Experiment No. – 3.2

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Subject Name: ADVANCED PROGRAMMING LAB
Subject Code: 20CSP-334

1. Aim/Overview of the practical:

Demonstrate insert ,delete and search in Treap.

2. Task to be done:

Demonstrate insert ,delete and search in Treap.

3. Steps for practical:

Insert

1) Create new node with key equals to x and value equals to a random value.
2) Perform standard BST insert.
3) A newly inserted node gets a random priority, so Max-Heap property may be violated.. Use rotations to make sure that inserted node's priority follows max heap property.

During insertion, we recursively traverse all ancestors of the inserted node.
a) If new node is inserted in left subtree and root of left subtree has higher priority, perform right rotation.
b) If new node is inserted in right subtree and root of right subtree has higher priority, perform left rotation.

Delete:

The delete implementation here is slightly different from the steps discussed in previous post.

1) If node is a leaf, delete it.
2) If node has one child NULL and other as non-NULL, replace node with the non-empty child.
3) If node has both children as non-NULL, find max of left and right children.
….a) If priority of right child is greater, perform left rotation at node
….b) If priority of left child is greater, perform right rotation at node.
The idea of step 3 is to move the node to down so that we end up with either case 1 or case 2.

4 . Code:

```
// C++ program to demonstrate search, insert and delete in Treap
#include <bits/stdc++.h>
using namespace std;

// A Treap Node
struct TreapNode
{
   int key, priority;
   TreapNode *left, *right;
};

/* T1, T2 and T3 are subtrees of the tree rooted with y
  (on left side) or x (on right side)
              y                               x
             / \     Right Rotation          /  \
            x   T3   – – – – – – – >        T1   y
           / \       < - - - - - - -            / \
          T1  T2     Left Rotation            T2  T3 */

// A utility function to right rotate subtree rooted with y
// See the diagram given above.
```

```
TreapNode *rightRotate(TreapNode *y)
{
    TreapNode *x = y->left,  *T2 = x->right;

    // Perform rotation
    x->right = y;
    y->left = T2;

    // Return new root
    return x;
}

// A utility function to left rotate subtree rooted with x
// See the diagram given above.
TreapNode *leftRotate(TreapNode *x)
{
    TreapNode *y = x->right, *T2 = y->left;

    // Perform rotation
    y->left = x;
    x->right = T2;

    // Return new root
    return y;
}

/* Utility function to add a new key */
TreapNode* newNode(int key)
{
    TreapNode* temp = new TreapNode;
    temp->key = key;
    temp->priority = rand()%100;
```

```
    temp->left = temp->right = NULL;
    return temp;
}

// C function to search a given key in a given BST
TreapNode* search(TreapNode* root, int key)
{
    // Base Cases: root is null or key is present at root
    if (root == NULL || root->key == key)
       return root;

    // Key is greater than root's key
    if (root->key < key)
       return search(root->right, key);

    // Key is smaller than root's key
    return search(root->left, key);
}

/* Recursive implementation of insertion in Treap */
TreapNode* insert(TreapNode* root, int key)
{
    // If root is NULL, create a new node and return it
    if (!root)
        return newNode(key);

    // If key is smaller than root
    if (key <= root->key)
    {
        // Insert in left subtree
        root->left = insert(root->left, key);
```

```
        // Fix Heap property if it is violated
        if (root->left->priority > root->priority)
            root = rightRotate(root);
    }
    else  // If key is greater
    {
        // Insert in right subtree
        root->right = insert(root->right, key);

        // Fix Heap property if it is violated
        if (root->right->priority > root->priority)
            root = leftRotate(root);
    }
    return root;
}

/* Recursive implementation of Delete() */
TreapNode* deleteNode(TreapNode* root, int key)
{
    if (root == NULL)
        return root;

    if (key < root->key)
        root->left = deleteNode(root->left, key);
    else if (key > root->key)
        root->right = deleteNode(root->right, key);

    // IF KEY IS AT ROOT

    // If left is NULL
    else if (root->left == NULL)
    {
```

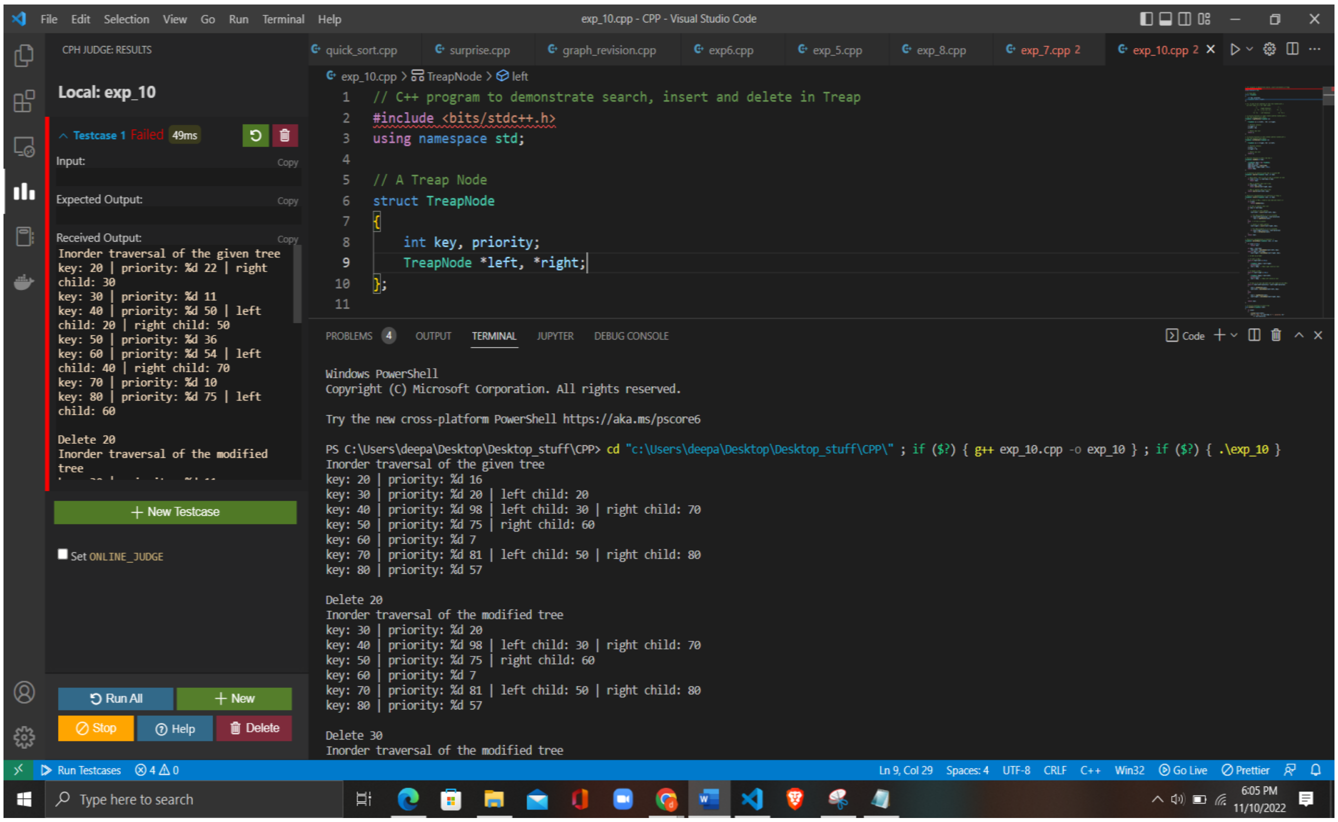
```
        TreapNode *temp = root->right;
        delete(root);
        root = temp;  // Make right child as root
    }

    // If Right is NULL
    else if (root->right == NULL)
    {
        TreapNode *temp = root->left;
        delete(root);
        root = temp;  // Make left child as root
    }

    // If key is at root and both left and right are not NULL
    else if (root->left->priority < root->right->priority)
    {
        root = leftRotate(root);
        root->left = deleteNode(root->left, key);
    }
    else
    {
        root = rightRotate(root);
        root->right = deleteNode(root->right, key);
    }

    return root;
}

// A utility function to print tree
void inorder(TreapNode* root)
{
    if (root)
```

```
    {
        inorder(root->left);
        cout << "key: "<< root->key << " | priority: %d "
            << root->priority;
        if (root->left)
            cout << " | left child: " << root->left->key;
        if (root->right)
            cout << " | right child: " << root->right->key;
        cout << endl;
        inorder(root->right);
    }
}


// Driver Program to test above functions
int main()
{
    srand(time(NULL));

    struct TreapNode *root = NULL;
    root = insert(root, 50);
    root = insert(root, 30);
    root = insert(root, 20);
    root = insert(root, 40);
    root = insert(root, 70);
    root = insert(root, 60);
    root = insert(root, 80);

    cout << "Inorder traversal of the given tree \n";
    inorder(root);

    cout << "\nDelete 20\n";
```

```
    root = deleteNode(root, 20);
    cout << "Inorder traversal of the modified tree \n";
    inorder(root);

    cout << "\nDelete 30\n";
    root = deleteNode(root, 30);
    cout << "Inorder traversal of the modified tree \n";
    inorder(root);

    cout << "\nDelete 50\n";
    root = deleteNode(root, 50);
    cout << "Inorder traversal of the modified tree \n";
    inorder(root);

    TreapNode *res = search(root, 50);
    (res == NULL)? cout << "\n50 Not Found ":
                cout << "\n50 found";

    return 0;
}
```

5. Output:

a)


exp_10.cpp - CPP - Visual Studio Code
Local: exp_10
// C++ program to demonstrate search, insert and delete in Treap
#include <bits/stdc++.h>
using namespace std;
// A Treap Node
struct TreapNode
{
int key, priority;
TreapNode *left, *right;
};
PROBLEMS OUTPUT TERMINAL JUPYTER DEBUG CONSOLE
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.
Try the new cross-platform PowerShell https://aka.ms/pscore6
Inorder traversal of the given tree
Delete 20
Inorder traversal of the modified tree
Delete 30
Inorder traversal of the modified tree


PROBLEMS 4 OUTPUT TERMINAL JUPYTER DEBUG CONSOLE
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.
Try the new cross-platform PowerShell https://aka.ms/pscore6
PS C:\Users\deepa\Desktop\Desktop_stuff\CPP> cd "c:\Users\deepa\Desktop\Desktop_stuff\CPP\" ; if ($?) { g++ exp_10.cpp -o exp_10 } ; if ($?) { .\exp_10 }
Inorder traversal of the given tree
key: 20 | priority: %d 16
key: 30 | priority: %d 20 | left child: 20
key: 40 | priority: %d 98 | left child: 30 | right child: 70
key: 50 | priority: %d 75 | right child: 60
key: 60 | priority: %d 7
key: 70 | priority: %d 81 | left child: 50 | right child: 80
key: 80 | priority: %d 57
Delete 20
Inorder traversal of the modified tree
key: 30 | priority: %d 20
key: 40 | priority: %d 98 | left child: 30 | right child: 70
key: 50 | priority: %d 75 | right child: 60
key: 60 | priority: %d 7
key: 70 | priority: %d 81 | left child: 50 | right child: 80
key: 80 | priority: %d 57

```
PROBLEMS 4   OUTPUT   TERMINAL   JUPYTER   DEBUG CONSOLE                Code

Delete 20
Inorder traversal of the modified tree
key: 30 | priority: %d 20
key: 40 | priority: %d 98 | left child: 30 | right child: 70
key: 50 | priority: %d 75 | right child: 60
key: 60 | priority: %d 7
key: 70 | priority: %d 81 | left child: 50 | right child: 80
key: 80 | priority: %d 57

Delete 30
Inorder traversal of the modified tree
key: 40 | priority: %d 98 | right child: 70
key: 50 | priority: %d 75 | right child: 60
key: 60 | priority: %d 7
key: 70 | priority: %d 81 | left child: 50 | right child: 80
key: 80 | priority: %d 57

Delete 50
Inorder traversal of the modified tree
key: 40 | priority: %d 98 | right child: 70
key: 60 | priority: %d 7
key: 70 | priority: %d 81 | left child: 60 | right child: 80
key: 80 | priority: %d 57

50 Not Found
PS C:\Users\deepa\Desktop\Desktop stuff\CPP>
```

6. Learning Outcomes:

- To learn the basics of Graph to how to take inputs.
- To learn the approach to how to solve problems related to graph.
- To learn about how to use stack data structure.
- To solve the problems using Dynamic Programming.

Evaluation Grid (To be created as per the SOP and Assessment guidelines by the faculty):

Sr. No.	Parameters	Marks Obtained	Maximum Marks
1.			
2.			
3.			