Department of Computer Science and Engineering

PES UNIVERSITY

UE19CS202: Data Structures and its Applications (4-0-0-4-4)

Trees
Binary Search Tree (BST): Deletion

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Deletion of a Node in Binary Search Tree

Consider the following 3 cases for deletion of a node in Binary Search Tree so that even after the node is deleted the BST property is preserved.

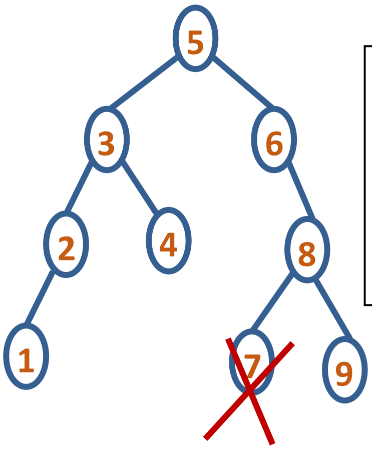
Case 1: Node with no child (leaf node)

Case 2: Node with 1 child

Case 3: Node with 2 children

Case 1: Deletion of a leaf node

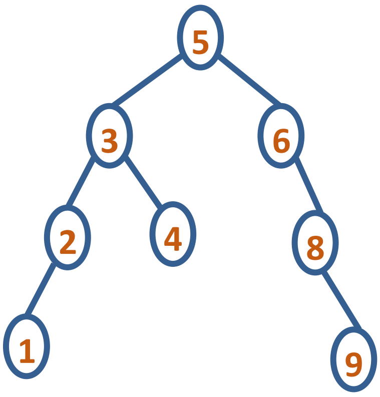
Set its parent's corresponding child field to point to NULL. Free memory allocated to the node.

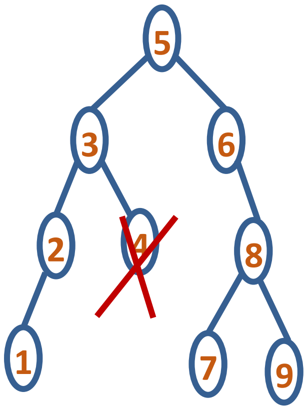


To delete the node with info 7:

Set its parent's left child field to point to NULL

Free memory allocated to

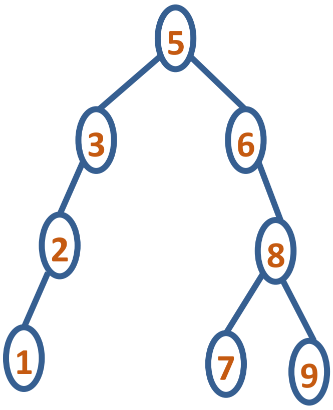




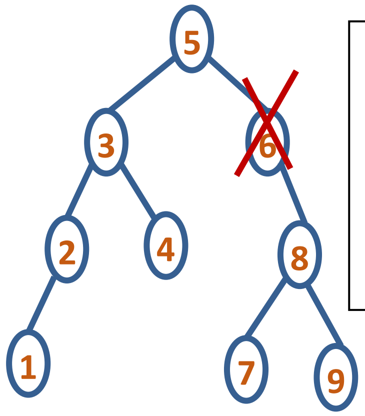
To delete the node with info 4:

Set its parent's right child field to point to NULL

Free memory allocated to node with info 4



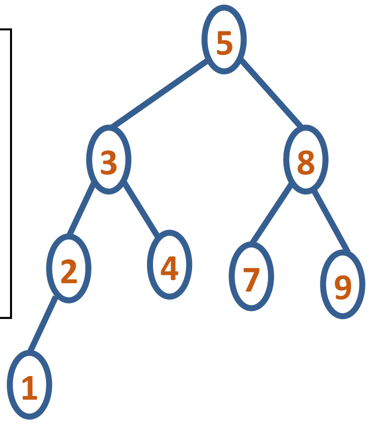
Case 2: Deletion of a node with one child
Connect the node's parent with node's child node

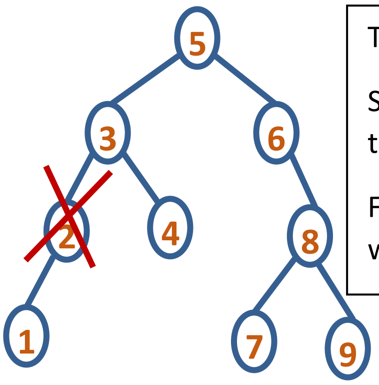


To delete the node with info 6:

Set its parent's right child field to point to its only child

Free memory allocated to node with info 6

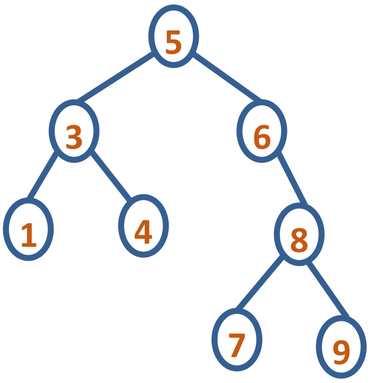




To delete the node with info 2:

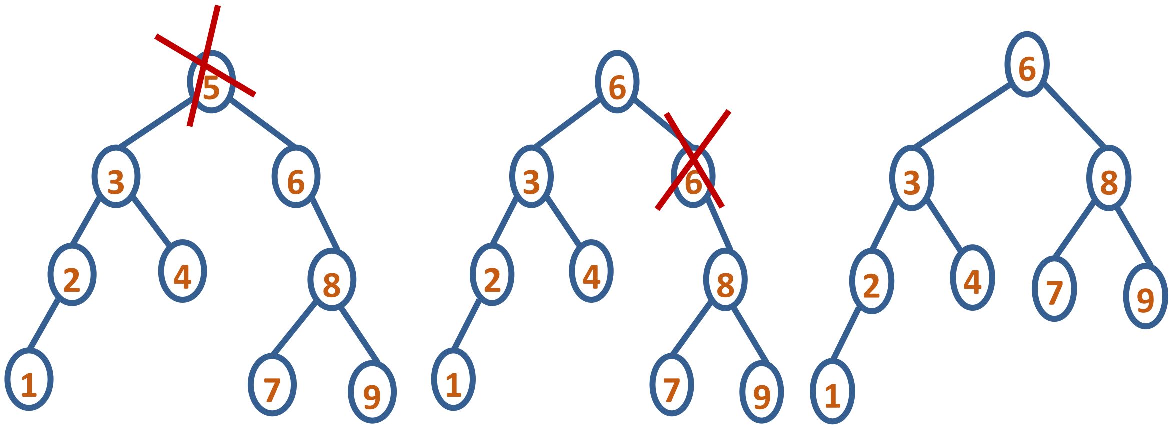
Set its parent's left child field to point to its only child

Free memory allocated to node with info 2



Case 3: Deletion of a node with 2 children
This case can be handled in 2 ways:
Way 1: Replace the node to be deleted with its inorder successor (Smallest in its Right subtree or Leftmost in its Right subtree) and delete that inorder successor.
Way2: Replace the node to be deleted with its inorder predecessor (Largest in its Left subtree) and delete that inorder predecessor.
For the deletion of inorder successor/predecessor, case 3 gets reduced to either case 1 or case 2. We know how to solve case1 and case2.

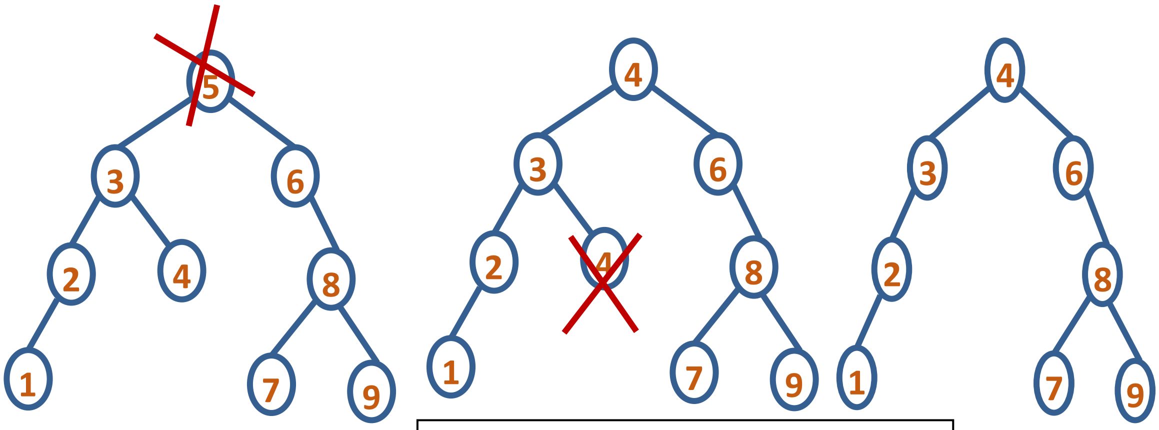
To delete node with info 5 (Way 1: Replace with inorder successor)



Replace 5 with its inorder successor

Now delete that inorder successor Now case3 has got changed to case2 (In general may change to case2 or case1)

To delete node with info 5 (Way 2: Replace with inorder predecessor)



Replace 5 with its inorder predecessor

Now delete that inorder predecessor Now case3 has got changed to case1 (In general may change to case2 or case1)

Note: For implementation we shall consider replacing with inorder successor.

```
//BST Deletion
#include<stdio.h>
#include<stdlib.h>
typedef struct node
{
        int info;
        struct node *left,*right;
}NODE;
typedef struct tree
{
        NODE *root;
}TREE;

void init(TREE  *pt)
{
        pt->root=NULL;
}

NODE* createNode(int e)
{
        NODE *temp=malloc(sizeof(NODE));
        temp->left=NULL;
        temp->right=NULL;
        temp->info=e;
        return temp;
}

void create(TREE *pt)
{
        NODE *p,*q;
        int e, wish;

        printf("Enter info\n");
        scanf("%d",&e);

        pt->root=createNode(e);

        do{
                printf("Enter info\n");
                scanf("%d",&e);

                q=NULL;
                p=pt->root;

                while(p!=NULL)
                {
                    q=p;

                    if(e < p->info)
                        p = p->left;
                    else
                        p = p->right;
                }

                if(e < q->info)
                    q->left = createNode(e);
                else
                    q->right = createNode(e);

                printf("Do you wish to continue\n");
                scanf("%d",&wish);
        }while(wish);
}

void io(NODE* r)
{
        if(r!=NULL)
        {
                io(r->left);
                printf("%d ",r->info);
                io(r->right);
        }
}

void inorder(TREE *pt)
{
        io(pt->root);
}
```

```
NODE* delNode(NODE *r,int ele)
{
        NODE *temp,*p;

        if(r==NULL)
                return r;

        if(ele < r->info)
                r->left = delNode(r->left,ele);
        else if(ele > r->info)
                r->right =  delNode(r->right,ele);
        else
        {
                if(r->left == NULL)                     //1 right child or No children
                {
                        temp=r->right;
                        free(r);
                        return temp;
                }
                else if(r->right == NULL)               //1 left  child or No children
                {
                        temp=r->left;
                        free(r);
                        return temp;
                }
                else
                {       //Node to be deleted has both children
                        //Finding p's leftmost child which is the inorder successor
                        p=r->right;
                        while(p->left != NULL)
                                p=p->left;

                        r->info=p->info;
                        r->right=delNode(r->right, p->info);
                }
        }
        return r;
}
void deleteNode(TREE *pt,int e)
{
        pt->root=delNode(pt->root,e);
}
```

```
int main()
{
        int e;
        TREE t;
        init(&t);
        create(&t);
        inorder(&t);
        printf("Enter the element to be deleted\n");
        scanf("%d",&e);
        deleteNode(&t,e);
        printf("After deletion\n");
        inorder(&t);

        return 0;
}
```