, 65, 70, 50, 95, 75, 80, 110 and delete 65, 95, 75 from an initially empty 2-3-4 tree.
30
After inserting 30
30 40
After inserting 40
30 40 60
After inserting 60
30 40 60 90
4-node splitted
After inserting 90
40 65
30 60 90
After inserting 65
40
30
60 65 90
40 65
30 60 70 90
After inserting 70
40 65
30 50 60 70 90
After inserting 50
40 65
30 50 60 70 90 95
After inserting 95
40 65 90
30 50 60 70 75 80 95
After inserting 80
40 65 90
30 50 60 70 75 95
After inserting 75
<=
40 65 90
30 50 60 70 95
4-node splitted
40 65 90
30 50 60 70 75 80 95 110
After inserting 110
40 70 90
30 50 60 75 80 95 110
inorder successor = 70
no 2-node encountered
40 70 90
30 50 60 75 80 95 110
After deleting 65



After deleting 95

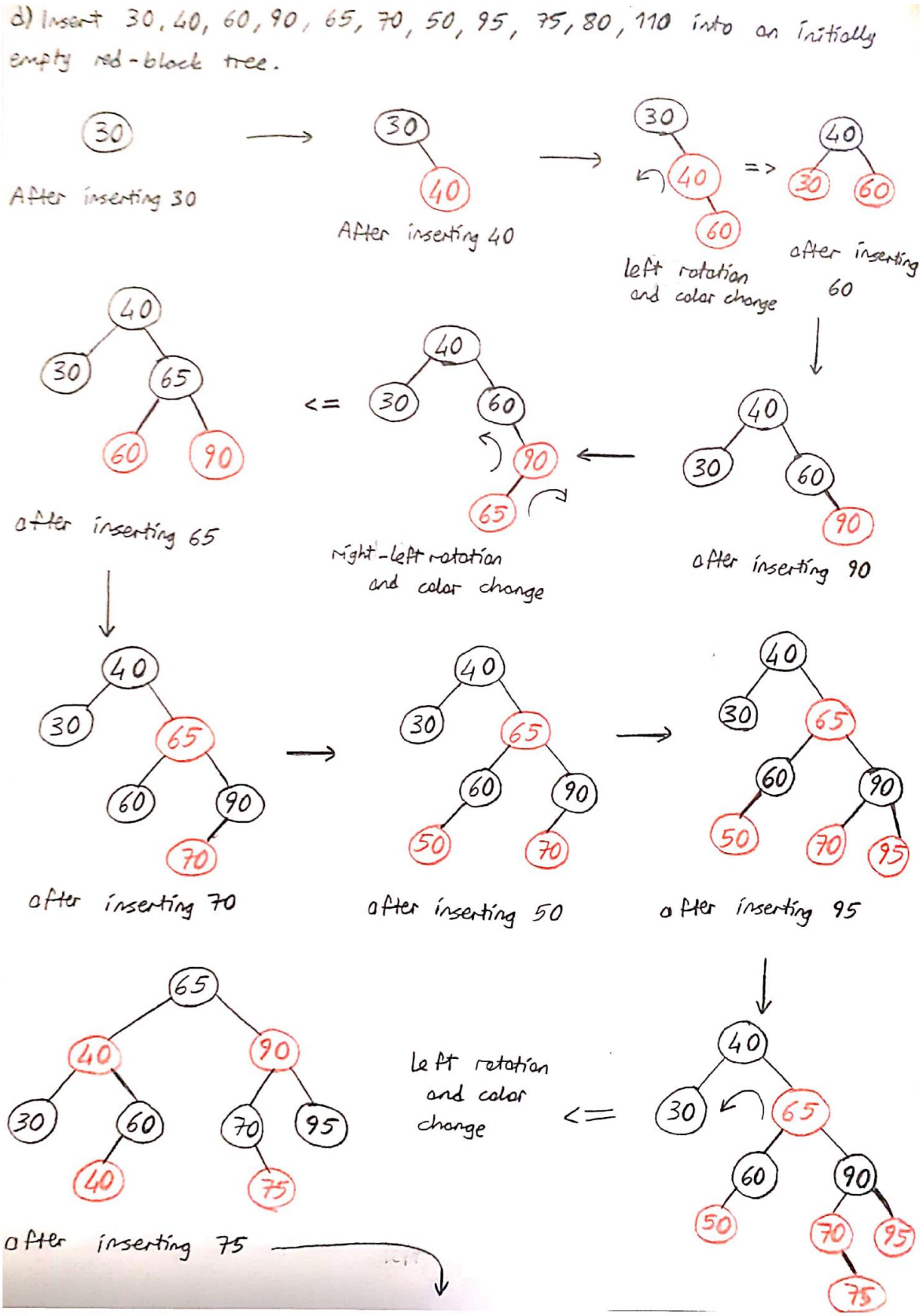
no 2-node encountered on the path

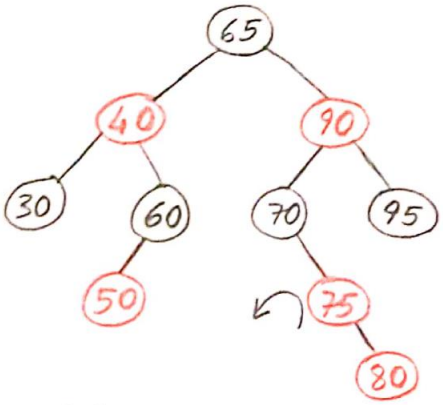


After deleting 75

no 2-node encountered on the path

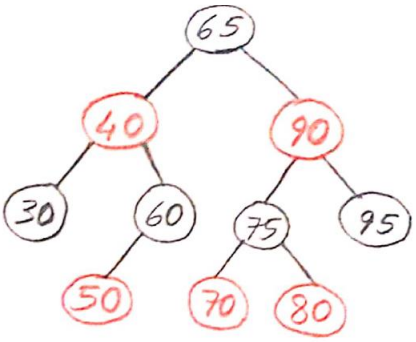
d) Red-Black tree



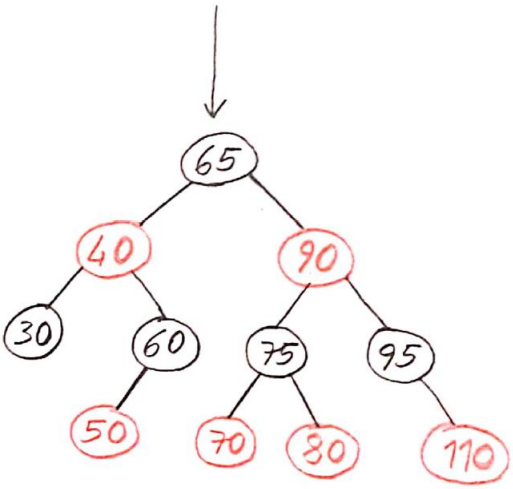


left rotation and color change

=>



after inserting 80



after inserting 110