# TITLE PAGE

Submitter’s Details :

Name: Karanpreet Singh

Enrollment Number : 18114036

Class : B.tech , CSE 2nd year

Email: ksingh2@cs.iitr.ac.in

Phone – 9530894998

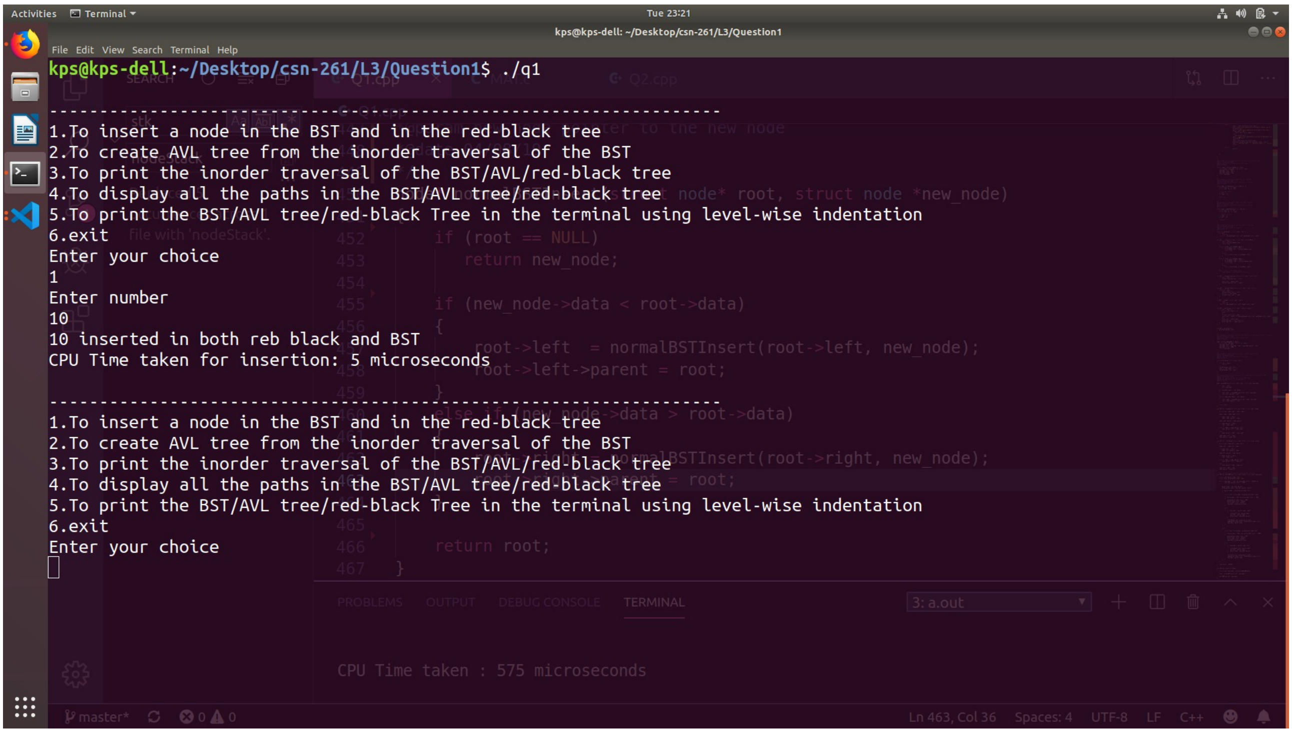
Github repository : https://github.com/karan0299/CSN-261-ASSIGNMENT

Q1.Given the set of integers, write a C++ program to create a binary search tree (BST) and print all possible paths for it. You are not allowed to use subarray to print the paths. Convert the obtained BST into the corresponding AVL tree for the same input. AVL tree is a self-balancing binary search tree. In an AVL tree, the heights of the two child subtrees of any node differ by at most one; if at any time they differ by more than one, rebalancing is done to restore this property.Convert the obtained BST into the corresponding red-black tree for the same input.
Write a menu driven program as follows: 1. To insert a node in the BST and in the red-black tree 2. To create AVL tree from the inorder traversal of the BST3. To print the inorder traversal of the BST/AVL/red-black tree4. To display all the paths in the BST/AVL tree/red-black tree 5. To print the BST/AVL tree/red-black Tree in the terminal using level-wise indentation (print color for red-black tree) 6. Exit

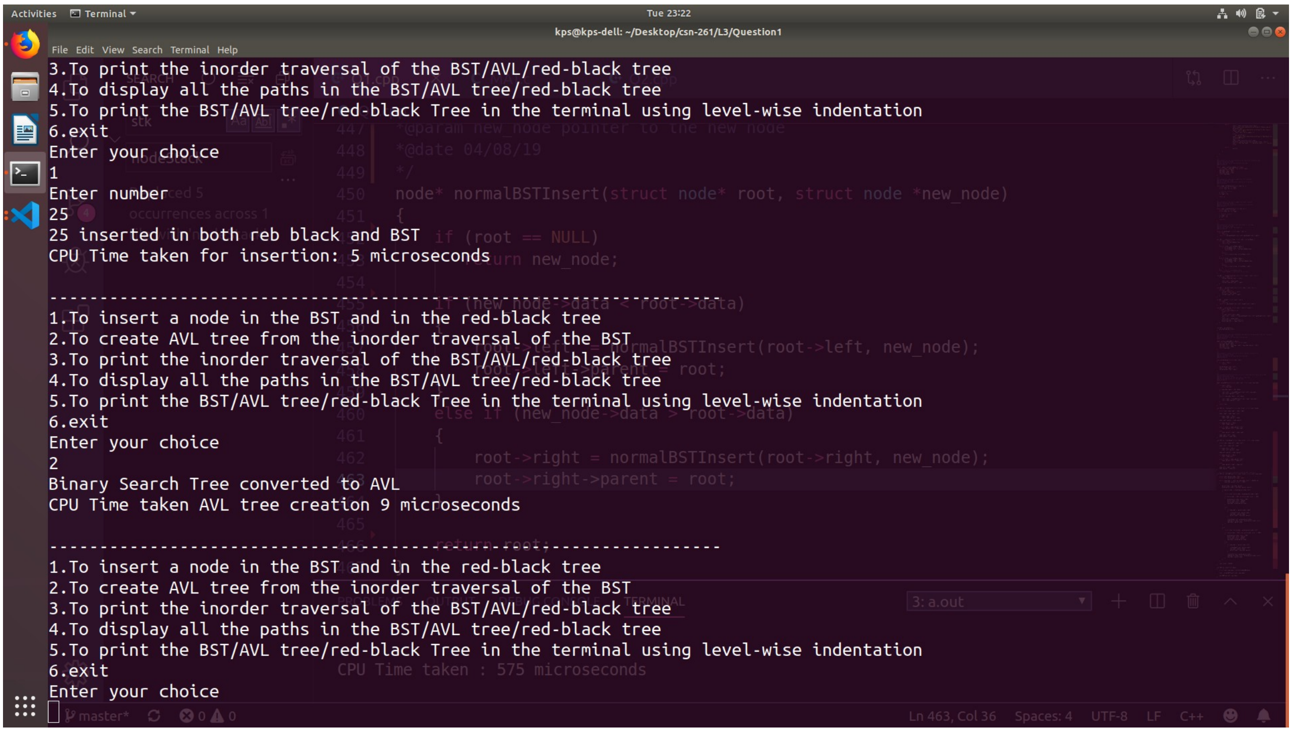
**Data Structures used :**
i) Binary Search Tree
ii) AVL tree
iii)Red Black tree
iv)Stack
v)Map

**Algorithms used :**
i) Insertion in AVL by rotations
ii) Insertion in RedBlackTree

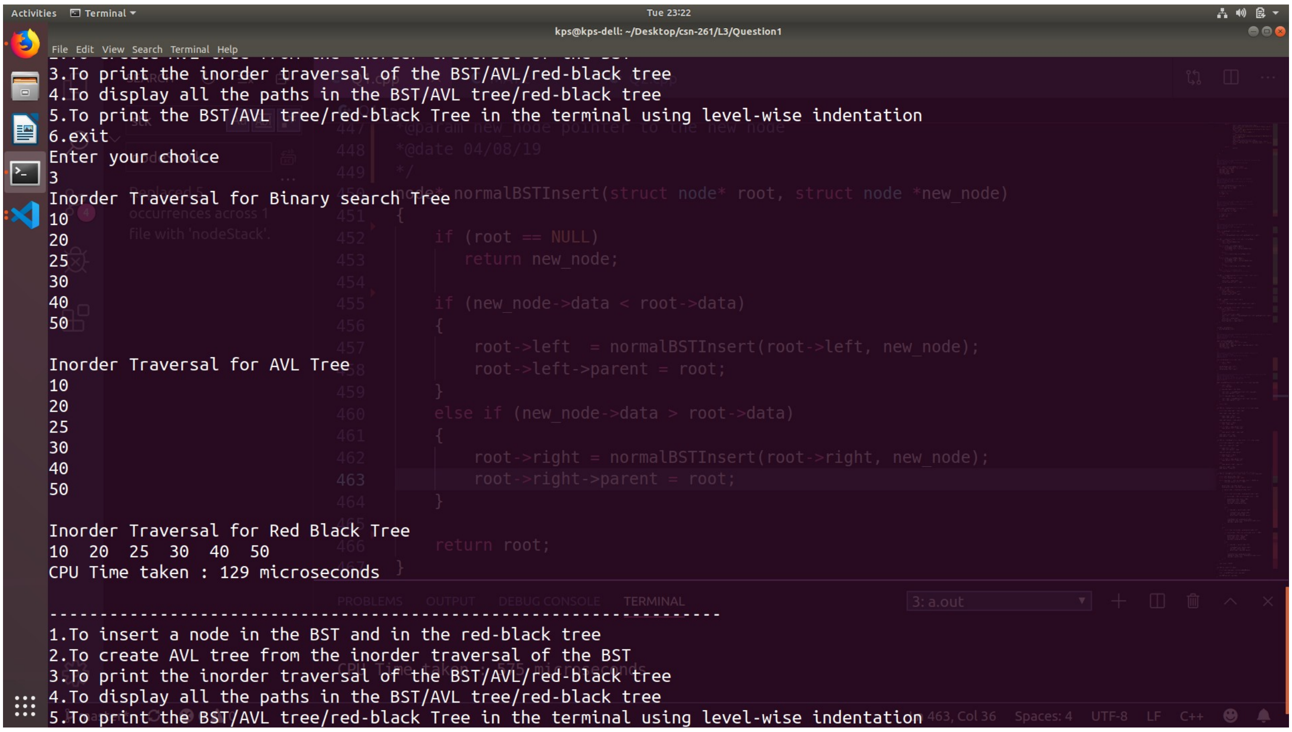
***Screenshots :***


Activities
Terminal
Tue 23:21
kps@kps-dell: ~/Desktop/csn-261/L3/Question1
File Edit View Search Terminal Help

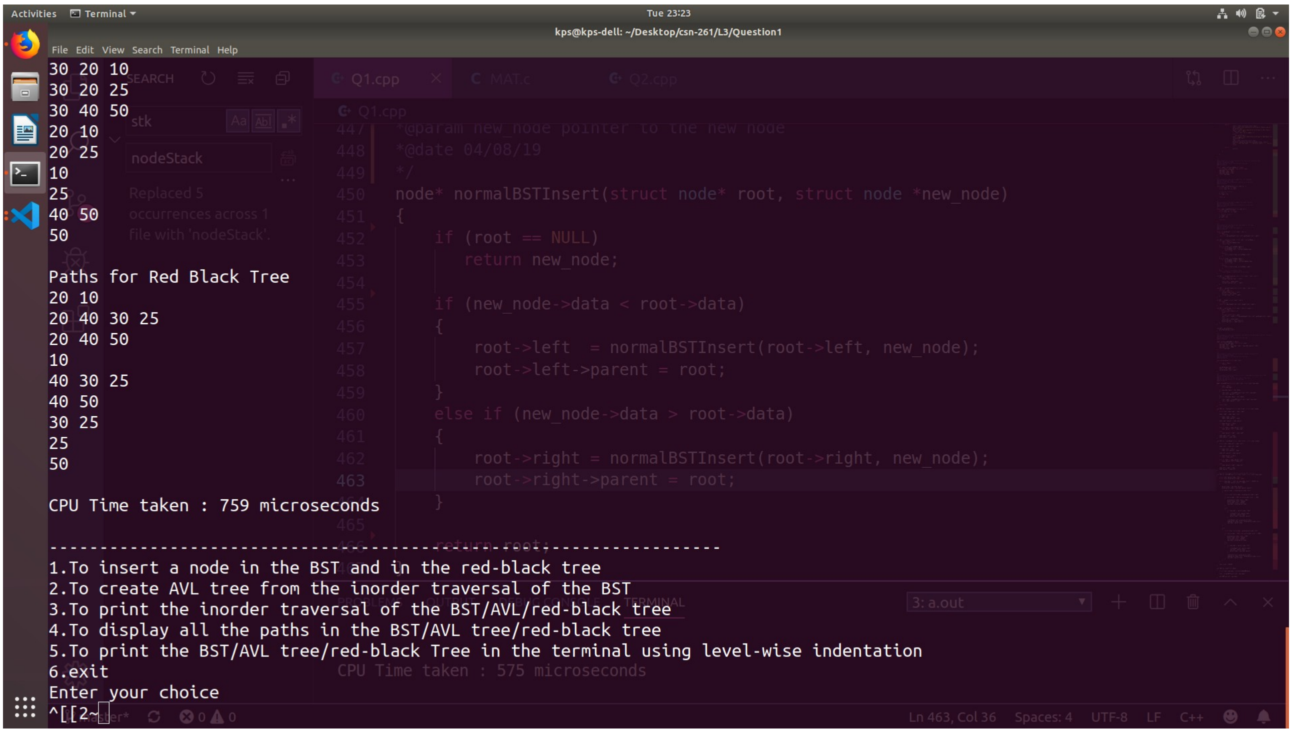
```
kps@kps-dell:~/Desktop/csn-261/L3/Question1$ ./q1

-------------------------------------------------------------------
1.To insert a node in the BST and in the red-black tree
2.To create AVL tree from the inorder traversal of the BST
3.To print the inorder traversal of the BST/AVL/red-black tree
4.To display all the paths in the BST/AVL tree/red-black tree
5.To print the BST/AVL tree/red-black Tree in the terminal using level-wise indentation
6.exit
Enter your choice
1
Enter number
10
10 inserted in both reb black and BST
CPU Time taken for insertion: 5 microseconds

-------------------------------------------------------------------
1.To insert a node in the BST and in the red-black tree
2.To create AVL tree from the inorder traversal of the BST
3.To print the inorder traversal of the BST/AVL/red-black tree
4.To display all the paths in the BST/AVL tree/red-black tree
5.To print the BST/AVL tree/red-black Tree in the terminal using level-wise indentation
6.exit
Enter your choice
```


Activities
Terminal
Tue 23:22
kps@kps-dell: ~/Desktop/csn-261/L3/Question1
File Edit View Search Terminal Help

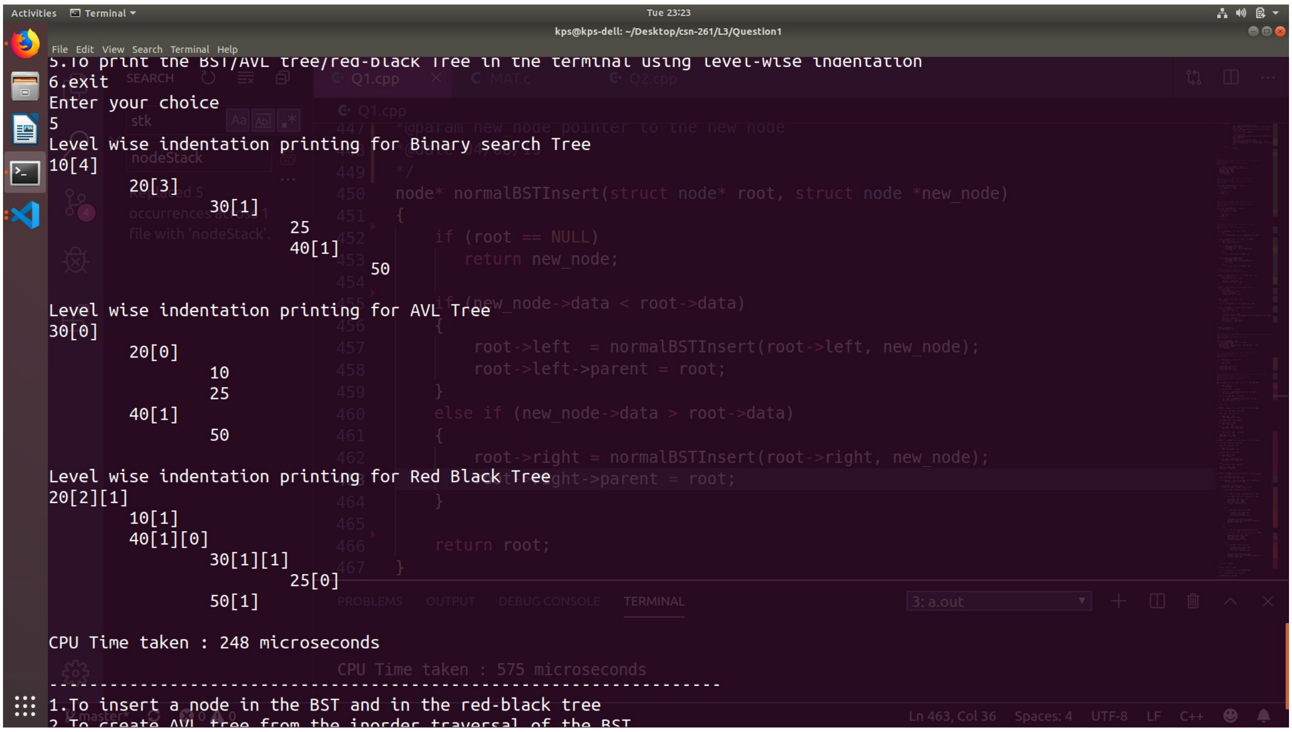
```
3.To print the inorder traversal of the BST/AVL/red-black tree
4.To display all the paths in the BST/AVL tree/red-black tree
5.To print the BST/AVL tree/red-black Tree in the terminal using level-wise indentation
6.exit
Enter your choice
1
Enter number
25
25 inserted in both reb black and BST
CPU Time taken for insertion: 5 microseconds

-------------------------------------------------------------------
1.To insert a node in the BST and in the red-black tree
2.To create AVL tree from the inorder traversal of the BST
3.To print the inorder traversal of the BST/AVL/red-black tree
4.To display all the paths in the BST/AVL tree/red-black tree
5.To print the BST/AVL tree/red-black Tree in the terminal using level-wise indentation
6.exit
Enter your choice
2
Binary Search Tree converted to AVL
CPU Time taken AVL tree creation 9 microseconds

-------------------------------------------------------------------
1.To insert a node in the BST and in the red-black tree
2.To create AVL tree from the inorder traversal of the BST
3.To print the inorder traversal of the BST/AVL/red-black tree
4.To display all the paths in the BST/AVL tree/red-black tree
5.To print the BST/AVL tree/red-black Tree in the terminal using level-wise indentation
6.exit
Enter your choice
```


Activities
Terminal
Tue 23:22
kps@kps-dell: ~/Desktop/csn-261/L3/Question1
File Edit View Search Terminal Help

```
3.To print the inorder traversal of the BST/AVL/red-black tree
4.To display all the paths in the BST/AVL tree/red-black tree
5.To print the BST/AVL tree/red-black Tree in the terminal using level-wise indentation
6.exit
Enter your choice
3
Inorder Traversal for Binary search Tree
10
20
25
30
40
50

Inorder Traversal for AVL Tree
10
20
25
30
40
50

Inorder Traversal for Red Black Tree
10  20  25  30  40  50
CPU Time taken : 129 microseconds

--------------------------------------------------------------------
1.To insert a node in the BST and in the red-black tree
2.To create AVL tree from the inorder traversal of the BST
3.To print the inorder traversal of the BST/AVL/red-black tree
4.To display all the paths in the BST/AVL tree/red-black tree
5.To print the BST/AVL tree/red-black Tree in the terminal using level-wise indentation
```


Activities
Terminal
Tue 23:23
kps@kps-dell: ~/Desktop/csn-261/L3/Question1
File Edit View Search Terminal Help

```
30 20 10
30 20 25
30 40 50
20 10
20 25
10
25
40 50
50

Paths for Red Black Tree
20 10
20 40 30 25
20 40 50
10
40 30 25
40 50
30 25
25
50

CPU Time taken : 759 microseconds

--------------------------------------------------------------------
1.To insert a node in the BST and in the red-black tree
2.To create AVL tree from the inorder traversal of the BST
3.To print the inorder traversal of the BST/AVL/red-black tree
4.To display all the paths in the BST/AVL tree/red-black tree
5.To print the BST/AVL tree/red-black Tree in the terminal using level-wise indentation
6.exit
Enter your choice
^[[2~
```


Activities
Terminal
Tue 23:23
kps@kps-dell: ~/Desktop/csn-261/L3/Question1
File Edit View Search Terminal Help

```
5.To print the BST/AVL tree/red-black Tree in the terminal using level-wise indentation
6.exit
Enter your choice
5
Level wise indentation printing for Binary search Tree
10[4]
        20[3]
                30[1]
                        25
                        40[1]
                                50

Level wise indentation printing for AVL Tree
30[0]
        20[0]
                10
                25
        40[1]
                50

Level wise indentation printing for Red Black Tree
20[2][1]
        10[1]
        40[1][0]
                30[1][1]
                        25[0]
                50[1]

CPU Time taken : 248 microseconds
-------------------------------------------------------------------
1.To insert a node in the BST and in the red-black tree
2.To create AVL tree from the inorder traversal of the BST
```

Q2.For a given sequence of positive integers A1, A2, ..., AN in decimal, find the triples (i, j, k), such that 1 ≤ i < j ≤ k ≤ N and Ai⊕Ai+1⊕...⊕Aj−1 = Aj⊕Aj+1⊕...⊕Ak, where ⊕ denotes bitwise XOR. This problem should be solved using dynamic programming approach and linked list data structures

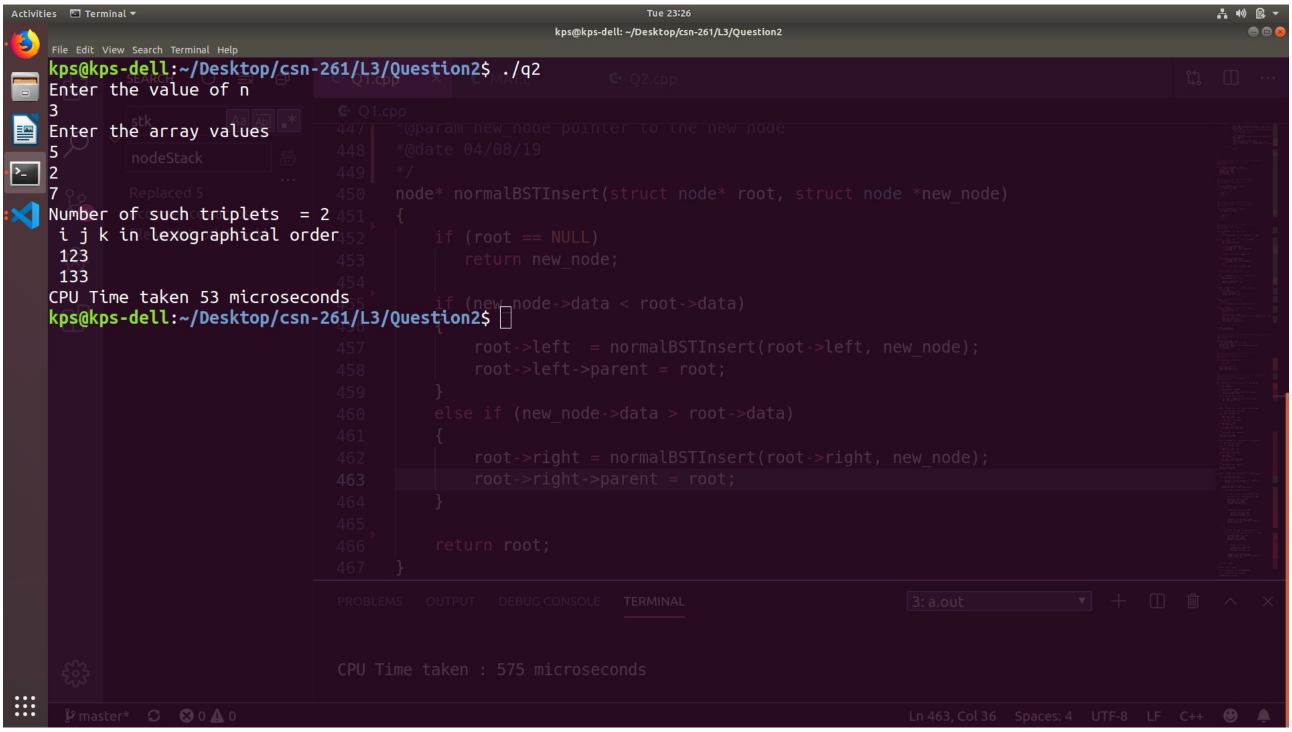
**Data Structures used :**

i) 2D linked list
ii) 1D linked list
iii) vector

**Algorithms used :**

i) Dynamic programming

### ***Screenshots :***



Activities
Terminal
Tue 23:26
kps@kps-dell: ~/Desktop/csn-261/L3/Question2
File Edit View Search Terminal Help

```
kps@kps-dell:~/Desktop/csn-261/L3/Question2$ ./q2
Enter the value of n
3
Enter the array values
5
2
7
Number of such triplets  = 2
 i j k in lexographical order
 123
 133
CPU Time taken 53 microseconds
kps@kps-dell:~/Desktop/csn-261/L3/Question2$ 
```

```
 *@param new_node pointer to the new node
 *@date 04/08/19
 */
node* normalBSTInsert(struct node* root, struct node *new_node)
{
    if (root == NULL)
       return new_node;

    if (new_node->data < root->data)
    {
        root->left  = normalBSTInsert(root->left, new_node);
        root->left->parent = root;
    }
    else if (new_node->data > root->data)
    {
        root->right = normalBSTInsert(root->right, new_node);
        root->right->parent = root;
    }

    return root;
}
```

```
CPU Time taken : 575 microseconds
```