Sub:- DSAL

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Assignment - 01

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Problem Statement -

Beginning with an empty B.T. Construct B.T. by inserting values in the order given. After Constructing a B.T. perform following operations on it.

* Perform inorder / Preorder / Postorder traversal
* change a tree so that the roles of the left and right pointers are swapped at every node.
* Find the height of tree.
* Copy the tree to another (= operator)
* Count the no of leaves, number of internal nodes
* Erase all the nodes in B.T.
  (impliment both recursive and non-recursive method)

Learning Objective -

1) To impliment non-linear data structure binary tree.
2) To impliment several operations on B.T. using the concept of OOP.

Learning Outcomes :-

1) We will able to construct binary tree data structure using oop concept.
2) We will get an idea of how to impliment operations on binary tree data structure.

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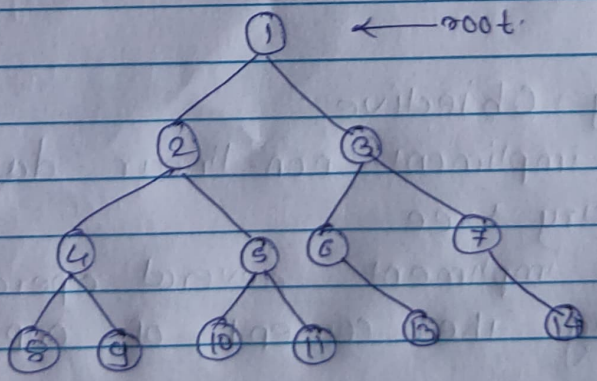
Concepts related to binary tree:-

Binary Tree data structure-

- B.T is tree type non-linear data structure with maximum of two children for every parent.
- Every node in a binary tree has a left and right reference along with data element the nodes that hold other sub node are parent nodes. A parent node has two child nodes left child and right child.
- The top nodes in the B.T is reffer as 'root'.

eg:-



A refference (left or right which dose'nt point to any other node is reffered as "NULL".

* Pseudocode -

① Class Node // Contains basic structure of node in B.T.
{
int data; // stores info of node
Node *lchild; // ptr to left child
Node *rchild; // ptr to right child
}

② Class stack // storing nodes
Node *S.item[max] // stack using an array.
int top; // index of top elem.
void Push(Node*) // add node
Node* Pop() // deletes & return node
int isEmpty() // return 1 is stack is empty
}

③ Algorithm push (Node *ptr)
{ // add item of type Node* into the stack.
if (top == (max-1) then
print "stack overflow"
else
top = top + 1
S.item[top] = ptr
}

```
Class BinaryTree // Contains all operation on B.T.
{
  Node *root; // holds address of root node in BT.
  Node *CreateTreeRecursivly()
  Void inorderRecursivly(Node*)
  Void PreorderRecursivly(Node*)
  Void PostorderRecursivly(Node*)

  Node *Create_iteratively()
  Void inorder_iteratively()
  Void preorder_iteratively()
  Void Postorder_iteratively()

  Void heightRecursivly(Node*)
  Void heightIteratively(Node*)
  Void mirrorRecursivly(Node*)
  Void mirrorIteratively(Node*)

  int leafnodeRecursivly(Node*)
  int leafnodeIteratively()
  int internalRecursivly(Node*)
  int internalIteratively()

  Void deleteRecursivly(Node*)
  Void deleteIteratively()
}
```

```
Algorithm Create_tree_Recursivly ()
 // Create tree return root node by Recursion.
{
   int element;
   Node *ptr = New Node();
   input element;
   if(element == -1) then
          return NULL;
   ptr := data = element;
   input ptr → data  // left child data.
   ptr → lchild = call createtree Recursivly ();
   input ptr → data  //right child data;
   ptr → rchild = Call Create_tree Recursivly ();
   return ptr;
}

Algorithm inorder-traversal
 // display BT element in order seq via recursion
  {
    if (ptr == NULL) then
        return.
    else:
        Call inorder_traversal_Recursivly (ptr → rchild)
        print (ptr → data)
        Call inorder_traversal Recursivly (ptr → lchild)
  }
```

```
// Algorithm Preorder Recursivly (Node *ptr)
{
  // display BT element in Preorder seq via
     recursion.
{
   if (ptr == NULL) then
         return;
   else.
         Print ptr → data;
         Call Preorder Recursivly ( ptr → lchild )
         Call Preorder Recursivly (ptr → rchild)
}
```

```
Algorithm PostorderRecursivly (Node* ptr)
  {
   // display BT. elem in Postorder seq via
      recursion
{
   if (ptr == NULL) then
        return
   else.
     Call Postorder Recursivly (ptr → lchild)
     Call Postorder Recursivly (ptr → rchild)
     Print (ptr → data)
```

```
Algorithm CreateTree iteratively ()
  // Create tree using loop & returns node.
{
  int element;
  Queue q; // q is object of class Queue.
  if (root == NULL) then
     Print element;
     Node *ptr = newNode (element)
     root = ptr;
     q.enqueue (ptr)
  while ( ! q.isEmpty())
     Node *ptr = q.dequeu();
     input element
     if (element = -1)
        ptr -> lchild = NULL
     else
        ptr -> lchild = newNode (element)
        q.enqueue (lchild)
     input element
     if (element != -1) then
        ptr -> rchild = NULL
     else
        ptr -> rchild = newNode (element)
        q.enqueue (ptr -> rchild)
  return root;
}
```

```
Algorithm inorderIteratively()
{
  stack s.
  Node *curr = root.
  while( curr != NULL || !s.isEmpty() )
     while( curr != NULL )
        s.push(curr)
        curr = curr->lchild
     curr = s.pop()
     Print curr->data.
     curr := curr->rchild.
}
```

```
Algorithm PreorderIteratively(Node *ptr)
  // display BT element. Iteratively
  if (root == NULL) then
     return.
  Stack s.;
  s.push (ptr)
  While (!s.isEmpty())
     Node *node = s.pop();
     Print node -> data;
     if (node->lchild) then
        s.push(node->lchild);
     if (node->rchild) then
        s.push(node->rchild);
}
```

```
Algorithm heightRecursivly (Node * ptr)
{ if (ptr == NULL) return 0.
   right = heightRecursivly (ptr -> lchild)
   left = heightRecursivly (ptr -> rchild)
if (right > left) return (right + 1)
else return (left + 1);
}

Algorithm heightIteratively ()
{ if (root == NULL)
    return
  else.
  Queue q
   q.push (root)
   height = 0.
   while(true){
       int. n = q.size().
       if (n == 0)
         return height
       height++.
       while (n > 0)
       Node * node = q.pop();
       if (node -> lchild)
          q.push(node -> lchild)
       if (node -> rchild)
          q.push (node -> rchild)
```

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Algorithm

```
mirror Recursivly (Node *ptr)
{
 if (ptr -> lchild == NULL || ptr -> rchild == NULL) {
 return }
 Node *t = ptr -> lchild;
 ptr -> lchild = ptr -> rchild;
 ptr -> rchild = t;
 if (ptr -> lchild) {
    mirrorRecursivly (ptr -> lchild)
 if (ptr -> rchild)
    mirror Recursivly (ptr -> rchild)
```

Algorithm.

```
mirrortree Iteratively ()
 if (root == NULL) {
    return.
  }
 Queue. q;
  q.push (root)
 while. (!q.isEmpty()) {
   Node *node = q.pop();
   Swap (node -> lchild, node -> rchild)
   if (node -> lchild)
      q.push (node -> lchild);
   if (node -> rchild)
      q.push (node -> rchild);
```

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Algorithm

```
leafNodeRecursivly (Node *ptr)
  if (ptr == NULL)
      return 0.
  if (ptr -> lchild == NULL && ptr -> rchild == NULL)
      return 1
  else. return
      (leafnode Recursivly (ptr -> lchild) +
       leafnode Recursivly (ptr -> rchild)
```

Algorithm leafnode Iteratively ()

```
  if (root == NULL)
      return 0
  else.
  Queue q;
  q. push (root)
  while ( ! q. isEmpty())
    Struct. Node *temp = q.pop
  if temp -> lchild != NULL)
      q. push (temp -> lchild)
  if (temp -> rchild != NULL)
      q. push (temp -> rchild)
  return Count.
```

```
Algorithm deleteRecursivly (Node *ptr)
{ if(ptr == NULL)
    return;
  deleteRecursivly (ptr->lchild)
  deleteIterativly (ptr->rchild)
  delete ptr.
  ptr = NULL;
}
```

```
Algorithm deleteIterativly()
  if(root == NULL)
    return.
  Queue q.
  q.push(root);
  while(!q.isEmpty()){
    Node *front;
    front = q.pop();
    if(front->lchild)
      q.push(front->lchild)
    if(front->rchild)
      q.push(front->rchild)
    delete front.
  root = NULL
}
```

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Test case.	Description.	Actual O/P	exp. O/P	Result.
①	Root data: 10 lchild of 10: 20 rchild of 10: 30			
	inorder.	20→10→30	20→10→30	pass.
	Preorder	10→20→30	10→20→30	pass.
	Postorder.	20→30→10	20→30→10	Pass
	height	2	2	pass.
	leaf node	2	2	Pass
	internal node	1	1	Pass

* Time Complexities :-

CreateRecursivly()	O(n)
CreateIteratively()	O(n)
inorderRecursivly(Node*)	O(n)
inorderIteratively()	$O(n^2)$
preorderRecursivly(Node*)	O(n)
PreorderIteratively()	O(n)
PostorderRecursivly(Node*)	O(n)
postorderiteratively	O(n)
heightRecursivly(Node*	O(n)
heightiteratively()	O(n)
mirrorRecursivly(Node*)	O(n)
mirroriteratively()	O(n)
NodecountRecursivly(Node*)	O(n)
Nodecountiteratively()	O(n)
deleteRecursivly(Node*)	O(n)
deleteIteratively()	O(n)

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Realtime Applications -

① Store hierarchical data like folder structure xml/ HTML parser.

② BST is a tree that allows fast search.

Conclusion -

Successfully implimented B.T. data structure & performed basic operations on it.