BCSE202P -
Data Structures and Algorithms

Digital Assignment – 3

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1. Write a program to perform the following operations:

a) Create a binary search tree

b) Insert an element into a binary search tree

c) Deletion of an element(all the options)

d) Sort the elements of the BST.

e) Search for an element in the BST

f) Display the leaf nodes alone.

f) Find the minimum and maximum element in the BST

g) Find the kth minimum and maximum element in the BST

CODE

```c
// DA-3
// Dhruv Rajeshkumar Shah
// 21BCE0611

// Binary Search Tree

#include <stdio.h>
#include <stdlib.h>

// Declaring node
struct node
{
    int value;
    struct node *left;
    struct node *right;
};

struct node *root = NULL;

// Function to create a new node
struct node *createNode(int value)
{
    struct node *newNode = (struct node *)malloc(sizeof(struct node));
    newNode->value = value;
    newNode->left = NULL;
    newNode->right = NULL;
    return newNode;
}

// Function to insert a node in BST
struct node *insert(struct node *root, int value)
```

```c
{
    if (root == NULL)
    {
        root = createNode(value);
    }
    else if (value < root->value)
    {
        root->left = insert(root->left, value);
    }
    else
    {
        root->right = insert(root->right, value);
    }
    return root;
}

// Function to delete a node from BST
struct node *delete (struct node *root, int value)
{
    if (root == NULL)
    {
        printf("Element not found in BST");
    }

    else if (value < root->value)
    {
        root->left = delete (root->left, value);
    }
    else if (value > root->value)
    {
        root->right = delete (root->right, value);
    }
    else
    {
        if (root->left == NULL && root->right == NULL)
        {
            free(root);
            root = NULL;
        }
        else if (root->left == NULL)
        {
            struct node *temp = root;
            root = root->right;
            free(temp);
        }
        else if (root->right == NULL)
        {
            struct node *temp = root;
```

```
            root = root->left;
            free(temp);
        }
        else
        {
            struct node *temp = root->right;
            while (temp->left != NULL)
            {
                temp = temp->left;
            }
            root->value = temp->value;
            root->right = delete (root->right, temp->value);
        }
    }

    return root;
}

// Function to sort the BST
void sort(struct node *root)
{
    if (root != NULL)
    {
        sort(root->left);
        printf("%d ", root->value);
        sort(root->right);
    }
}

// Function to search a node in BST
struct node *search(struct node *root, int value)
{
    if (root == NULL)
    {
        printf("Element not found in BST");
    }
    else if (value < root->value)
    {
        root->left = search(root->left, value);
    }
    else if (value > root->value)
    {
        root->right = search(root->right, value);
    }
    else
    {
        printf("Element found in BST");
    }
```

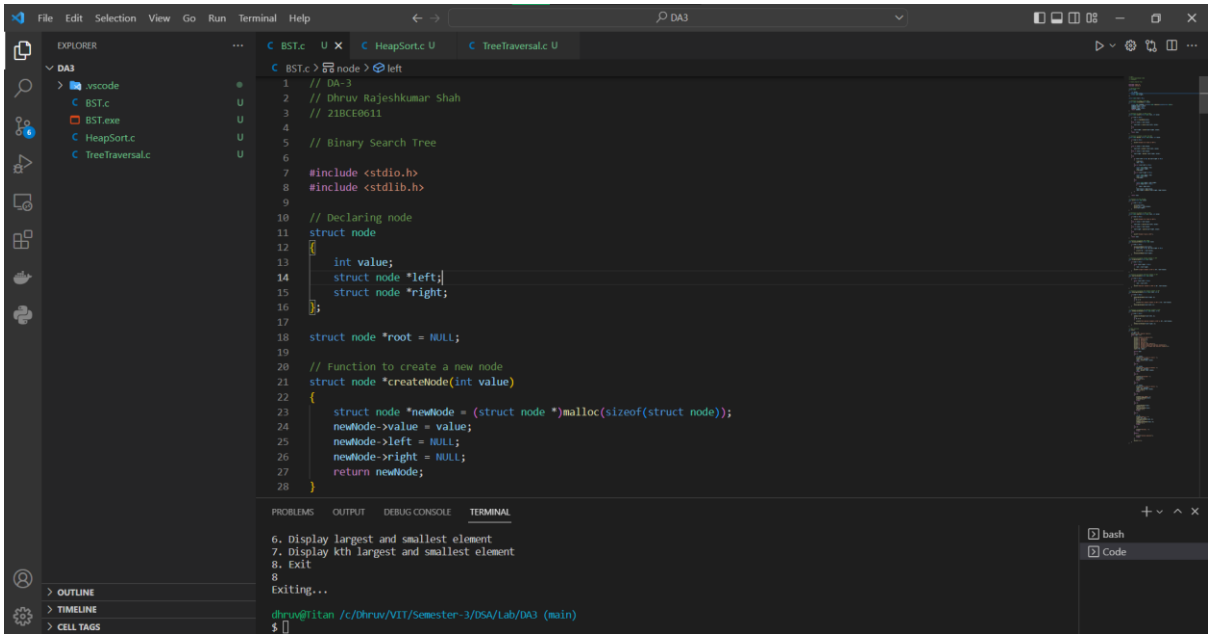
```c
    return root;
}

// Function to display leaf nodes
void displayLeafNodes(struct node *root)
{
    if (root != NULL)
    {
        displayLeafNodes(root->left);
        if (root->left == NULL && root->right == NULL)
        {
            printf("%d ", root->value);
        }
        displayLeafNodes(root->right);
    }
}

// Function to display largest element in BST
void largestElement(struct node *root)
{
    if (root != NULL)
    {
        while (root->right != NULL)
        {
            root = root->right;
        }
        printf("Largest element in BST is %d", root->value);
    }
}

// Function to display smallest element in BST
void smallestElement(struct node *root)
{
    if (root != NULL)
    {
        while (root->left != NULL)
        {
            root = root->left;
        }
        printf("Smallest element in BST is %d", root->value);
    }
}

// Function to display kth largest element in BST
void kthLargestElement(struct node *root, int k)
{
    if (root != NULL)
    {
```

```
        kthLargestElement(root->right, k);
        k--;
        if (k == 0)
        {
            printf("Kth largest element in BST is %d", root->value);
        }
        kthLargestElement(root->left, k);
    }
}

// Function to display kth smallest element in BST
void kthSmallestElement(struct node *root, int k)
{
    if (root != NULL)
    {
        kthSmallestElement(root->left, k);
        k--;
        if (k == 0)
        {
            printf("Kth smallest element in BST is %d", root->value);
        }
        kthSmallestElement(root->right, k);
    }
}

// Main function
int main()
{
    int opt = 0;
    printf("Binary Search Tree\n");
    while (opt != 8)
    {
        printf("Choose an option:\n");
        printf("1. Insert\n");
        printf("2. Delete\n");
        printf("3. Sort\n");
        printf("4. Search\n");
        printf("5. Display leaf nodes\n");
        printf("6. Display largest and smallest element\n");
        printf("7. Display kth largest and smallest element\n");
        printf("8. Exit\n");
        scanf("%d", &opt);

        switch (opt)
        {
        case 1:
        {
            int value;
```

```
            printf("Enter value to insert: ");
            scanf("%d", &value);
            root = insert(root, value);
            break;
        }
        case 2:
        {
            int value;
            printf("Enter value to delete: ");
            scanf("%d", &value);
            root = delete (root, value);
            break;
        }
        case 3:
        {
            printf("Sorted BST: ");
            sort(root);
            printf("\n");
            break;
        }
        case 4:
        {
            int value;
            printf("Enter value to search: ");
            scanf("%d", &value);
            root = search(root, value);
            printf("\n");
            break;
        }
        case 5:
        {
            printf("Leaf nodes: ");
            displayLeafNodes(root);
            printf("\n");
            break;
        }
        case 6:
        {
            largestElement(root);
            printf("\n");
            smallestElement(root);
            printf("\n");
            break;
        }
        case 7:
        {
            int k;
            printf("Enter k: ");
```

```
            scanf("%d", &k);
            kthLargestElement(root, k);
            printf("\n");
            kthSmallestElement(root, k);
            printf("\n");
            break;
        }
        case 8:
        {
            printf("Exiting...");
            break;
        }
        default:
        {
            printf("Invalid option\n");
            break;
        }
        }
        printf("\n");
    }
}
```

SCREENSHOT



OUTPUT

```
dhruv@Titan /c/Dhruv/VIT/Semester-3/DSA/Lab/DA3 (main)
$ gcc -o BST BST.c && ./BST
Binary Search Tree
Choose an option:
1. Insert
2. Delete
3. Sort
4. Search
5. Display leaf nodes
6. Display largest and smallest element
7. Display kth largest and smallest element
8. Exit
1
Enter value to insert: 7

Choose an option:
1. Insert
2. Delete
3. Sort
4. Search
5. Display leaf nodes
6. Display largest and smallest element
7. Display kth largest and smallest element
8. Exit
1
Enter value to insert: 4

Choose an option:
1. Insert
2. Delete
3. Sort
4. Search
5. Display leaf nodes
6. Display largest and smallest element
7. Display kth largest and smallest element
8. Exit
1
Enter value to insert: 10

Choose an option:
1. Insert
2. Delete
3. Sort
4. Search
5. Display leaf nodes
```

```
6. Display largest and smallest element
7. Display kth largest and smallest element
8. Exit
1
Enter value to insert: 2

Choose an option:
1. Insert
2. Delete
3. Sort
4. Search
5. Display leaf nodes
6. Display largest and smallest element
7. Display kth largest and smallest element
8. Exit
1
Enter value to insert: 5

Choose an option:
1. Insert
2. Delete
3. Sort
4. Search
5. Display leaf nodes
6. Display largest and smallest element
7. Display kth largest and smallest element
8. Exit
1
Enter value to insert: 13

Choose an option:
1. Insert
2. Delete
3. Sort
4. Search
5. Display leaf nodes
6. Display largest and smallest element
7. Display kth largest and smallest element
8. Exit
3
Sorted BST: 2 4 5 7 10 13

Choose an option:
1. Insert
2. Delete
```

```
3. Sort
4. Search
5. Display leaf nodes
6. Display largest and smallest element
7. Display kth largest and smallest element
8. Exit
4
Enter value to search: 1
Element not found in BST

Choose an option:
1. Insert
2. Delete
3. Sort
4. Search
5. Display leaf nodes
6. Display largest and smallest element
7. Display kth largest and smallest element
8. Exit
4
Enter value to search: 5
Element found in BST

Choose an option:
1. Insert
2. Delete
3. Sort
4. Search
5. Display leaf nodes
6. Display largest and smallest element
7. Display kth largest and smallest element
8. Exit
5
Leaf nodes: 2 5 13

Choose an option:
1. Insert
2. Delete
3. Sort
4. Search
5. Display leaf nodes
6. Display largest and smallest element
7. Display kth largest and smallest element
8. Exit
6
```

```
Largest element in BST is 13
Smallest element in BST is 2

Choose an option:
1. Insert
2. Delete
3. Sort
4. Search
5. Display leaf nodes
6. Display largest and smallest element
7. Display kth largest and smallest element
8. Exit
7
Enter k: 2
Kth largest element in BST is 5Kth largest element in BST is 4
Kth smallest element in BST is 5Kth smallest element in BST is 10

Choose an option:
1. Insert
2. Delete
3. Sort
4. Search
5. Display leaf nodes
6. Display largest and smallest element
7. Display kth largest and smallest element
8. Exit
2
Enter value to delete: 4

Choose an option:
1. Insert
2. Delete
3. Sort
4. Search
5. Display leaf nodes
6. Display largest and smallest element
7. Display kth largest and smallest element
8. Exit
3
Sorted BST: 2 5 7 10 13

Choose an option:
1. Insert
2. Delete
3. Sort
```

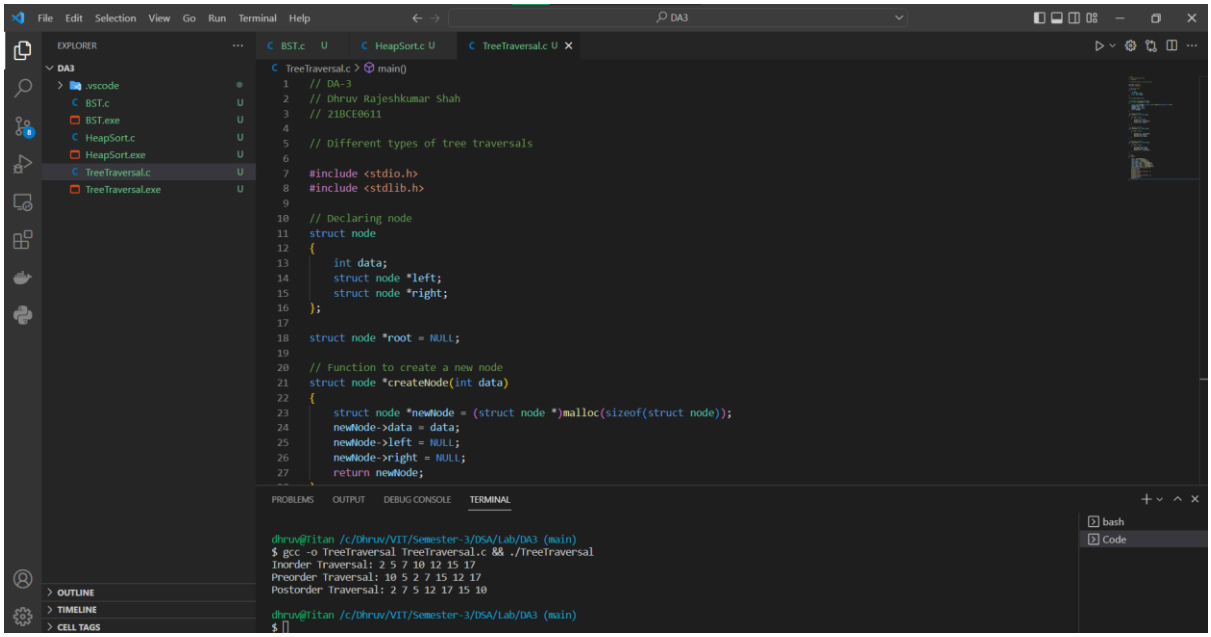
2. Write a program to visit the nodes of a binary tree in all possible ways. Display the order of visiting the nodes.

CODE

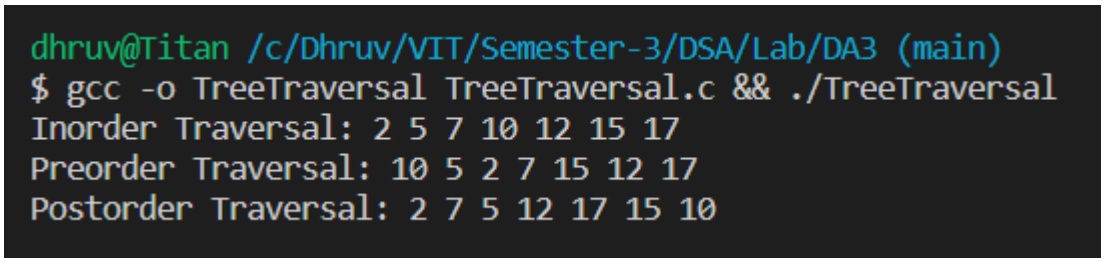
```c
// DA-3
// Dhruv Rajeshkumar Shah
// 21BCE0611

// Different types of tree traversals

#include <stdio.h>
#include <stdlib.h>

// Declaring node
struct node
{
    int data;
    struct node *left;
    struct node *right;
};

struct node *root = NULL;

// Function to create a new node
struct node *createNode(int data)
{
    struct node *newNode = (struct node *)malloc(sizeof(struct node));
    newNode->data = data;
    newNode->left = NULL;
    newNode->right = NULL;
    return newNode;
}

// Inorder Traversal
void inorder(struct node *root)
{
    if (root != NULL)
    {
        inorder(root->left);
        printf("%d ", root->data);
        inorder(root->right);
    }
}

// Preorder Traversal
void preorder(struct node *root)
{
    if (root != NULL)
```

```
    {
        printf("%d ", root->data);
        preorder(root->left);
        preorder(root->right);
    }
}

// Postorder Traversal
void postorder(struct node *root)
{
    if (root != NULL)
    {
        postorder(root->left);
        postorder(root->right);
        printf("%d ", root->data);
    }
}

// Main
int main()
{
    root = createNode(10);
    root->left = createNode(5);
    root->right = createNode(15);
    root->left->left = createNode(2);
    root->left->right = createNode(7);
    root->right->left = createNode(12);
    root->right->right = createNode(17);
    printf("Inorder Traversal: ");
    inorder(root);
    printf("\n");
    printf("Preorder Traversal: ");
    preorder(root);
    printf("\n");
    printf("Postorder Traversal: ");
    postorder(root);
    printf("\n");
    return 0;
}
```

SCREENSHOT



OUTPUT



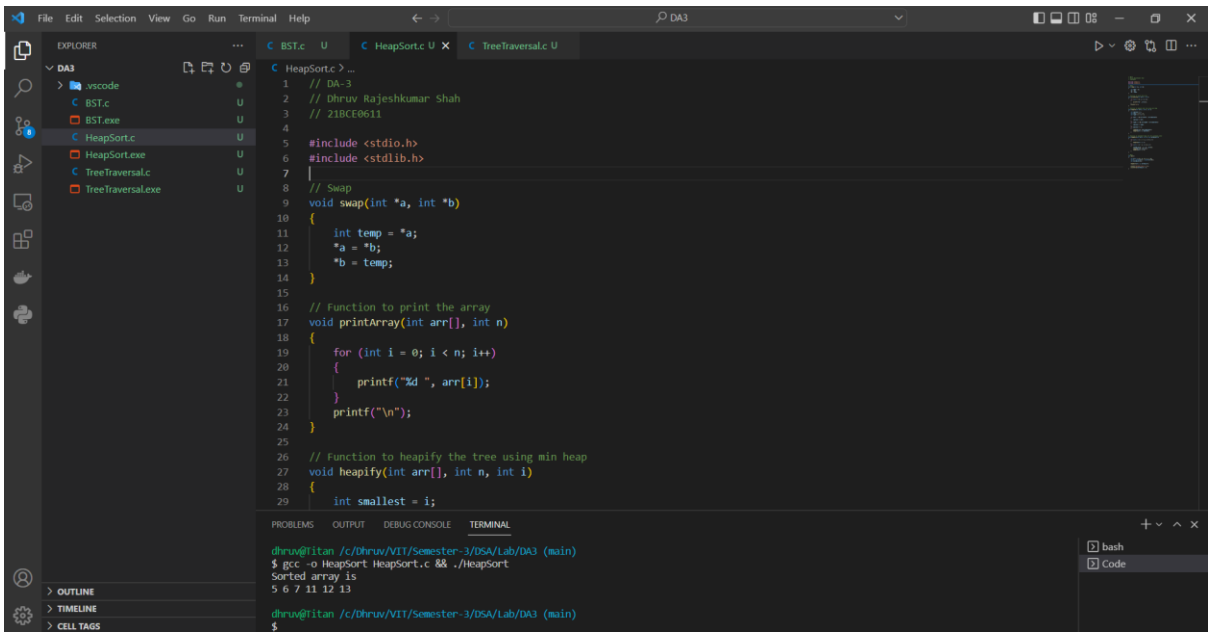
3. Given an array of elements, construct a min Heap and perform in-place sorting (ascending order) using heap sort.

CODE

```c
// DA-3
// Dhruv Rajeshkumar Shah
// 21BCE0611

#include <stdio.h>
#include <stdlib.h>

// Swap
void swap(int *a, int *b)
{
    int temp = *a;
    *a = *b;
    *b = temp;
}

// Function to print the array
void printArray(int arr[], int n)
{
    for (int i = 0; i < n; i++)
    {
        printf("%d ", arr[i]);
    }
    printf("\n");
}

// Function to heapify the tree using min heap
void heapify(int arr[], int n, int i)
{
    int smallest = i;
    int left = 2 * i + 1;
    int right = 2 * i + 2;

    if (left < n && arr[left] < arr[smallest])
    {
        smallest = left;
    }
    if (right < n && arr[right] < arr[smallest])
    {
        smallest = right;
    }
    if (smallest != i)
    {
        swap(&arr[i], &arr[smallest]);
        heapify(arr, n, smallest);
```

```
    }
}

// Function to implement heap sort for ascending order
void heapSort(int arr[], int n, int sorted_arr[])
{
    for (int i = n / 2 - 1; i >= 0; i--)
    {
        heapify(arr, n, i);
    }
    for (int i = n - 1; i >= 0; i--)
    {
        sorted_arr[n - 1 - i] = arr[0];
        swap(&arr[0], &arr[i]);
        heapify(arr, i, 0);
    }
}

// Main
int main()
{
    int arr[] = {12, 11, 13, 5, 7, 6};
    int n = sizeof(arr) / sizeof(arr[0]);
    int sorted_arr[n];

    heapSort(arr, n, sorted_arr);

    printf("Sorted array is \n");
    printArray(sorted_arr, n);
}
```

SCREENSHOT



OUTPUT

```
dhruv@Titan /c/Dhruv/VIT/Semester-3/DSA/Lab/DA3 (main)
$ gcc -o HeapSort HeapSort.c && ./HeapSort
Sorted array is
5 6 7 11 12 13
```