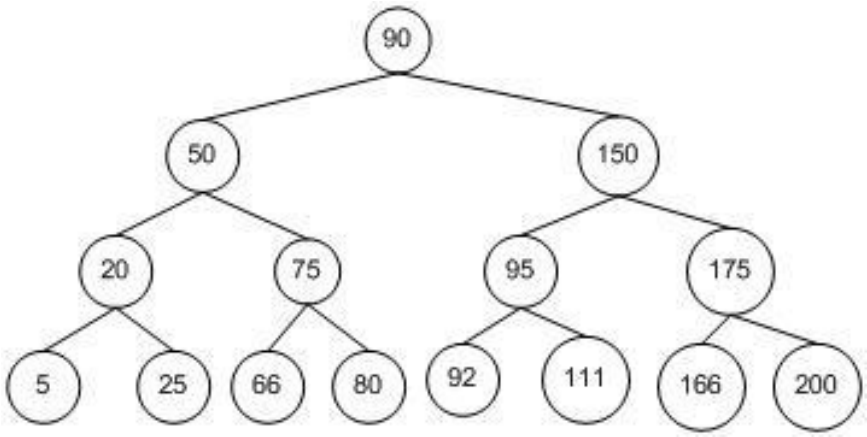
- **Implementation of binary tree with operations like Insertion, deletion, traversal.**

A **Binary Search Tree (BST)** is a widely used data structure. In that data structure, the nodes are in held in a tree-like structure. A Tree-like structure means a parent node is linked with its child nodes. In Binary Search tree a parent node can have only two child node. Nodes in a tree are linked together. The top node is called the root node or simply root.

The Value of parent node should be greater than the value of child node and smaller than equal to the value of right child node.

In the example below, a binary search tree has been implemented. The Tree facilitates you to insert new node and traverse it in various ways.



In **Pre-order (NLR)** the parent node visited first then the left child node and at last the right child node.

In **In-order (LNR)** the left child node visited first then parent node and at last the right child node.

In **Post-order (LRN)** the left child node visited first then the right child node and in last parent node.

```c
# include <stdio.h>
# include <malloc.h>

struct node
{
	int info;
	struct node *lchild;
	struct node *rchild;
}*root;



void find(int item,struct node **par,struct node **loc)
{
	struct node *ptr,*ptrsave;

	if(root==NULL)  /*tree empty*/
	{
		*loc=NULL;
		*par=NULL;
		return;
	}
	if(item==root->info) /*item is at root*/
	{
		*loc=root;
		*par=NULL;
		return;
	}
	/*Initialize ptr and ptrsave*/
	if(item<root->info)
		ptr=root->lchild;
	else
		ptr=root->rchild;
	ptrsave=root;

	while(ptr!=NULL)
	{
		if(item==ptr->info)
		{	*loc=ptr;
			*par=ptrsave;
			return;
		}
		ptrsave=ptr;
		if(item<ptr->info)
			ptr=ptr->lchild;
		else
			ptr=ptr->rchild;
```

```
        }/*End of while */
        *loc=NULL;   /*item not found*/
        *par=ptrsave;
}/*End of find()*/

void insert(int item)
{       struct node *tmp,*parent,*location;
       find(item,&parent,&location);
       if(location!=NULL)
       {
              printf("Item already present");
              return;
       }

       tmp=(struct node *)malloc(sizeof(struct node));
       tmp->info=item;
       tmp->lchild=NULL;
       tmp->rchild=NULL;

       if(parent==NULL)
              root=tmp;
       else
              if(item<parent->info)
                     parent->lchild=tmp;
              else
                     parent->rchild=tmp;
}/*End of insert()*/


void case_a(struct node *par,struct node *loc )
{
       if(par==NULL) /*item to be deleted is root node*/
              root=NULL;
       else
              if(loc==par->lchild)
                     par->lchild=NULL;
              else
                     par->rchild=NULL;
}/*End of case_a()*/

void case_b(struct node *par,struct node *loc)
{
       struct node *child;

       /*Initialize child*/
       if(loc->lchild!=NULL) /*item to be deleted has lchild */
              child=loc->lchild;
       else                  /*item to be deleted has rchild */
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                child=loc->rchild;

        if(par==NULL )    /*Item to be deleted is root node*/
                root=child;
        else
                if( loc==par->lchild)   /*item is lchild of its
parent*/
                        par->lchild=child;
                else                    /*item is rchild of its parent*/
                        par->rchild=child;
}/*End of case_b()*/

void case_c(struct node *par,struct node *loc)
{
        struct node *ptr,*ptrsave,*suc,*parsuc;

        /*Find inorder successor and its parent*/
        ptrsave=loc;
        ptr=loc->rchild;
        while(ptr->lchild!=NULL)
        {
                ptrsave=ptr;
                ptr=ptr->lchild;
        }
        suc=ptr;
        parsuc=ptrsave;

        if(suc->lchild==NULL && suc->rchild==NULL)
                case_a(parsuc,suc);
        else
                case_b(parsuc,suc);

        if(par==NULL) /*if item to be deleted is root node */
                root=suc;
        else
                if(loc==par->lchild)
                        par->lchild=suc;
                else
                        par->rchild=suc;

        suc->lchild=loc->lchild;
        suc->rchild=loc->rchild;
}/*End of case_c()*/
int del(int item)
{
        struct node *parent,*location;
        if(root==NULL)
        {
```

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                printf("Tree empty");
                return 0;
        }

        find(item,&parent,&location);
        if(location==NULL)
        {
                printf("Item not present in tree");
                return 0;
        }

        if(location->lchild==NULL && location->rchild==NULL)
                case_a(parent,location);
        if(location->lchild!=NULL && location->rchild==NULL)
                case_b(parent,location);
        if(location->lchild==NULL && location->rchild!=NULL)
                case_b(parent,location);
        if(location->lchild!=NULL && location->rchild!=NULL)
                case_c(parent,location);
        free(location);
}/*End of del()*/

int preorder(struct node *ptr)
{
        if(root==NULL)
        {
                printf("Tree is empty");
                return 0;
        }
        if(ptr!=NULL)
        {
                printf("%d  ",ptr->info);
                preorder(ptr->lchild);
                preorder(ptr->rchild);
        }
}/*End of preorder()*/

void inorder(struct node *ptr)
{
        if(root==NULL)
        {
                printf("Tree is empty");
                return;
        }
        if(ptr!=NULL)
        {
                inorder(ptr->lchild);
                printf("%d  ",ptr->info);
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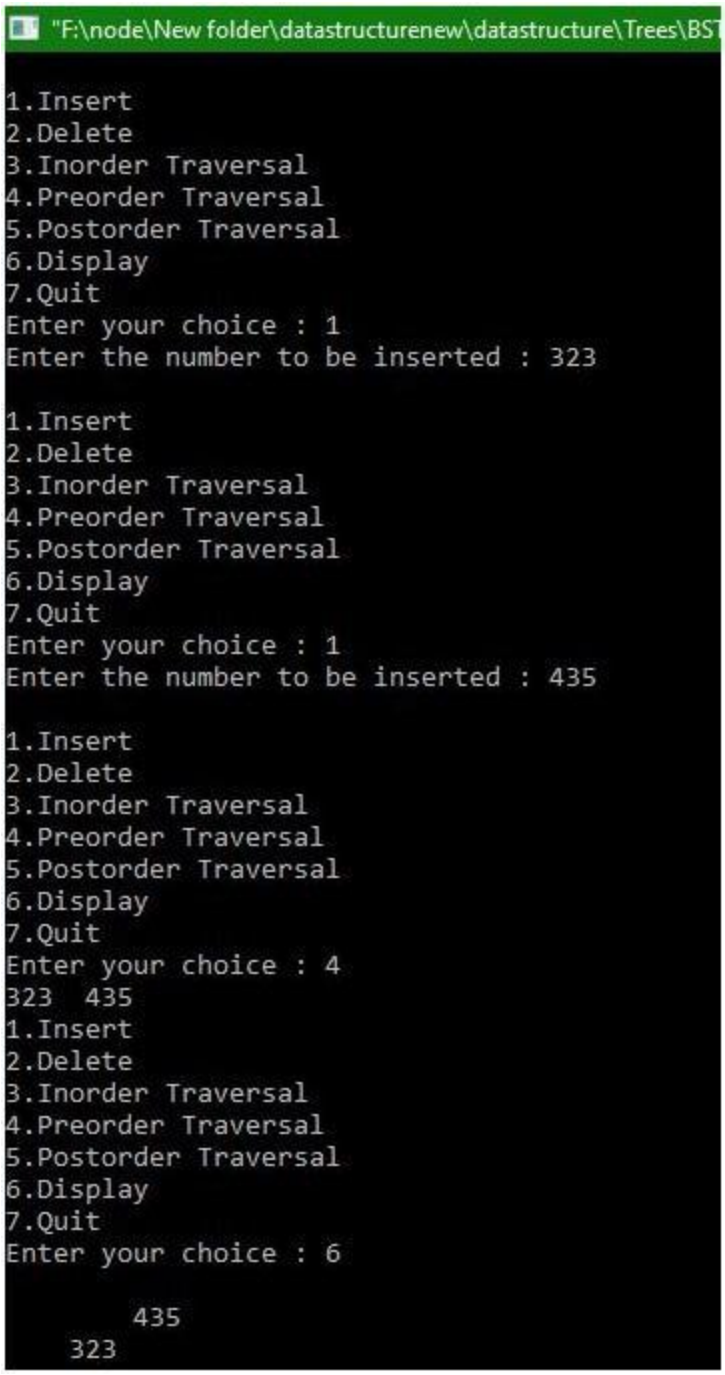
                inorder(ptr->rchild);
        }
}/*End of inorder()*/

void postorder(struct node *ptr)
{
        if(root==NULL)
        {
                printf("Tree is empty");
                return;
        }
        if(ptr!=NULL)
        {
                postorder(ptr->lchild);
                postorder(ptr->rchild);
                printf("%d  ",ptr->info);
        }
}/*End of postorder()*/

void display(struct node *ptr,int level)
{
        int i;
        if ( ptr!=NULL )
        {
                display(ptr->rchild, level+1);
                printf("\n");
                for (i = 0; i < level; i++)
                        printf("    ");
                printf("%d", ptr->info);
                display(ptr->lchild, level+1);
        }/*End of if*/
}/*End of display()*/
main()
{
        int choice,num;
        root=NULL;
        while(1)
        {
                printf("\n");
                printf("1.Insert\n");
                printf("2.Delete\n");
                printf("3.Inorder Traversal\n");
                printf("4.Preorder Traversal\n");
                printf("5.Postorder Traversal\n");
                printf("6.Display\n");
                printf("7.Quit\n");
                printf("Enter your choice : ");
                scanf("%d",&choice);
```

```
            switch(choice)
            {
             case 1:
                   printf("Enter the number to be inserted : ");
                   scanf("%d",&num);
                   insert(num);
                   break;
             case 2:
                   printf("Enter the number to be deleted : ");
                   scanf("%d",&num);
                   del(num);
                   break;
             case 3:
                   inorder(root);
                   break;
             case 4:
                   preorder(root);
                   break;
             case 5:
                   postorder(root);
                   break;
             case 6:
                   display(root,1);
                   break;
             case 7:
          break;
             default:
                   printf("Wrong choice\n");
            }/*End of switch */
      }/*End of while */
}/*End of main()*/
```

Output:


"F:\node\New folder\datastructurenew\datastructure\Trees\BST
1.Insert
2.Delete
3.Inorder Traversal
4.Preorder Traversal
5.Postorder Traversal
6.Display
7.Quit
Enter your choice : 1
Enter the number to be inserted : 323
1.Insert
2.Delete
3.Inorder Traversal
4.Preorder Traversal
5.Postorder Traversal
6.Display
7.Quit
Enter your choice : 1
Enter the number to be inserted : 435
1.Insert
2.Delete
3.Inorder Traversal
4.Preorder Traversal
5.Postorder Traversal
6.Display
7.Quit
Enter your choice : 4
323 435
1.Insert
2.Delete
3.Inorder Traversal
4.Preorder Traversal
5.Postorder Traversal
6.Display
7.Quit
Enter your choice : 6
435
323