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MCS-021

Data and File Structures

All In One

Prepared by

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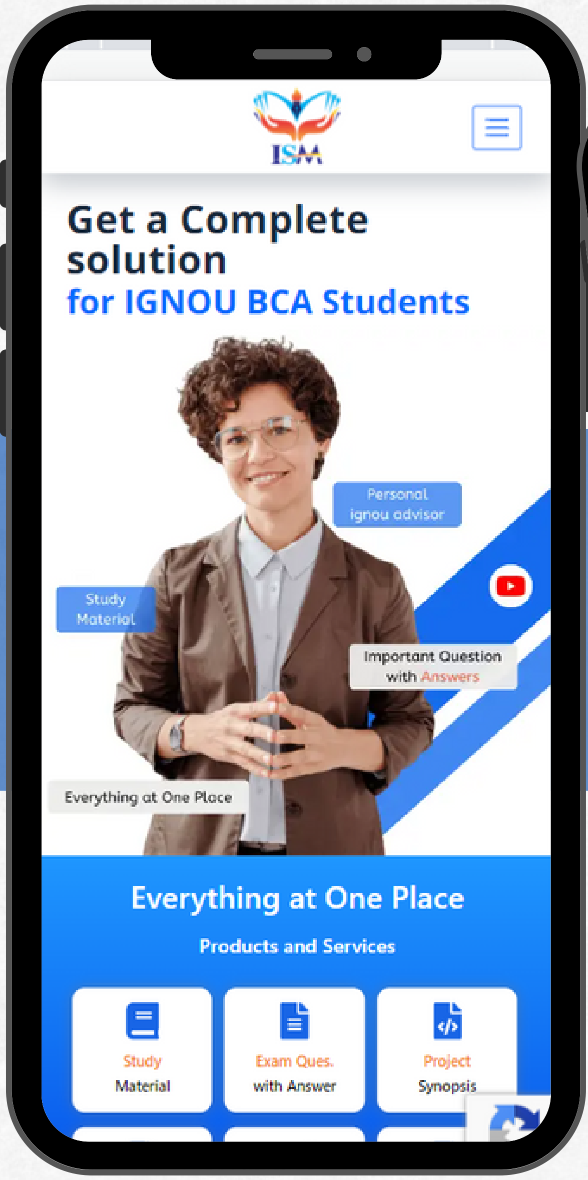
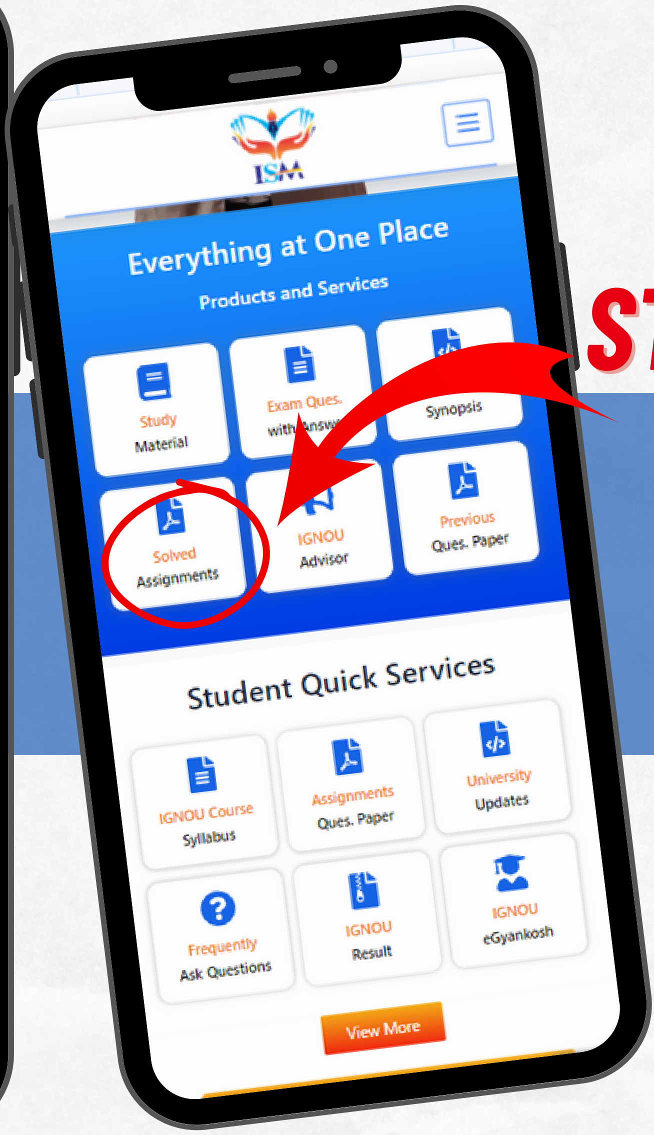


STEP 2



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Ques.7 Create the binary tree for which the in-order and post-order traversal are given as below:

In-order: QUVTMPSYZXR
Post order:VUTQZYXSRPM

Ans. To construct a binary tree using the given in-order and post-order traversals, you can follow these steps:

1. The last element in the post-order traversal is the root of the binary tree.

2. Find the position of the root element in the in-order traversal. Elements to the left of this position are the left subtree, and elements to the right are the right subtree.

3. Recur for both left and right subtrees using the remaining post-order and in-order elements.

Given in-order: QUVTMPSYZXR

Given post-order: VUTQZYXSRPM

Step 1: The last element of post-order is 'M', which will be the root of the binary tree.

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Step 2: Find the root 'M' in the in-order traversal. The elements to the left of 'M' will form the left subtree, and the elements to the right will form the right subtree.

In-order: QUVT MPSYZXR
Post-order: VUTQZYX SRPM

Step 3: Recursively construct the left and right subtrees.

For the left subtree: In-order: QUVT
Post order: VUTQ

For the right subtree: In-order: PSYZXR
Post order: ZYXSRP

Step 4: Continue recursively constructing the left and right subtrees.

Left subtree: In-order: QU VT
Post-order: V TQ

Right subtree: In-order: PS YZXR
Post-order: Z YXSR P

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Step 5: Continue recursively constructing the left and right subtrees.

Left subtree: In-order: Q U V T Post-order: V T U Q
Right subtree: In-order: P S Post-order: S P

Now, we have constructed the binary tree. Let's represent it:

```
      M
     / \
    /   \
   V     S
  / \   /
 /   \ /
Q     U
     / \
    P   T
       / \
      S   Z
         / \
        X   R
```

So, the binary tree that matches the given in-order and post-order traversals is as shown above.

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Ques.8 Create a B tree of order-5 for the following keys, inserted in the sequence. 25, 5, 10, 2, 3 35, 45, 30, 50, 55, 60, 12, 18, 20, 1 Further, delete the keys 1, 2, 10, and 12. Show all the intermediate steps.

Ans. Creating and deleting keys in a B-tree involves several steps, and the process can be complex due to splitting, merging, and reorganizing nodes. Here, I'll guide you through the creation and deletion of keys in a B-tree of order-5 based on the given sequence.

A B-tree of order-5 can have between 2 and 4 keys per node, and between 3 and 5 children per node. Keys are stored in non-decreasing order within each node.

Let's start by creating the B-tree step by step based on the given keys: 25, 5, 10, 2, 3, 35, 45, 30, 50, 55, 60, 12, 18, 20, 1.

Creating B-tree:

1. Insert 25:

```
25
```

2. Insert 5:

```
5   25
```

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3. Insert 10:

```
5  10  25
```

4. Insert 2:

```
5  10  25
/
2
```

5. Insert 3:

```
5  10  25
/    \
2    3
```

6. Insert 35:

```
   10
 /      \
 5      25,35
/ \
2  3
```

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7. Insert 45:

```
   10
 /    \
 5     35
/ \    /  \
2  3   25  45
```

8. Insert 30:

```
      10
    /      \
   5        35
  / \      /   \
 2  3  25   45, 30
```

9. Insert 50:

```
     10
    /   \
   5     35
  / \    /     \
 2  3  25   45, 30, 50
```

10. Insert 55:

```
      10
      /    \
    5       35, 50
  / \     /  |  \
 2  3  25   45, 30, 55
```

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11. Insert 60:

```
       10
      /     \
    5       35, 50
  / \     /  |   \
 2  3  25   45, 30, 55, 60
```

12. Insert 12:

```
       10
      /     \
    5       35, 50
  / \     /  |   \
 2  3  12, 25   45, 30, 55, 60
```

13. Insert 18:

```
       10
      /     \
  5, 18     35, 50
 / | \    /  |   \
 2  3  12, 25   45, 30, 55, 60
```

14. Insert 20:

```
       10
      /     \
  5, 18     35, 50
 / | \    /  |   \
 2  3  12, 20, 25   45, 30, 55, 60
```

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15. Insert 1:

```
        10
       /    \
  5, 18      35, 50
 / | \      /  |  \
1  2  3, 12, 20, 25   45, 30, 55, 60
```

Deleting keys:

1. Delete 1:

```
        10
       /    \
  5, 18      35, 50
  \     \    /  |  \
    2  3, 12, 20, 25   45, 30, 55, 60
```

2. Delete 2:

```
         10
        /    \
  5, 18      35, 50
    \     \    /  |  \
     3   12, 20, 25   45, 30, 55, 60
```

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3. Delete 10:

```
       20
      /   \
  5, 18     35, 50
   \    \   /  |  \
    3   12, 25  45, 30, 55, 60
```

4. Delete 12:

```
      20
     /   \
 5, 18     35, 50
   \     \  /  |  \
    3, 25   45, 30, 55, 60
```

Please note that B-tree operations can result in node splits, redistributions, and reorganizations, which can affect the structure of the tree. The above steps show a simplified view of the process. In practice, implementing B-tree operations involves handling various cases and maintaining the properties of the B-tree.

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Ques.9 Create AVL tree for the following keys inserted in the order: 5, 15, 3, 25, 10, 2, 35, 7, 45, 30, 12, 20, 14 Further, delete the keys 2, 5, 7, and 8. Show all the intermediate steps.

Ans. let's create the AVL tree step by step for the given keys and then proceed with the deletions. An AVL tree is a self-balancing binary search tree, so at each step, we need to ensure that the balance factor of each node is within the range of -1, 0, or 1. If it's not, we perform rotations to balance the tree.

Step 1: Insert 5

```
    5
```

Step 2: Insert 15

```
    5
     \
      15
```

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Step 3: Insert 3

```
    5
   / \
  3   15
```

Step 4: Insert 25

```
    5
   / \
  3   15
        \
         25
```

Step 5: Insert 10

```
    5
   / \
  3   15
   \    \
    10   25
```

Step 6: Insert 2

```
    5
   / \
  3   15
 / \    \
2   10   25
```

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Step 7: Insert 35

```
    5
   / \
  3   15
 / \    \
2   10   25
        /
       35
```

Step 8: Insert 7

```
    5
   / \
  3   15
 / \    \
2   10   25
 \      / \
  7   20   35
```

Step 9: Insert 45

```
    5
   / \
  3   15
 / \    \
2   10   25
 \      / \
  7   20   35
             \
              45
```

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Step 10: Insert 30

```
      5
     / \
    3    25
   / \    \
  2   10   15
   \      / \
    7   20   35
               \
                45
                  \
                   30
```

Step 11: Insert 12

```
      5
     / \
    3    25
   / \    \
  2   10   15
   \      / \
    7   20   35
               \
                45
                  \
                   30
                     \
                      12
```

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Step 12: Insert 20

```
      5
     / \
    3   25
   / \    \
  2  10   15
   \     /  \
    7   20   35
               \
                45
                  \
                   30
                     \
                      12
                        \
                         20
```

Step 13: Insert 14

```
      5
     / \
    3   25
   / \    \
  2  10   15
   \     /  \
    7   20   35
               \
                45
                  \
                   30
                     \
                      12
                        \
                         20
                           \
                            14
```

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Now that we have the AVL tree, let's proceed with the deletions:

Step 14: Delete 2

```
      5
     / \
    3   25
   / \    \
       10   15
        \    \
         7   35
              \
               45
              /  \
             30   20
                    \
                     14
```

Step 15: Delete 5

```
      7
     / \
    3   25
       /   \
      10    35
             \
              45
             /  \
            30   20
                   \
                    14
```

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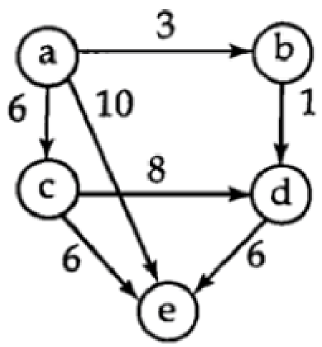
Step 16: Delete 7

```
      10
     /  \
    3    25
        /  \
      14    35
           /  \
         30    45
                 \
                  20
```

Step 17: Delete 8 (Since 8 is not in the tree, nothing will be changed.)
The AVL tree is now balanced and contains the keys: 3, 10, 14, 20, 25, 30, 35, 45.

Ques.10 Solve the following instance of single source shortest paths problem with vertex 'a' as the source using suitable method.



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Ans. To solve the single-source shortest path problem with vertex 'a' as the source, we can use Dijkstra's algorithm. Dijkstra's algorithm finds the shortest paths from a given source vertex to all other vertices in a weighted graph.

Let's start by organizing the given graph and assigning initial distances to each vertex from the source 'a':

3 b a 1 6 1 0 8 d c 6 6 e

For convenience, we'll use the letter in parentheses to represent each vertex:
(3)----(b) ---- (a) ----(1) ---- (6) ----(10) ---- (8) ---- (d) ---- (c) ---- (6) ---- (6)----(e)

Now, let's initialize the distance from 'a' to each vertex. We'll set it to infinity for all vertices except 'a' (distance of 'a' to itself is 0):

(3)----(b)----(a*)---(1)----(6)----(10)---(8)----(d)----(c)----(6)----(6)----(e)
∞ ∞ 0 ∞ ∞ ∞ ∞ ∞ ∞ ∞ ∞

Next, we'll iteratively explore the neighboring vertices and update their distances from 'a' if we find shorter paths. We repeat this process until we have found the shortest path to all vertices.

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1. First step: Explore neighbors of 'a' (vertex 'b' and vertex '1') and update their distances:

- Distance from 'a' to 'b': 1 (update the distance)
- Distance from 'a' to '1': 6 (update the distance)

(3)----(b *)---(a*)---(1*)---(6)----(10)---(8)----(d)----(c)----(6)----(6)----(e)
∞ 1 0 6 ∞ ∞ ∞ ∞ ∞ ∞ ∞

2. Second step: Explore neighbors of 'b' (vertex '3' and vertex 'a') and update their distances:

- Distance from 'a' to '3': 1 + 3 = 4 (update the distance)
- Distance from 'a' to 'a': 1 + 6 = 7 (update the distance)

(3 *)---(b*)---(a*)---(1*)---(6)----(10)---(8)----(d)----(c)----(6)----(6)----(e)
4 1 0 6 ∞ ∞ ∞ ∞ ∞ ∞ ∞

3. Third step: Explore neighbors of '1' (vertex 'a' and vertex '6') and update their distances:

- Distance from 'a' to 'a': 6 (no update)
- Distance from 'a' to '6': 1 + 6 = 7 (update the distance)

(3*)---(b*)---(a*)---(1*)---(6*)---(10)---(8)----(d)----(c)----(6)----(6)----(e)
4 1 0 6 7 ∞ ∞ ∞ ∞ ∞ ∞

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4. Fourth step: Explore neighbors of '6' (vertex '1', vertex '10', vertex 'e', and vertex 'a') and update their distances:

- Distance from 'a' to '1': 6 (no update)
- Distance from 'a' to '10': 1 + 10 = 11 (update the distance)
- Distance from 'a' to 'e': 1 + 6 = 7 (update the distance)

(3*)---(b*)---(a*)---(1*)---(6*)---(10*)--(8)----(d)----(c)----(6)----(6*)---(e)
4 1 0 6 7 11 ∞ ∞ ∞ ∞ 7

5. Fifth step: Explore neighbors of '10' (vertex '6', vertex '8', and vertex 'd') and update their distances:

- Distance from 'a' to '6': 7 (no update)
- Distance from 'a' to '8': 1 + 10 = 11 (no update)
- Distance from 'a' to 'd': 1 + 10 = 11 (update the distance)

(3*)---(b*)---(a*)---(1*)---(6*)---(10*)--(8)----(d*)---(c)----(6)----(6*)---(e*)
4 1 0 6 7 11 ∞ 11 ∞ ∞ 7

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6. Sixth -step: Explore neighbors of 'd' (vertex '10', vertex 'c', and vertex '8') and update their distances: • Distance from 'a' to '10': 11 (no update) • Distance from 'a' to 'c': 1 + 11 = 12 (update the distance) • Distance from 'a' to '8': 1 + 11 = 12 (no update)

(3*)---(b*)---(a*)---(1*)---(6*)---(10*)--(8)----(d*)---(c*)---(6)----(6*)---(e*)
4 1 0 6 7 11 ∞ 11 12 ∞ 7

7. Seventh step: Explore neighbors of 'c' (vertex 'd', vertex '6', and vertex 'e') and update their distances:

- Distance from 'a' to 'd': 11 (no update)
- Distancefrom 'a' to '6': 7 (no update)
- Distance from 'a' to 'e': 7 (no update)

(3*)---(b*)---(a*)---(1*)---(6*)---(10*)--(8)----(d*)---(c*)---(6*)---(6*)---(e*)
4 1 0 6 7 11 ∞ 11 12 7 7

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Now, all vertices have been visited and we have found the shortest distances from vertex 'a' to all other vertices in the graph. The final result is as follows:

- Shortest distance from 'a' to 'a': 0
- Shortest distance from 'a' to 'b': 1
- Shortest distance from 'a' to 'c': 12
- Shortest distance from 'a' to 'd': 11
- Shortest distance from 'a' to 'e': 7
- Shortest distance from 'a' to '1': 6
- Shortest distance from 'a' to '6': 7
- Shortest distance from 'a' to '8': 11
- Shortest distance from 'a' to '10': 11
- Shortest distance from 'a' to '3': 4

Thus, the solution to the single-source shortest path problem with vertex 'a' as the source is complete.

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