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ASSIGNMENT NUMBER : 02

1.a What are the seven sorting strategies discussed in class? Identify them as having a run-time of $\theta(n)$, or $\theta(n \log n)$ or $\theta(n^2)$?

Ans : The seven sorting strategies are :

1. Insertion sort
2. Bubble sort
3. Heap sort
4. Quick sort
5. Merge sort
6. Bucket sort
7. Radix sort.

Run Time for $\theta(n)$ sorting algorithm are :

- Bucket sort
- Radix sort

Run Time for $\theta(n \log n)$ sorting algorithm are :

- Heap sort
- Quick sort
- Merge sort

Run Time for $\theta(n^2)$ sorting algorithm are :

- Insertion sort
- Bubble sort

1.b. What are the number of inversion pairs in the following unsorted list (6, 7, 3, 9, 2, 9, 3, 4, 2, 8, 8)?

1b) unsorted list $(8 < 1)$
(6, 7, 3, 9, 2, 9, 3, 4, 2, 8, 8)

step 1 → (6, 7) (6, 3) (6, 9) (6, 2) (6, 9) (6, 3)
(6, 4) (6, 2) (6, 8) (6, 8)
→ (7, 3) (7, 9) (7, 2), (7, 9), (7, 3), (7, 4)
(7, 2) (7, 8) (7, 8)
→ (3, 9) (3, 2) (3, 9) (3, 3) (3, 4) (3, 2)
(3, 8) (3, 8)
→ (9, 2) (9, 9) (9, 3) (9, 4) (9, 2) (9, 8) (9, 8)
→ (2, 9) (2, 3) (2, 4) (2, 2), (2, 8) (2, 8)
→ (9, 3) (9, 4) (9, 2) (9, 8) (9, 8)
→ (3, 4) (3, 2) (3, 8) (3, 8)
→ (4, 2) (4, 8) (4, 8)
→ (2, 8) (2, 8)
→ (8, 8)

step 2 ⇒ Inversions
→ (6, 3), (6, 2), (6, 3), (6, 4), (6, 2)
→ (7, 3), (7, 2), (7, 3), (7, 4), (7, 2)
→ (3, 2), (3, 2)
→ (9, 2), (9, 3), (9, 4), (9, 2), (9, 8), (9, 8)
→ (2, 2)

→ (9, 3), (9, 4), (9, 2), (9, 8), (9, 8)
 → (4, 2)

i.e., There are 25 inversion's



1.c. Why is an in-place sorting algorithm more preferable to one that is not?

Ans : In-Place sorting algorithm is preferred because other sorting algorithms require the allocation of second array of equal size. i.e., it requires $\Theta(n)$ additional memory.

1.d. Apply Quick Sort (using 3 medians) on this sequence : 7, 11, 14, 6, 9, 4, 3, 12 ?

1d) Quick Sort

Unsorted array:

7	11	14	6	9	4	3	12
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Median

$$\frac{0+8}{2} = 4$$

0	1	2	3	4	5	6	7
7	11	14	6	9	4	3	12

so taking 7, 9, 12.

Consider 9 as pivot

0	1	2	3	4	5	6
7	11	14	6	12	4	3

P = 9

7 < 9 ✓ 3 > 9 ✗
 11 < 9 ✗
 i(11) < i(3) ✓

→ swap

0	1	2	3	4	5	6
7	3	14	6	12	4	11

P = 9

14 < 9 ✗ 4 > 9 ✗
 i(14) < i(4) ✓

Swap

0	1	2	3	4	5	6
7	3	4	6	12	14	11

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CONTINUE....

$$6 < 9 \checkmark$$

$$12 > 9 \checkmark$$

0	1	2	3	4	5	6
7	3	4	6	12	14	11

$$i(12) < i(6) \times$$

7	3	4	6	9	14	11	12
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Now left side of pivot is smaller than pivot
& right side element are larger than pivot
so it will ~~sort~~ sort accordingly

0	1	2	3	4	5	6	7
7	3	4	6		9	14	11

Mid point for Left array

— ①

$$\frac{0+4}{2} = 2$$

0	1	2	3
7	3	4	6

~~re-arrange~~

so

4	3	7
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$$P = 6$$

$$4 < 6 \checkmark \quad 7 > 6 \checkmark$$

$$3 < 6 \checkmark \quad 3 > 6 \times$$

$$7 < 6 \times$$

$$i(7) < i(3) \times$$

so,

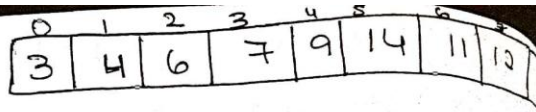
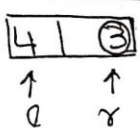
0	1	2	3	4	5	6	7
4	3	6	7	9	14	11	12

$$\text{mid point} \rightarrow \frac{0+2}{2} = ①$$



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CONTINUE....



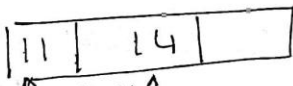
Mid point for

14	11	12	
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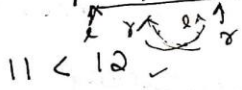
 is

$$\frac{5+8}{2} = 6$$

so,



$$P = 12$$



$$14 > 12$$

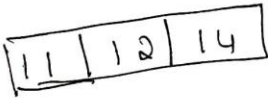
move pointer

$$14 < 12 \times$$

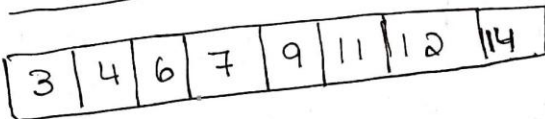
$$11 > 12 \times$$

$$i(14) < i(11) \times$$

so



→ so the entire sorted array is



2.a. Insert the following sequence of elements into an AVL tree, starting with an empty tree (show each step) : 10, 20, 15, 25, 30, 16, 18, 19?

2) a) AVL tree → height of left & right subtree must be less than or equal.
10, 20, 15, 25, 30, 16, 18, 19

Step 1: insert 10

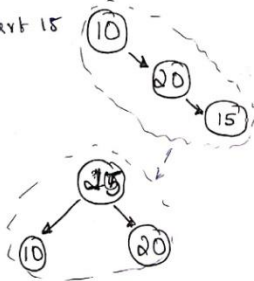
(10)

② insert 20



height of left - right subtree
 $1 - 0 = 1$

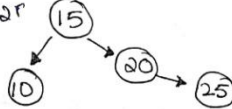
③ insert 15



→ $2 - 0 = 2$ ✗

→ $1 - 0 = 1$

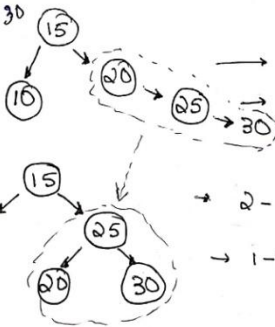
④ insert 25



→ $2 - 1 = 1$

→ $1 - 0 = 1$

⑤ insert 30

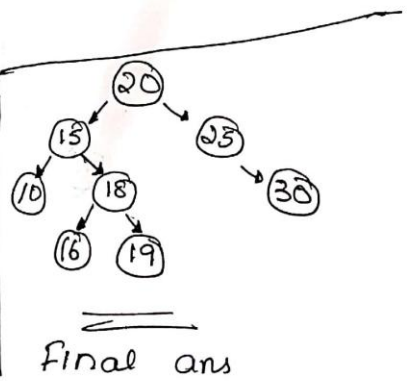
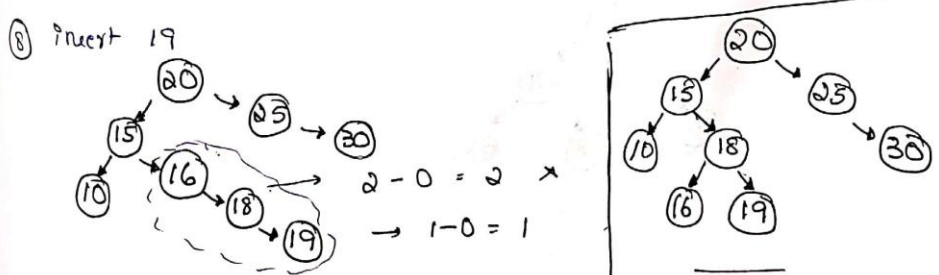
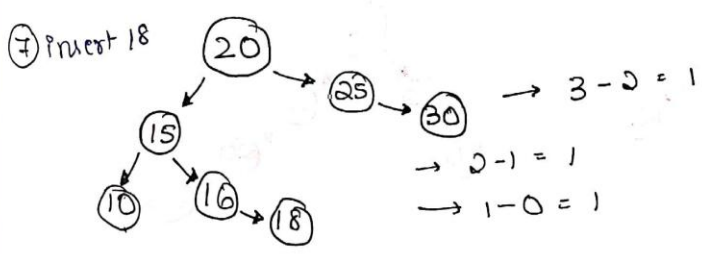
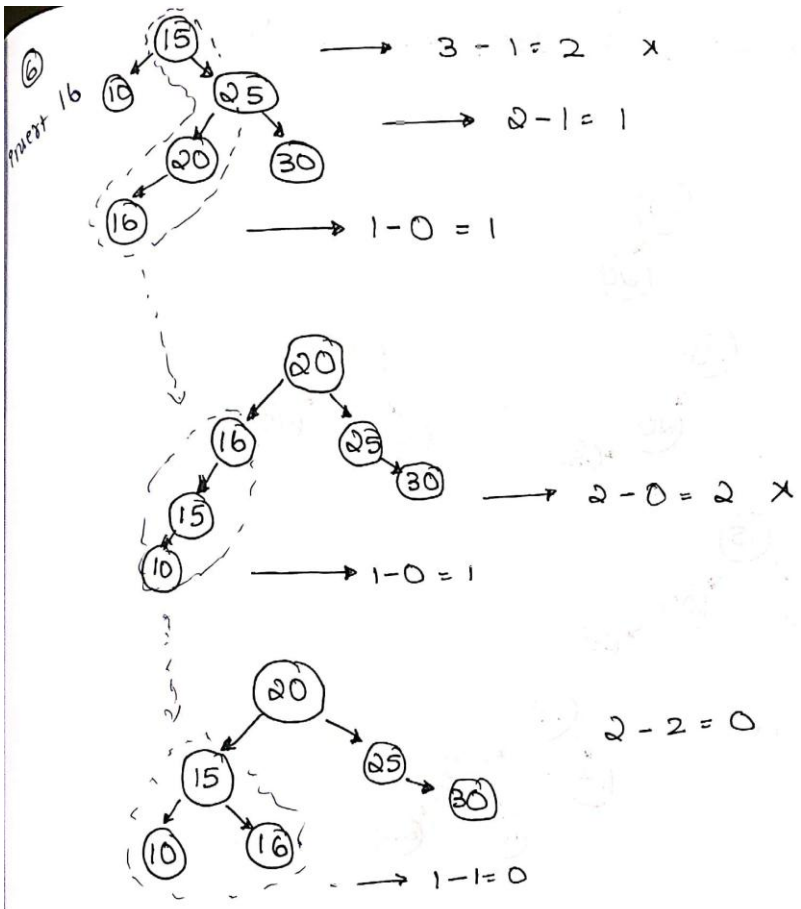


→ $2 - 0 = 2$ ✗

→ $1 - 0 = 1$

→ $2 - 1 = 1$

→ $1 - 1 = 0$



2.b. Delete 30 in the AVL tree that you got ?

2b) 10, 20, 15, 25, 16, 18, 19

1) Insert 10

2) Insert 20

3) Insert 15

4) Insert 25

5) Insert 16

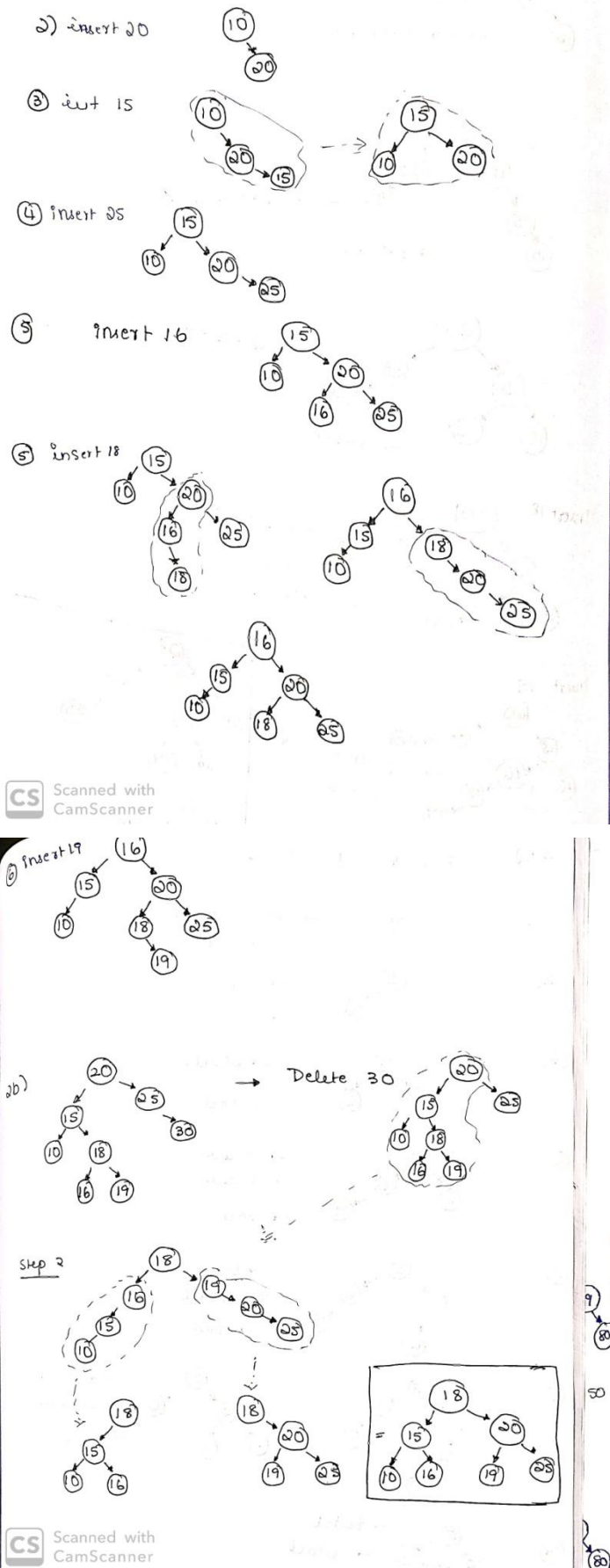
6) Insert 18

7) Insert 19

2b)

Step 2

Delete 30



ANS : Maximum difference in heights between the leafs of a AVL tree is **1**.

ANS : operations that could be performed in $O(\log n)$ time complexity are:

- 3.b. Insert the following sequence in to a red black tree (show each step): 5, 6, 1, 9, 2, 4, 3, 8, 7 ?

