DATA STRUCTURES AND ITS APPLICATIONS
UE19CS202

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DATA STRUCTURES AND ITS APPLICATIONS

Threaded BST and its Implementation

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Threaded Binary Search Tree

Motivation

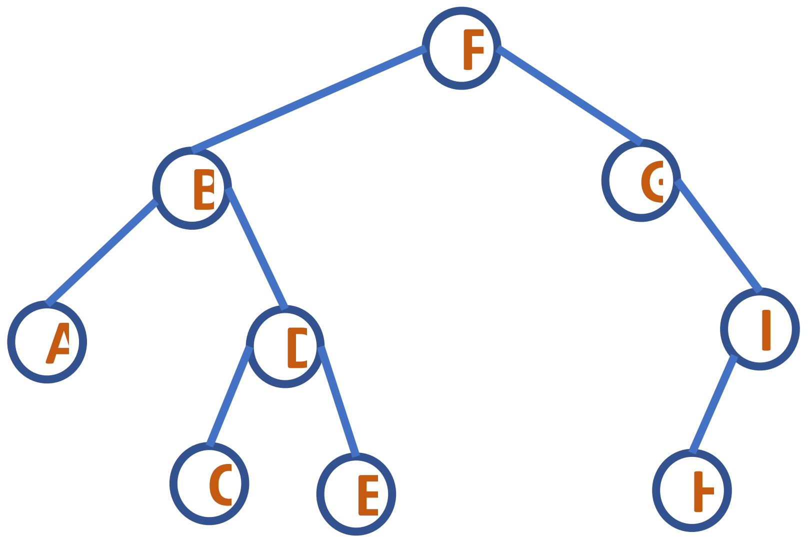
- Iterative Inorder Traversal requires Explicit stack
- Costly
- Since we loose track of address as and when we navigate, Node addresses were stacked
- If this can be achieved through some other less expensive mechanism, we can eliminate the use of explicit stack
- Small structural modification carried on Binary tree will solve the above problem

Threaded Binary Search Tree

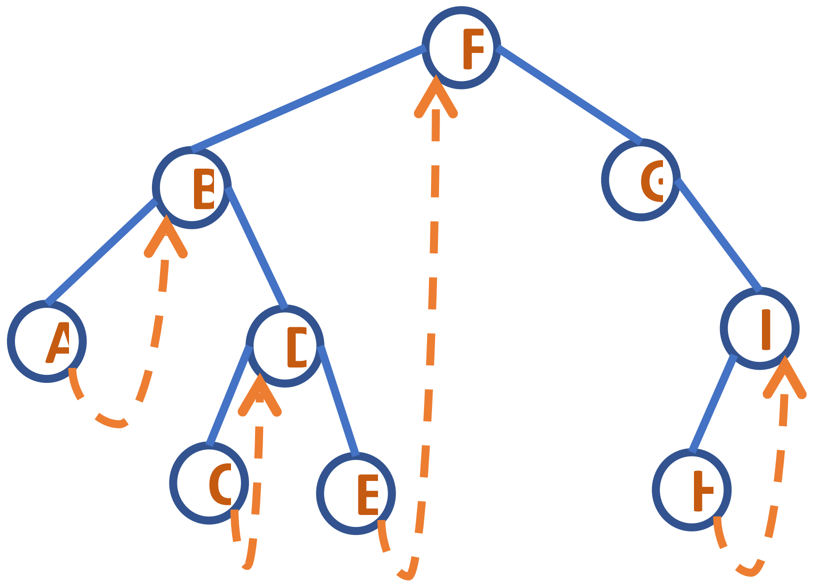
- We can use the right pointer of a node to point to the inorder successor if in case it is not pointing to the child. Such a tree is called **Right-In Threaded** Binary Tree
- If we use the left pointer to store the inorder predecessor, the tree is called **Left-In Threaded** Binary Tree
- If we use both the pointers, the tree is called **In Threaded** Binary Tree

Threaded Binary Search Tree

Right-In Threaded Binary Tree



Binary Tree

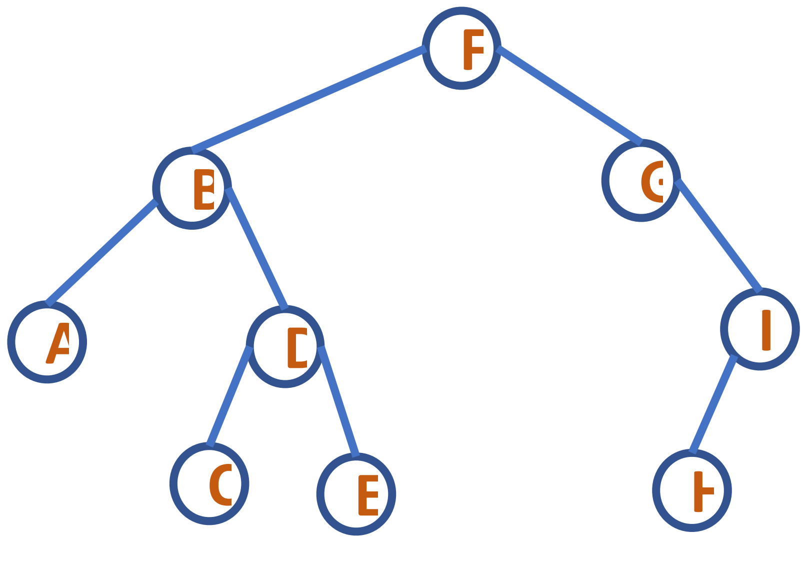


Right-In Threaded Binary Tree

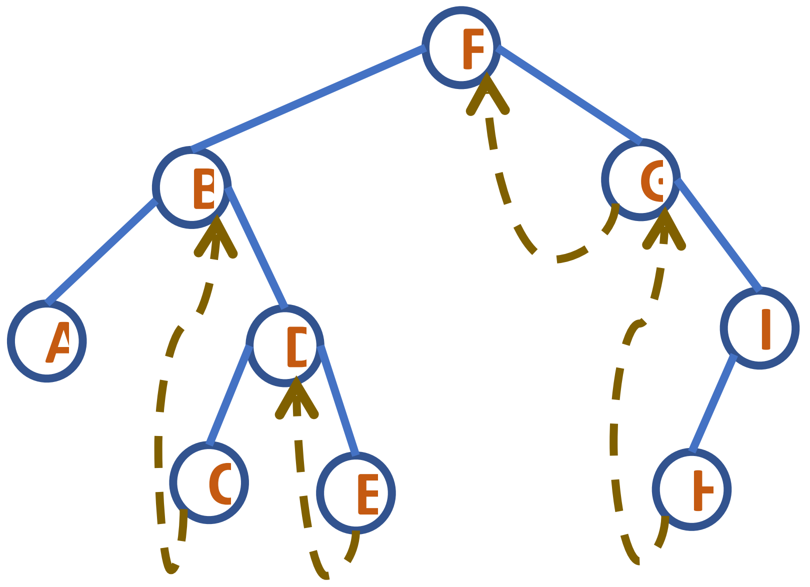
Inorder Traversal:
A B C D E F G H I

Nodes with Right Pointer NULL	A	C	E	H	I
Inorder Successor	B	D	F	I	-

Left-In Threaded Binary Tree



Binary Tree



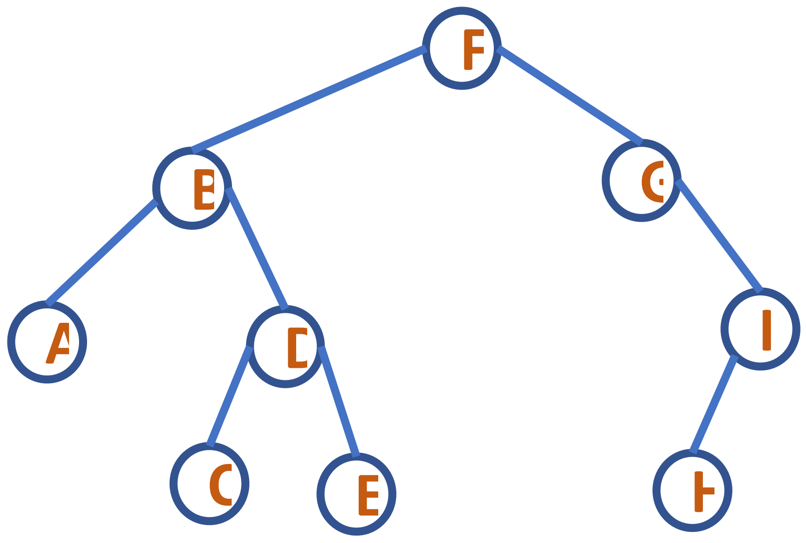
Left-In Threaded Binary Tree

Inorder Traversal:
A B C D E F G H I

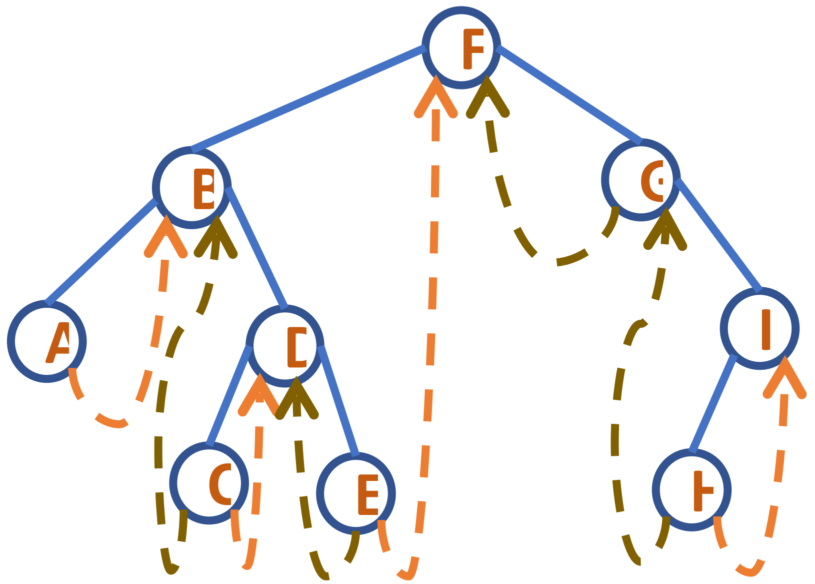
Nodes with Left Pointer NULL	A	C	E	G	H
Inorder Predecessor	-	B	D	F	G

Threaded Binary Search Tree

In Threaded Binary Tree



Binary Tree



In Threaded Binary Tree

Threaded Binary Search Tree: Implementation

Right In Threaded Binary Tree

```
typedef struct node
{
        int info;
        struct node *left;      // pointer to left child
        struct node *right;     // pointer to right child
        int rthread;            // rthread is TRUE if right is NULL
                         // or a non-NULL thread
}NODE;
```

Node Structure

info	left	right	rthread

Threaded Binary Search Tree: Implementation

```
NODE* createNode(int e)
{
        NODE* temp=malloc(sizeof(NODE));
        temp->info=e;
        temp->left=NULL;
        temp->right=NULL;
        temp->rthread=1;
        return temp;          // Returns: 2000
}
```

info	left	right	rthread

createNode(57)

temp ->

57	NULL	NULL	1

Let Address of this node on Heap: 2000

Threaded Binary Search Tree: Implementation

Right In Threaded Binary Tree: 57, 25, 28

- A node is created with rthread set to TRUE
- **insert 57**

Address: 800

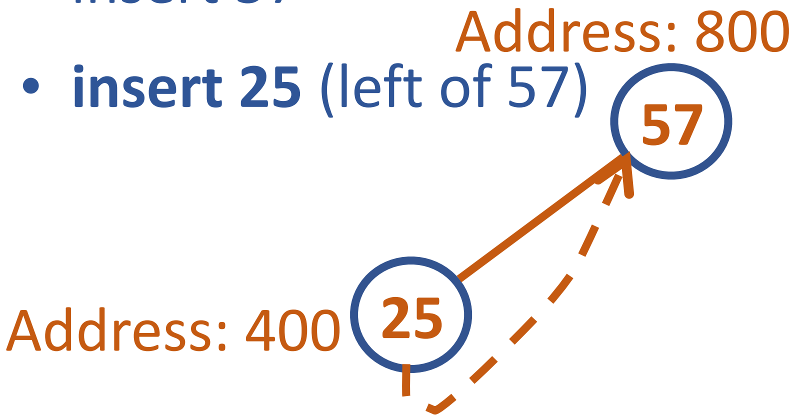
Node Structure

info	left	right	rthread
57	NULL	NULL	1

Threaded Binary Search Tree: Implementation

Right In Threaded Binary Tree: 57, 25, 28

- A node is created with rthread set to TRUE
- insert 57
- **insert 25** (left of 57)



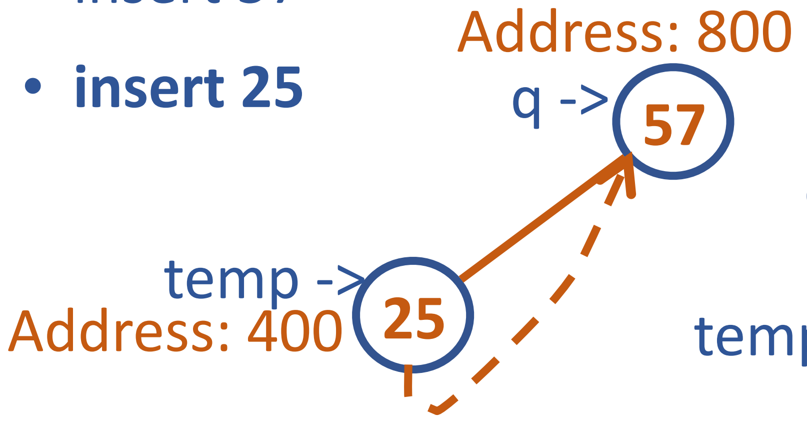
Node Structure

info	left	right	rthread
57	NULL 400	NULL	1
25	NULL	NULL 800	1

Threaded Binary Search Tree: Implementation

Right In Threaded Binary Tree: 57, 25, 28

- A node is created with rthread set to TRUE
- insert 57
- **insert 25**



Node Structure

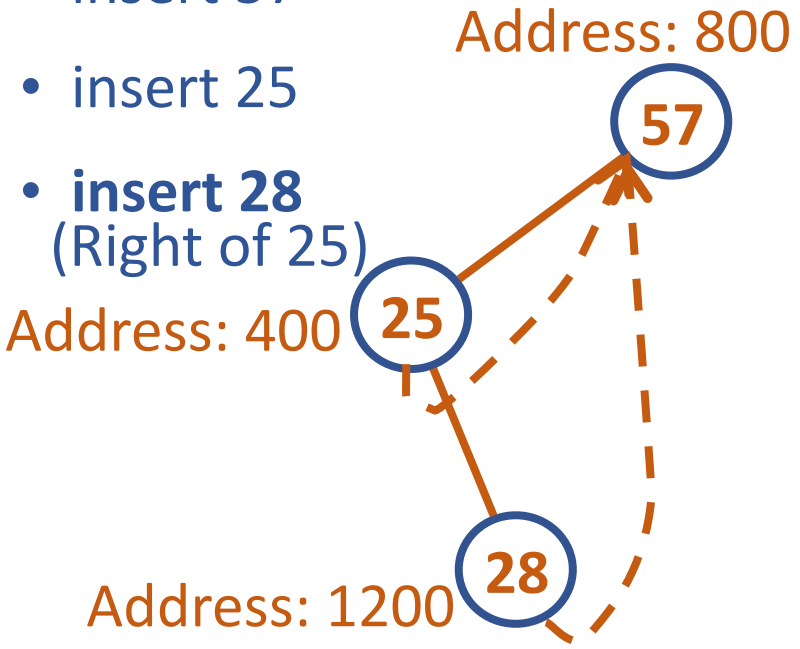
	info	left	right	rthread
q ->	57	NULL 400	NULL	1
temp ->	25	NULL	NULL 800	1

```
void setLeft(NODE* q, int e) {      //set node with info e to left of q
        NODE* temp=createNode(e);           //e=25
        q->left=temp;
        temp->right=q;
}
```

Threaded Binary Search Tree: Implementation

Right In Threaded Binary Tree: 57, 25, 28

- A node is created with rthread set to TRUE
- insert 57
- insert 25
- **insert 28**
  (Right of 25)



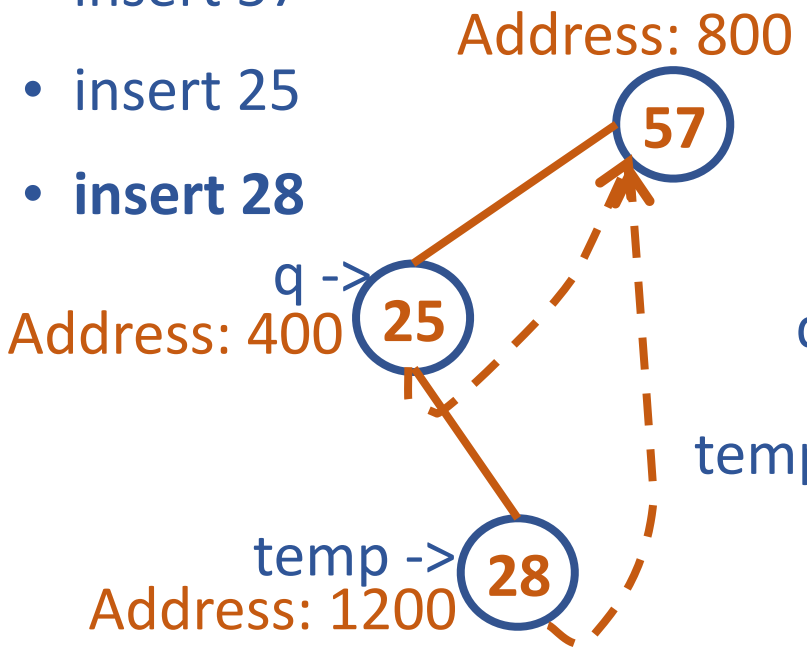
Node Structure

info	left	right	rthread
57	400	NULL	1
25	NULL	1200 800	0 1
28	NULL	NULL 800	1

Threaded Binary Search Tree: Implementation

Right In Threaded Binary Tree: 57, 25, 28

- A node is created with rthread set to TRUE
- insert 57
- insert 25
- **insert 28**



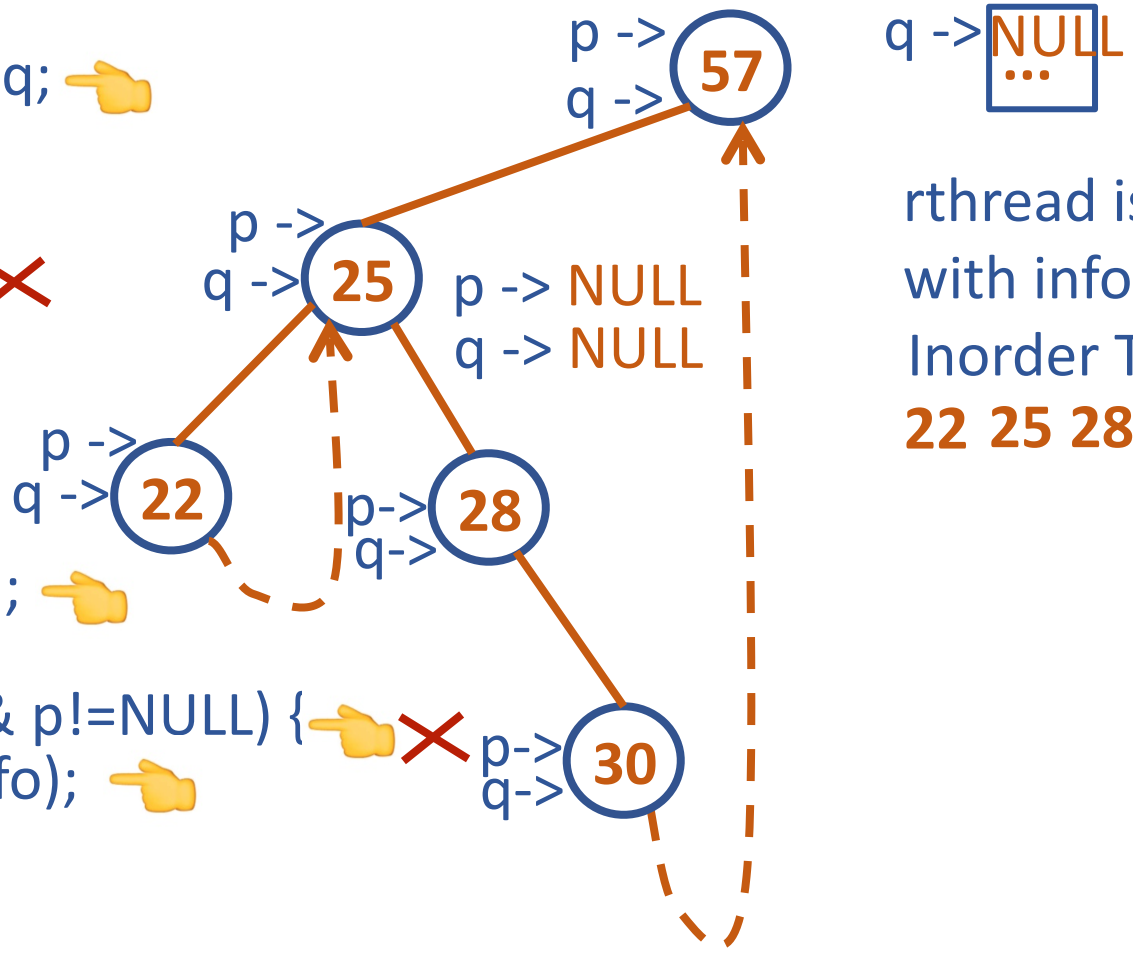
Node Structure

	info	left	right	rthread
	57	400	NULL	1
q ->	25	NULL	800 1200	1 0
temp ->	28	NULL	NULL 800	1

```
void setRight(NODE* q,int e) {
    NODE* temp=createNode(e);
    temp->right=q->right;
    q->right=temp;
    q->rthread=0;
}
```

Threaded Binary Search Tree: Inorder Traversal

```
void inOrder(NODE *root) {
   NODE *p=root;   NODE *q;
   do{
         q=NULL;
         while(p!=NULL) {
            q=p;
            p=p->left;
         }
         if(q!=NULL) {
            printf("%d ",q->info);
            p=q->right;
            while(q->rthread && p!=NULL) {
               printf("%d ",p->info);
               q=p;
               p=p->right;
            }
         }
   }while(q!=NULL);
}
```



rthread is TRUE for nodes with info: 22, 30, 57

Inorder Traversal:

22 25 28 30 57

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THANK YOU

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