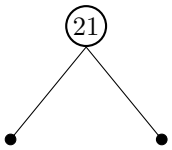
# CS320 Homework 3

Dustin Randall

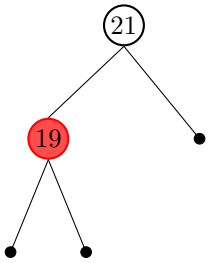
October 29, 2025

## 1 Construct RBT with the following keys: 21, 19, 17, 12, 15, 9

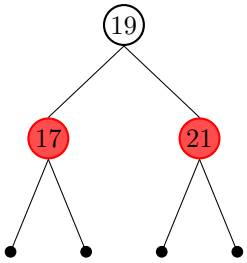
**Insert 21**



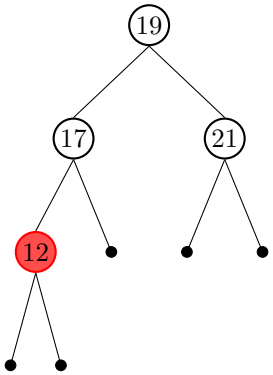

**Insert 19**



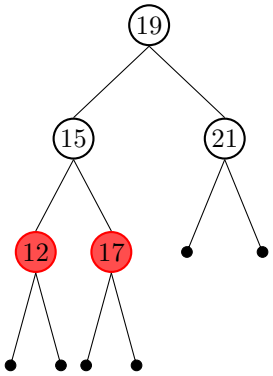

**Insert 17**



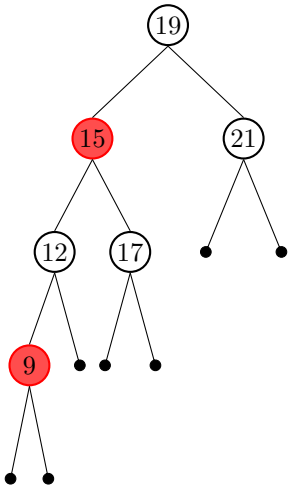
**Insert 12**




**Insert 15**

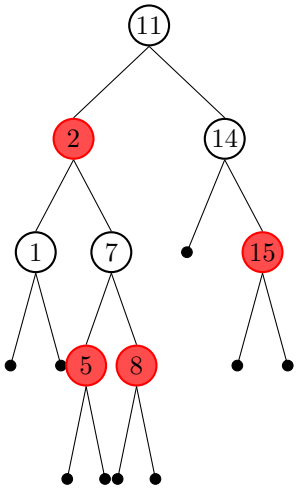


**Insert 9**

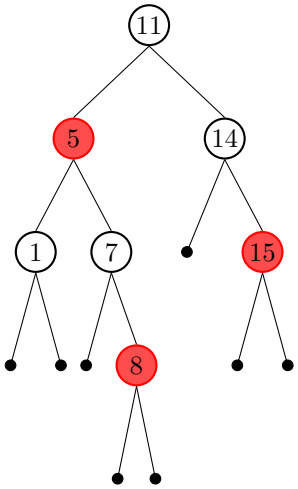



## 2 Delete the nodes of the RBT in the following order: 2, 5, 1, 14, 11, 15, 7, 8

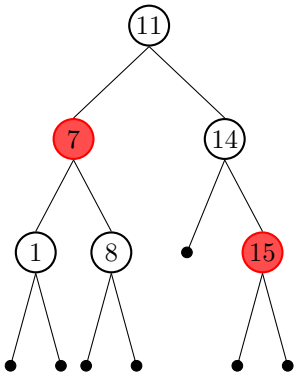
**Initial Tree**



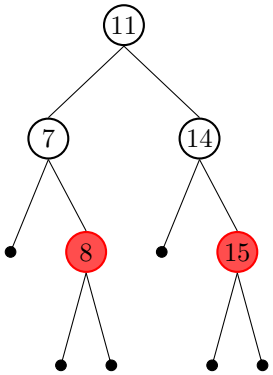
**Delete 2**



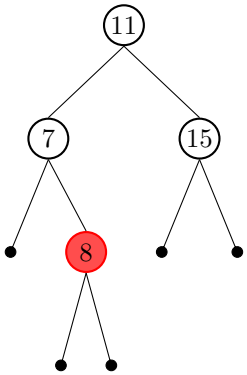

**Delete 5**



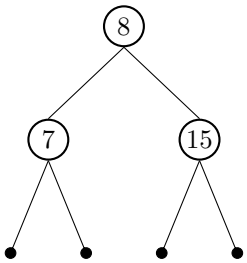
**Delete 1**



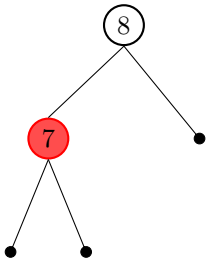

**Delete 14**



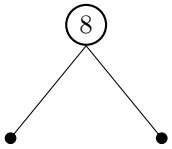

**Delete 11**



**Delete 15**




**Delete 7**




**Delete 8**

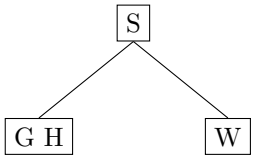
## 3 Trace the one-pass construction of a B-Tree with t=2 with the following nodes: S, G, W, H, O, U, M, A, C, X, P

**Insert S**

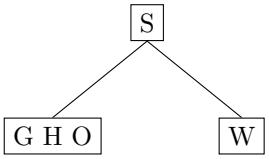

**Insert G**


**Insert W**

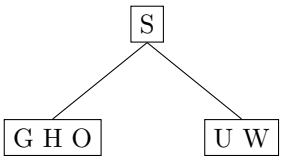

**Insert H**



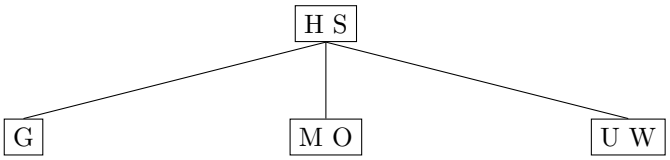
**Insert O**



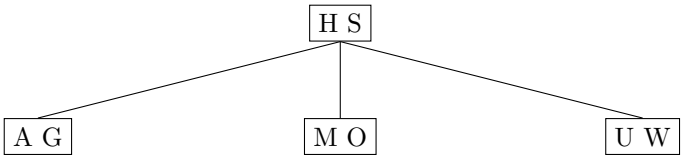

**Insert U**



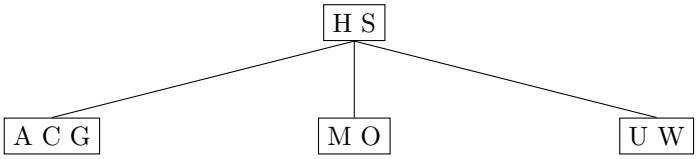

**Insert M**



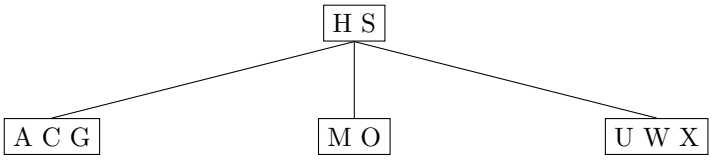

**Insert A**



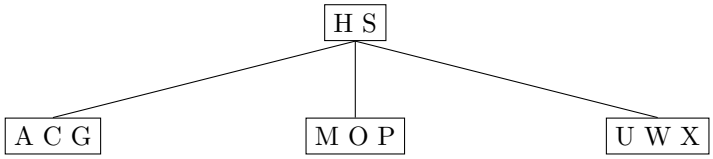

**Insert C**



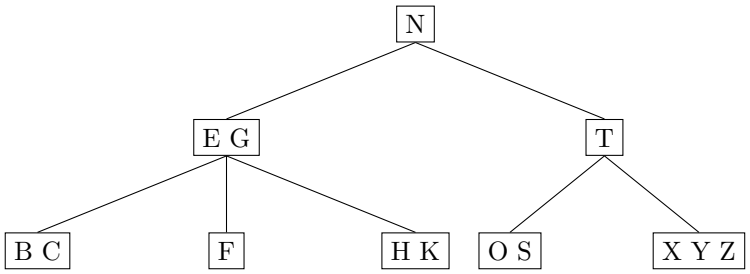

**Insert X**



**Insert P**

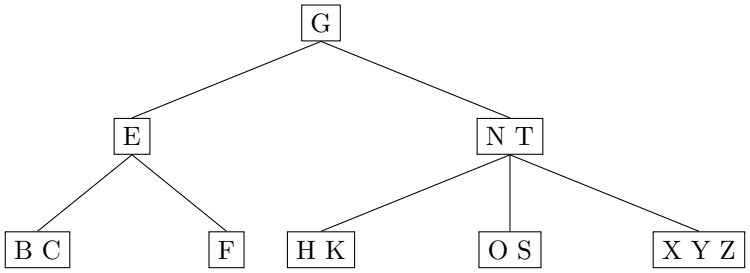



## 4 Delete the following nodes in order from the initial B-Tree: T, G, F, O

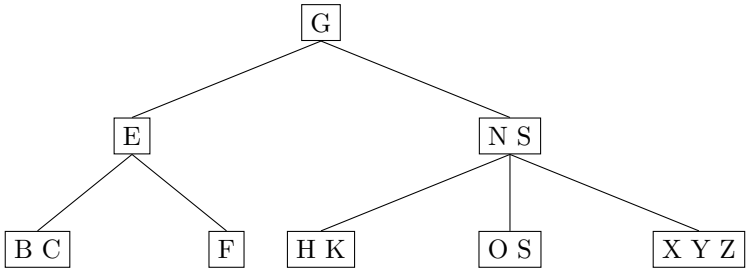



**Delete T**

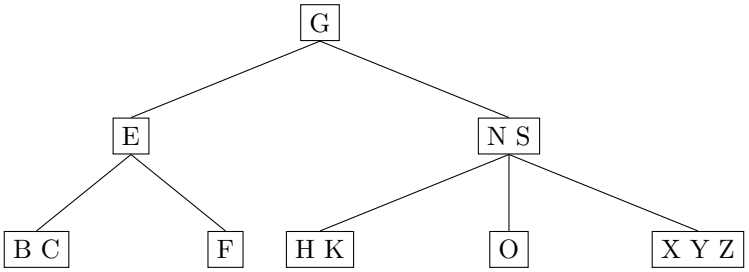
**Borrow G from Left Child**




**Swap Predecessor S with T**

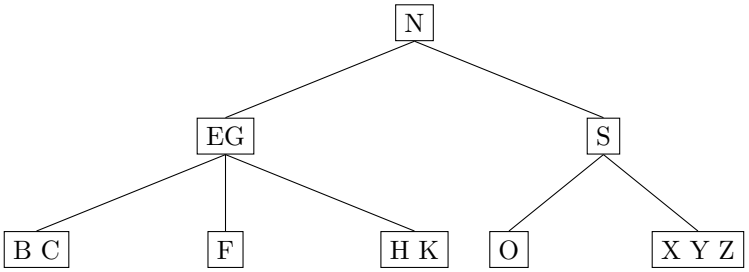


**Delete S from Leaf**

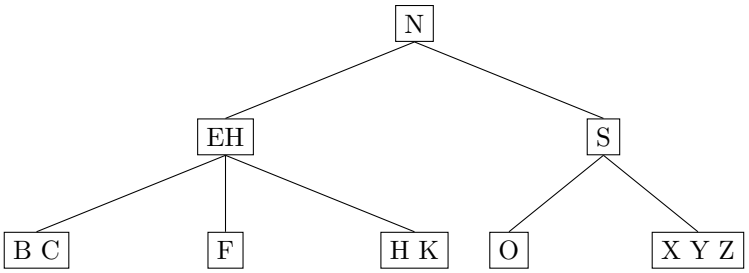



## Delete G

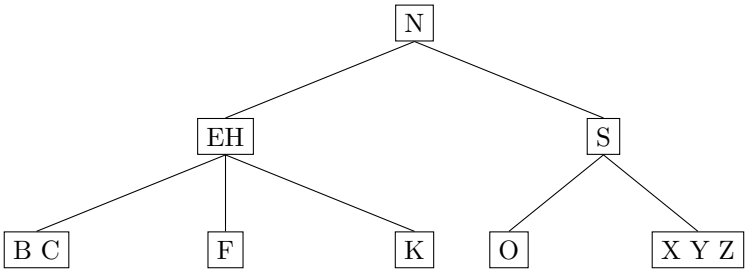
**Borrow N from Right Child**




**Swap G with Successor H**

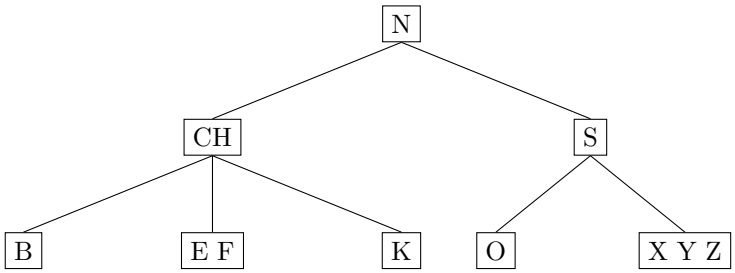



**Delete H from Leaf**

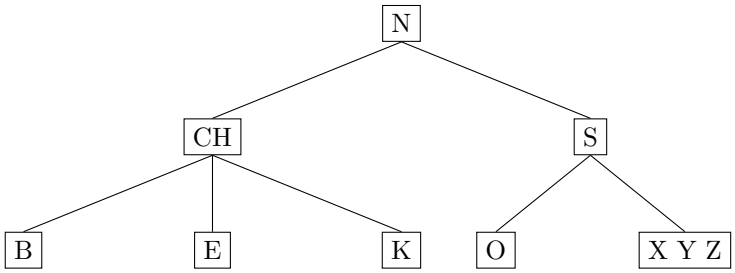


## Delete F

#### 4.0.1 Borrow C from Left Sibling

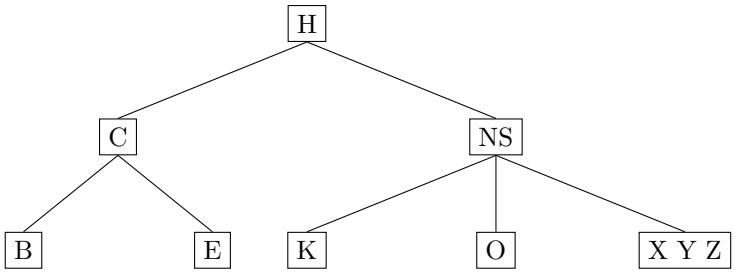



**Delete F from Leaf**

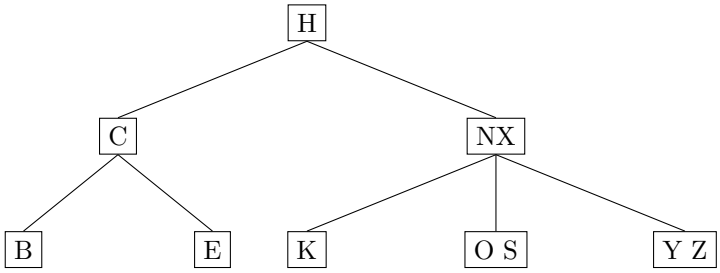



## Delete O

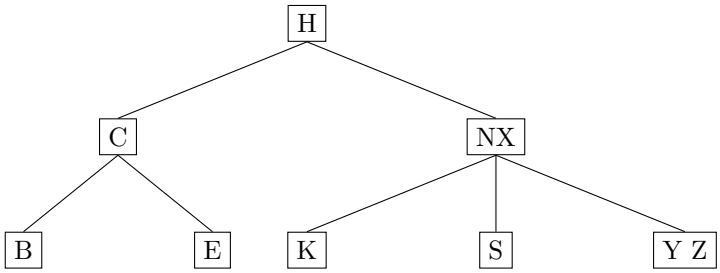
**Borrow H from Left Sibling**



**Borrow X from Right Sibling**




**Delete O from Leaf**




# 5 Explain BTreeMin and BTreeSuccessor

## BTreeMin

Given a node, traverse down the left-most child until there are no more children. Once there, return the index of the smallest element in that node, along with a pointer to the node.

## BTreeSuccessor

If the node has children return the BTreeMin of the node.Right Otherwise, while we're the right most child of our parent, get the next parent. Finally after finding a non-right-most parent, return the key after our node. If we run out of parents, return null.

## Pseudocode

```
(Node, Index) BTreeMin(root) {
    while(root.Children.Count > 0) {
        root = root.Children[0]; // DISK_READ
    }
    // assuming keys are in order
    return (root, 0);
```

```
    // alternatively, return (root, min(root.Keys))
}

(successor_node, j) BTreeSuccessor(node, i) {
    if(node.Children.Count > 0) {
        // there must be keys.Count + 1 children
        return BTreeMin(node.Children[i + 1]);
    }
    //in a leaf node, and successor is in this node
    if(i + 1 < node.Keys.Count) {
        return (node, i + 1);
    } else {
        Node parent = node.Parent; // DISK_READ
        pIndex = parent.FindIndex(node);
        while(pIndex == parent.Keys.Count) {
            node = parent;
            parent = node.Parent; // DISK_READ
            if(parent == null) return null;
            pIndex = parent.FindIndex(node);
        }
        return (parent, pIndex);
    }
}
```