# CS 61B Binary Trees Spring 2020

## 1 Law and Order

Write the DFS pre-order, DFS in-order, DFS post-order, and BFS traversals of the following binary search tree. For all traversals, process child nodes left to right.

```
        10
       /  \
     3     12
    / \      \
   1   7      13
                \
                 15
```

## 2 Is This a BST?

(a) The following code should check if a given binary tree is a BST. However, for some trees, it returns the wrong answer. Give an example of a binary tree for which `brokenIsBST` fails.

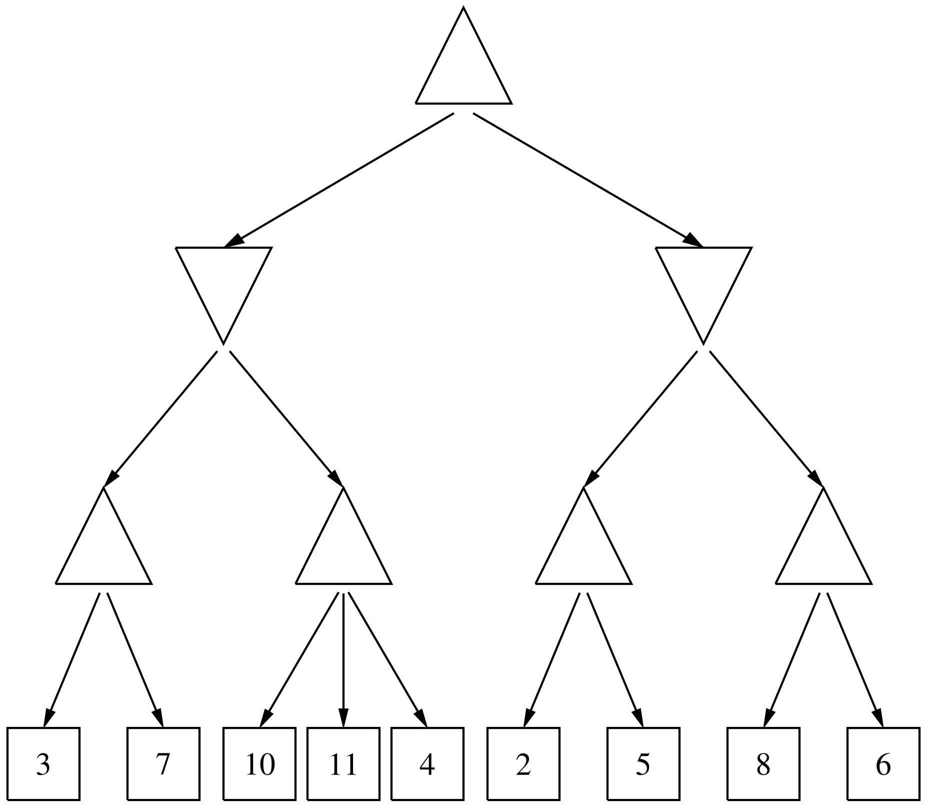
```java
public static boolean brokenIsBST(TreeNode T) {
    if (T == null) {
        return true;
    } else if (T.left != null && T.left.val > T.val) {
        return false;
    } else if (T.right != null && T.right.val < T.val) {
        return false;
    } else {
        return brokenIsBST(T.left) && brokenIsBST(T.right);
    }
}
```

(b) Now, write `isBST` that fixes the error encountered in part (a).
*Hint*: You will find `Integer.MIN_VALUE` and `Integer.MAX_VALUE` helpful.

```java
public static boolean isBST(TreeNode T) {
    return isBSTHelper(                                        );
}

public static boolean isBSTHelper(                                    ) {










}
```

## 3 Shall we play a game?

In the partial game tree below, we represent maximizing nodes as △; minimizing nodes as ▽; and nodes with static values as □. Determine the values for the nodes that would result from the minimax algorithm without pruning (write them inside the nodes), and then cross out branches that would not be traversed (would be pruned) as a result of alpha-beta pruning. Assume we evaluate children of a node from left to right.



## 4 Extra Binary Tree Practice: Sum Paths

Define a root-to-leaf path as a sequence of nodes from the root of a tree to one of its leaves. Write a method `printSumPaths(TreeNode T, int k)` that prints out all root-to-leaf paths whose values sum to k. For example, if T is the binary tree in the diagram below and k is 13, then the program will print out `10 2 1` on one line and `10 4 -1` on another.

```
      10
     /  \
   2     4
  / \     \
 5   1     -1
```

(a) Provide your solution by filling in the code below:

```
public static void printSumPaths(TreeNode T, int k) {
    if (T != null) {
        sumPaths(                                );
    }
}

public static void sumPaths(TreeNode T, int k, String path) {








}
```

(b) What is the worst case runtime of `printSumPaths` in terms of $N$, the number of nodes in the tree? What is the worst case runtime in terms of $h$, the height of the tree?