

## **University Of Asia Pacific**

#### **Department of CSE**

Course Code : CSE 208

Course Title : Data Structures and Algorithms II Lab

No Of Assignment : 02

Date of Performance: 19.09.2024

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## **Submitted By:**

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**Semester**: 2<sup>nd</sup> Year 2<sup>nd</sup> Semester

## **Submitted To:**

Suri Dipannita Sayeed

Lecturer,

**Department of CSE, UAP** 

## Problem no: 02: Implement insertion and deletion in a balanced binary search tree.

#### Code:

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                  search(struct node* root, int key, int& index, string path = "", int currentIndex = 0) : node
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Start here X BST INSERT_DELETE_SEARCH.cpp X
            #include <iostream>
      2
           using namespace std;
      3
           struct node {
      5
                int kev:
                struct node* left;
      6
                 struct node* right;
      8
      9
     10
           struct node* newNode(int element) {
     11
                struct node* temp = new node();
     12
                temp->key = element;
     13
                temp->left = temp->right = NULL;
     14
                return temp;
     15
     16
     17
           struct node* findMin(struct node* root) {
     18
                while (root && root->left != NULL) {
     19
                     root = root->left;
     20
     21
                return root;
     22
     23
          struct node* search(struct node* root, int key, int& index, string path = "", int currentIndex = 0)
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v search(struct node* root, int key, int& index, string path = "", int currentIndex = 0) : node
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₩ № /** *< 📵 😰 🖏 🖾
Start here × BST INSERT_DELETE_SEARCH.cpp ×
     22
     23
          struct node* search(struct node* root, int key, int& index, string path = "", int currentIndex = 0)
     24
     25
                if (root == NULL) {
     26
                     return NULL;
     27
     28
     29
                if (root->key == key) {
     30
                     cout << "Found at index: " << index << " (Path: " << path << ")" << endl;</pre>
     31
     32
                     return root;
     33
     34
     35
     36
                struct node* leftResult = search(root->left, key, index, path + "left -> ", currentIndex + 1);
     37
                if (leftResult != NULL) {
     38
                     return leftResult;
     39
     40
     41
                return search(root->right, key, index, path + "right -> ", currentIndex + 1);
     42
     43
     44
     45
          struct node* insertNode(struct node* Node, int a) {
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search(struct node* root, int key, int& index, string path = "", int currentIndex = 0): node
<global>
# ₺ /** *< • ② < •
Start here X BST INSERT_DELETE_SEARCH.cpp X
     43 -}
     44
          struct node* insertNode(struct node* Node, int a) {
     45
     46
                if (Node == NULL) {
                    return newNode(a);
     47
     48
     49
                if (a < Node->key) {
     50
                    Node->left = insertNode(Node->left, a);
     51
                } else if (a > Node->key) {
     52
                    Node->right = insertNode(Node->right, a);
     53
     54
                return Node:
     55
     56
     57
     58
          void preOrder(struct node* root) {
     59
               if (root != NULL) {
                     cout << " " << root->key << " ";
     60
     61
                     preOrder(root->left);
     62
                    preOrder(root->right);
     63
     64
     65
           struct node* deleteNode(struct node* root, int t) {
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Start here X BST INSERT_DELETE_SEARCH.cpp X
     65
          struct node* deleteNode(struct node* root, int t) {
     66
                if (root == NULL) {
     67
                    cout << "Value " << t << " is not found for deletion.\n";</pre>
     68
                     return NULL;
     69
     70
     71
     72
                if (t < root->key) {
     73
                     root->left = deleteNode(root->left, t);
     74
                } else if (t > root->key) {
     75
                    root->right = deleteNode(root->right, t);
     76
                } else {
     77
     78
                     if (root->left == NULL) {
                         struct node* temp = root->right;
     79
     80
                         delete root;
     81
                         return temp;
     82
                     } else if (root->right == NULL) {
     83
                         struct node* temp = root->left;
     84
                         delete root:
     8.5
                         return temp;
     86
     87
     88
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∨ main(): int

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# ₺ /** *< • ② ◇ ▷
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     89
                     struct node* temp = findMin(root->right);
     90
                     root->key = temp->key;
     91
                     root->right = deleteNode(root->right, temp->key);
     92
     93
                return root:
     94
     95
     96
          void displayMenu() {
                cout << "Menu:\n";
cout << "1. Insert a node\n";</pre>
     97
     98
     99
                cout << "2. Search for a node\n";</pre>
                cout << "3. Delete a node\n";</pre>
    100
                cout << "4. Display tree (pre-order) \n";</pre>
    101
    102
                cout << "5. Exit\n";</pre>
    103
    104
    105
          \equivint main() {
                struct node* root = NULL;
    106
                int choice, value, index;
    107
    108
    109
                while (true) {
    110
                    displayMenu();
                     cout << "Enter your choice: ";</pre>
    111
    112
                     cin >> choice;
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    104
    105
          \equivint main() {
    106
                 struct node* root = NULL;
    107
                int choice, value, index;
    108
    109
                while (true) {
    110
                     displayMenu();
                     cout << "Enter your choice: ";</pre>
    111
    112
                     cin >> choice;
    113
    114
                     switch (choice) {
    115
    116
                              cout << "Enter the value to insert: ";</pre>
                              cin >> value;
    117
                              root = insertNode(root, value);
    118
    119
                              cout << "Value inserted.\n";</pre>
    120
                              break:
    121
    122
    123
                              cout << "Enter the value to search for: ";</pre>
    124
                              cin >> value;
    125
                               index = -1;
    126
                               if (search(root, value, index) != NULL) {
    127
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                                                                                                                                      ~ E 4 0 P
  <global>

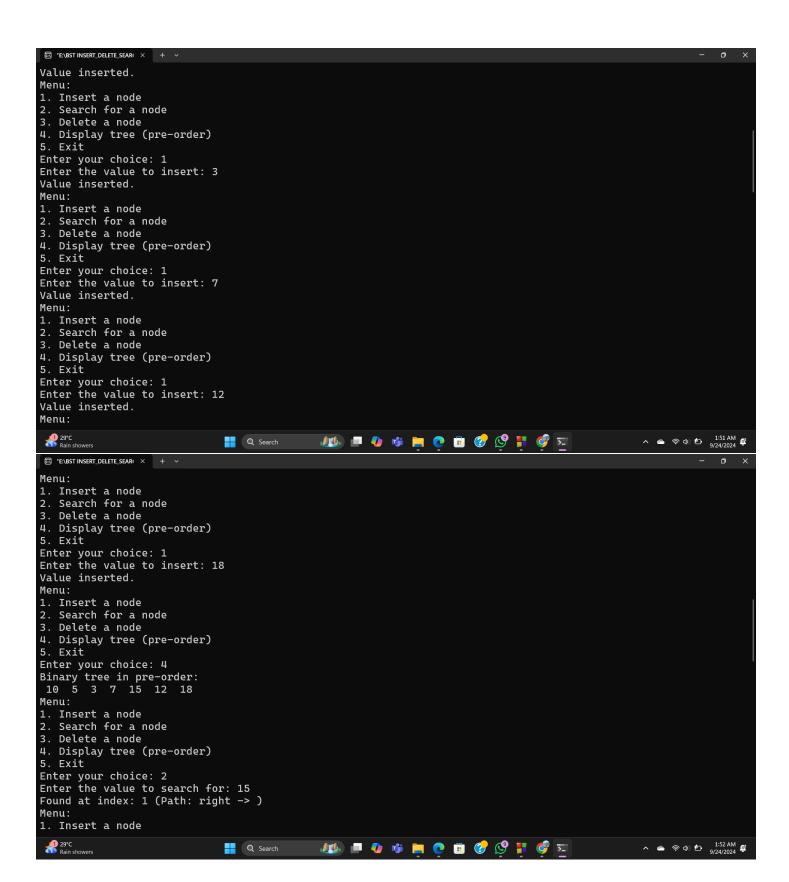
∨ main(): int

  ₩ № /** *< • 2 < •
 Start here X BST INSERT_DELETE_SEARCH.cpp X
             122
                                                                                  case 2:
             123
                                                                                                 cout << "Enter the value to search for: ";</pre>
             124
                                                                                                 cin >> value;
                                                                                                  index = -1;
             125
                                                                                                 if (search(root, value, index) != NULL) {
             126
                                                                                                                // Output handled in search function
             127
             128
                                                                                                  } else {
             129
                                                                                                               cout << "Not Found\n";</pre>
             130
             131
                                                                                                 break;
             132
             133
                                                                                  case 3:
                                                                                                 cout << "Enter the value to delete: ";</pre>
             134
             135
                                                                                                 cin >> value;
             136
                                                                                                 root = deleteNode(root, value);
             137
                                                                                                 break:
             138
             139
                                                                                  case 4:
                                                                                                 cout << "Binary tree in pre-order:\n";</pre>
             140
             141
                                                                                                 preOrder(root);
                                                                                                 cout << endl;
             142
             143
                                                                                                 break:
             144
             145
                                                                                   case 5:
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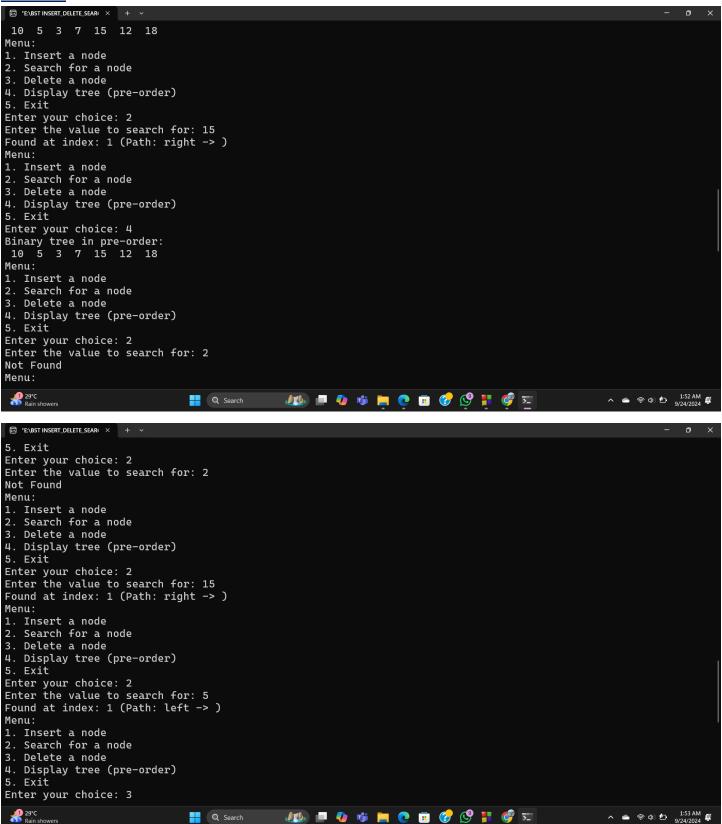
#### **Output:**

#### **Insert:**

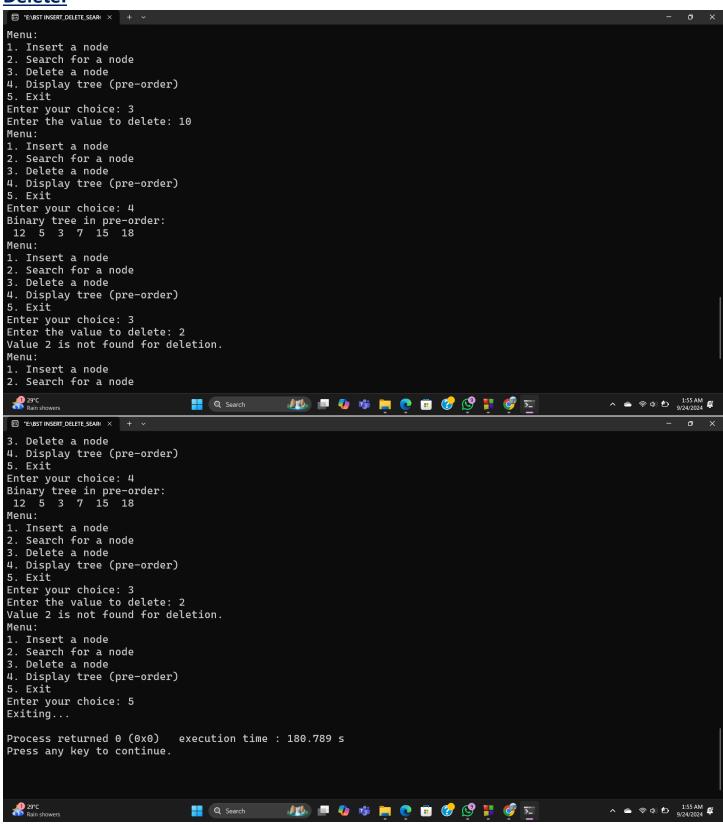
```
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Menu:
1. Insert a node
2. Search for a node
3. Delete a node
4. Display tree (pre-order)
5. Exit
Enter your choice: 1
Enter the value to insert: 10
Value inserted.
Menu:
1. Insert a node
2. Search for a node
3. Delete a node
4. Display tree (pre-order)
5. Exit
Enter your choice: 1
Enter the value to insert: 5
Value inserted.
Menu:
1. Insert a node
2. Search for a node
3. Delete a node
4. Display tree (pre-order)
5. Exit
Enter your choice: 1
Enter the value to insert: 15
Value inserted.
Menu:
1. Insert a node
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```



#### Search:



#### **Delete:**



# Problem:03(Part-1): Discuss time complexity of insertion, deletion and search in a balanced BST.

## **Solution:**

Time complexity between BST insertion, deletion and search is given below:

Operation	Best Case	Average Case	Worst Case
Insertion	O(1)	O(log₂n)	O(log₂n)
Deletion	O(1)	O(log <sub>2</sub> n)	O(log₂n)
Search	O(1)	O(log₂n)	O(log₂n)