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CISP - 430

Assignment 6

3/7/2018

Program 6.0 - Binary Search Tree Implementation

Description:

The goal for this assignment was to implement a binary search tree. This tree is to support preorder, postorder, and inorder traversals. In addition, our search function must run in O(LogN) time. The following code is based on pseudocode provided by my professor.

Source Code:

```
//Code written by Quinn Roemer, based on code by Professor Ross.
#include <iostream>
using namespace std;

//Node definition.
class node {
public:
    int data;
    node* left = NULL;
    node* right = NULL;
};

//Global node pointer.
node* root = NULL;

//Function Prototypes.
void insert(int);
void print_postorder(node*);
void print_preorder(node*);
void print_inorder(node*);
int search(int);
void process(node*);

//Main function to execute.
int main()
{
    char answer;

    cout << "Enter 1 for Sequence A or 2 for Sequence B." << endl;
    cin >> answer;
    cout << endl;

    while (answer != '1' && answer != '2')
    {
        cout << "Invalid input, please try again." << endl;
        cin >> answer;
        cout << endl;
    }
```

```
//Sequence A.
if (answer == '1')
{
    int dataArray[] = { 1,5,4,6,7,2,3 };

    for (int index = 0; index < sizeof(dataArray) / 4; index++)
    {
        insert(dataArray[index]);
    }
}

//Sequence B.
if (answer == '2')
{
    int dataArray[] = { 150,125,175,166,163,123,108,116,117,184,165,137,141,111,138,

   122,109,194,143,183,178,173,139,126,170,190,140,188,120,195,113,104,193,181,

   185,198,103,182,136,115,191,144,145,155,153,151,112,129,199,135,146,157,176,

   159,196,121,105,131,154,107,110,158,187,134,132,179,133,102,172,106,177,171,

   156,168,161,149,124,189,167,174,147,148,197,160,130,164,152,142,162,118,186,

   169,127,114,192,180,101,119,128,100 };

    for (int index = 0; index < sizeof(dataArray) / 4; index++)
    {
        insert(dataArray[index]);
    }
}

//Demonstrating functionality.
node* temp = root;

cout << "Printing Preorder." << endl;
print_preorder(temp);
temp = root;
cout << endl << endl;

cout << "Printing Postorder." << endl;
print_postorder(temp);
temp = root;
cout << endl << endl;

cout << "Printing Inorder." << endl;
print_inorder(temp);
temp = root;
cout << endl << endl;
```

```
    cout << "Searching for 196." << endl;
    cout << search(196) << endl;

    cout << "\nSearching for 137." << endl;
    cout << search(137) << endl;

    cout << "\nSearching for 102." << endl;
    cout << search(102) << endl;

    cout << "\nSearching for 190." << endl;
    cout << search(190) << endl;

    cout << "\nSearching for 200." << endl;
    cout << "Nodes visited: " << search(200) << endl << endl;

}

//Insert function, using O(LogN) time.
void insert(int info)
{
    //Creating a new data element.
    node* temp = new node;
    temp->data = info;

    //Insertion point pointers.
    node* pc = NULL;
    node* c = root;

    //If no other nodes.
    if (root == NULL)
    {
        root = temp;
        return;
    }

    //Find insertion point.
    while (c != NULL)
    {
        pc = c;

        if (temp->data < c->data)
        {
               c = c->left;
        }

        else
        {
               c = c->right;
        }
```

```
    }

    //Hook up node.
    if (temp->data < pc->data)
    {
        pc->left = temp;
    }
    else
    {
        pc->right = temp;
    }
}

//Print in the following fashion: Root, Left, Right.
void print_preorder(node* location)
{
    if (location != NULL)
    {
        process(location);
        print_preorder(location->left);
        print_preorder(location->right);
    }
}

//Print in the following fashion: Left, Right, Root.
void print_postorder(node* location)
{
    if (location != NULL)
    {
        print_postorder(location->left);
        print_postorder(location->right);
        process(location);
    }
}

//Print in the following fashion: Left, Root, Right.
void print_inorder(node* location)
{
    if (location != NULL)
    {
        print_inorder(location->left);
        process(location);
        print_inorder(location->right);
    }
}

//Prints the data in the passed node.
void process(node* info)
{
    cout << info->data << " ";
```

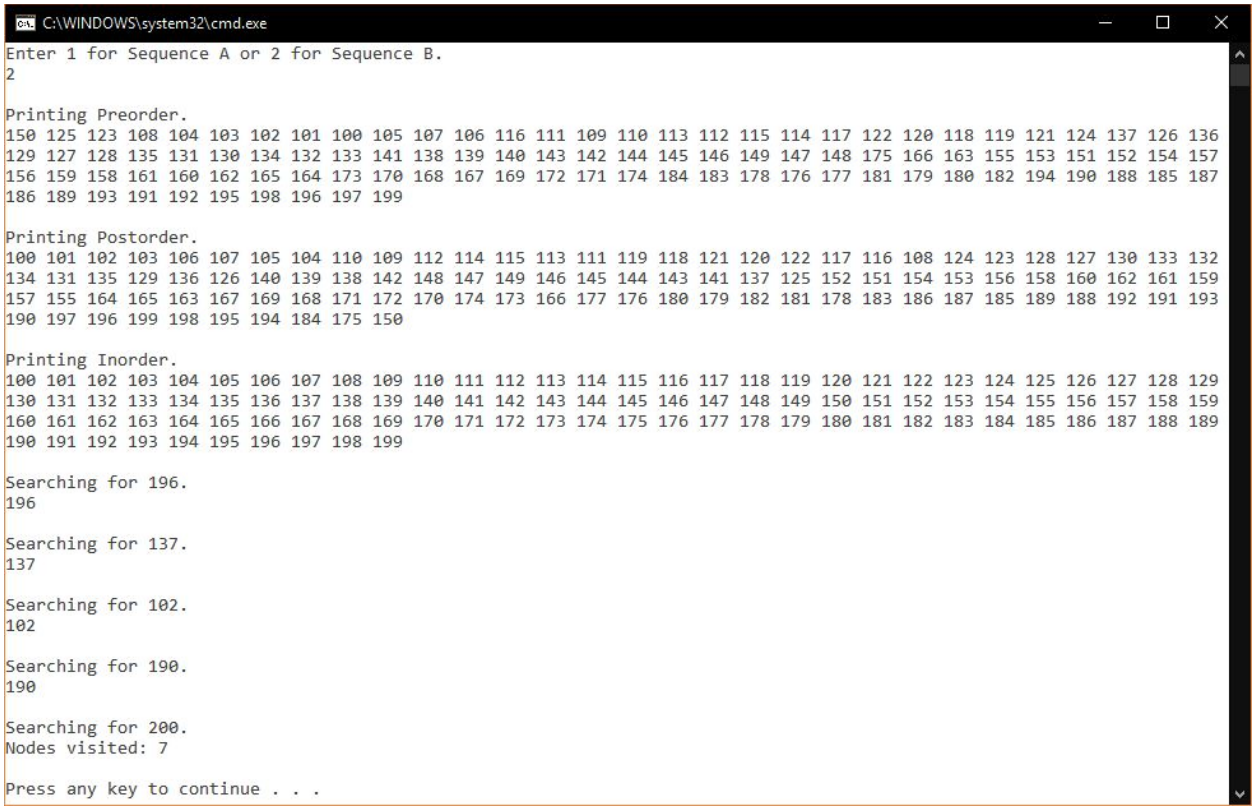
```
}

//Search function, using O(LogN) time.
int search(int searchTerm)
{
    node* location = root;
    int nodesVisited = 0;

    while (location != NULL)
    {
        //Data found.
        if (location->data == searchTerm)
        {
               //cout << "Search for " << searchTerm << " successful!" << endl;
               return location->data;
        }

        else
        {
               if (location->data < searchTerm)
               {
                      location = location->right;
                      nodesVisited++;
               }

               else
               {
                      location = location->left;
                      nodesVisited++;
               }
        }
    }

    //cout << "Search for " << searchTerm << " failed." << endl;
    return nodesVisited;
}
```

Output (1 of 2):

Sequence A

Output (2 of 2):

Sequence B



BigO of Functions:

void insert(int data):
This function has to have a time complexity of O(LogN). This is because the function only runs until it finds a suitable insertion point. This never means traversing the entire tree. Only the necessary nodes are traversed before insertion begins.

void print_inorder(node* root):
This function has to have a time complexity of O(N). This is because every node must be processed in order to output it.

void print_preorder(node* root):
This function has to have a time complexity of O(N). This is because every node must be processed in order to output it.

void print_postorder(node* root):
This function has to have a time complexity of O(N). This is because every node must be processed in order to output it.

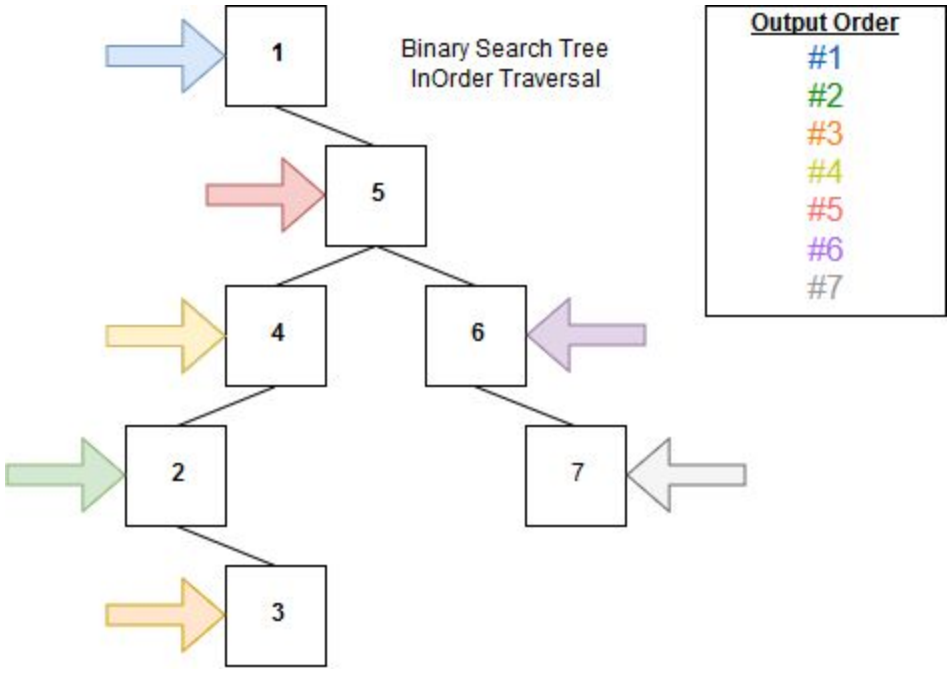
int search(int data):
This function has to have a time complexity of O(LogN). This is because the search function does not need to search every node individually. This function always chooses the best path to find where the data is.

Program 6.1 - Sequence A Hand Execution

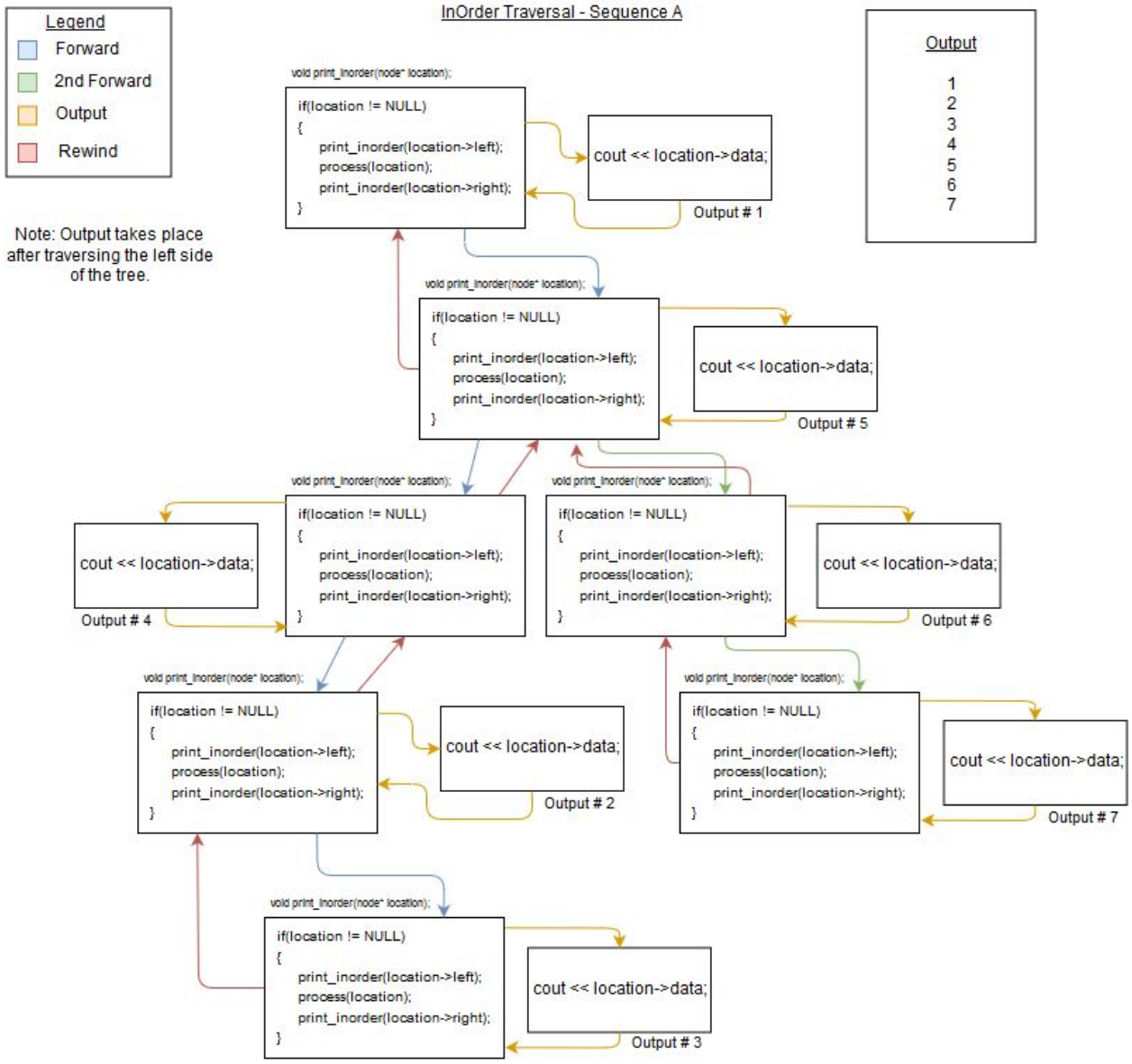
Description:

The goal for this part of the assignment was to hand implement sequence A of the code. My diagrams are to indicate the path where the processing of each node occurs. To do this, I created two diagrams for each traversal type. One concentrates on showing the recursive nature of the function, while the other tries to show the processing order clearly.

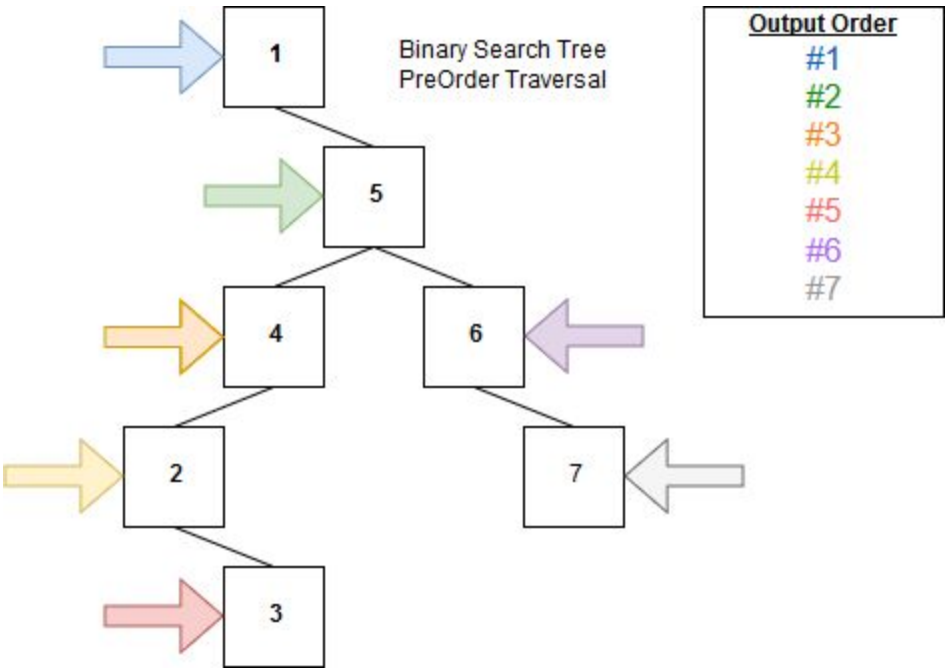
InOrder Diagram (1 of 2):



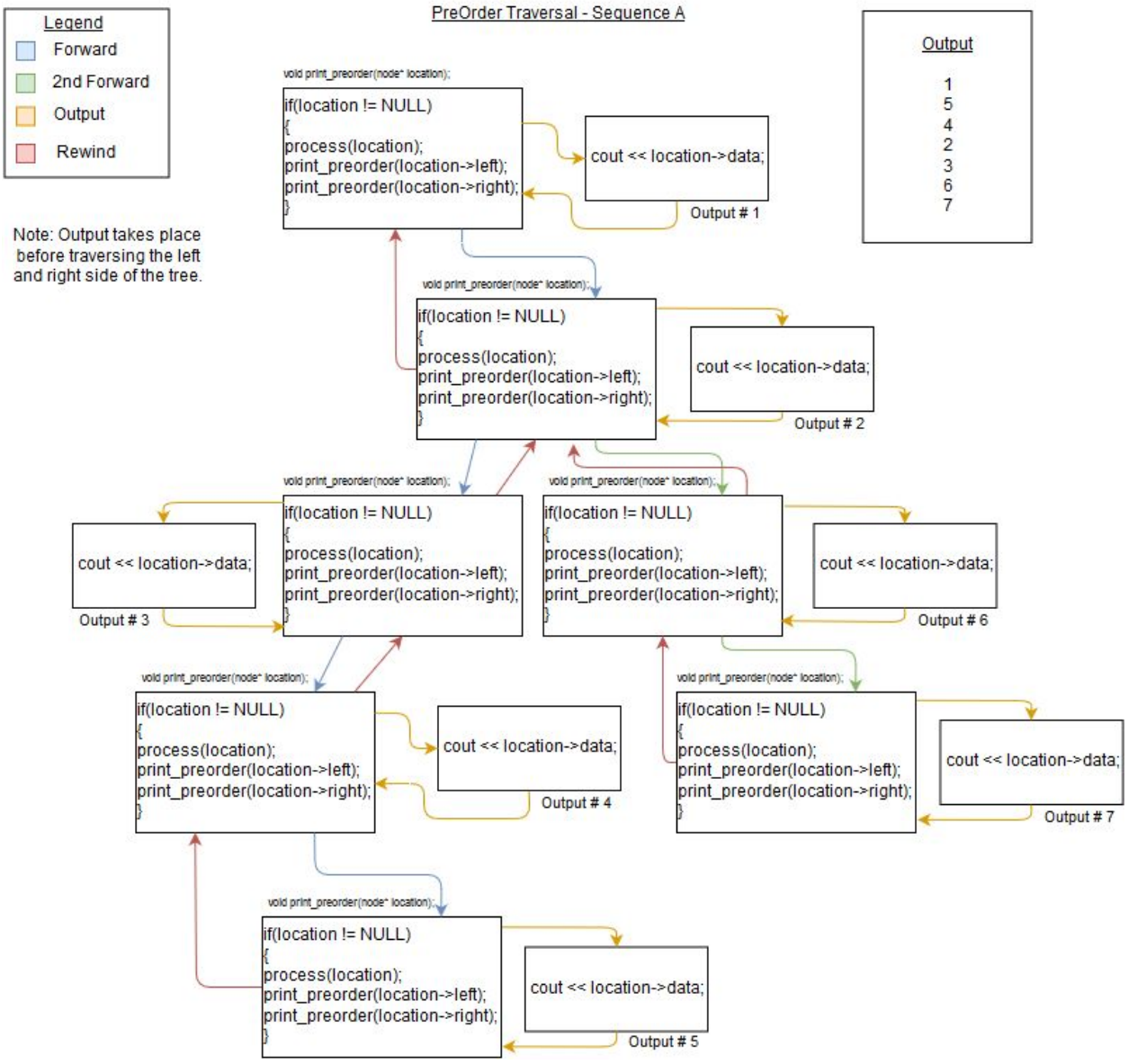
InOrder Diagram (2 of 2):



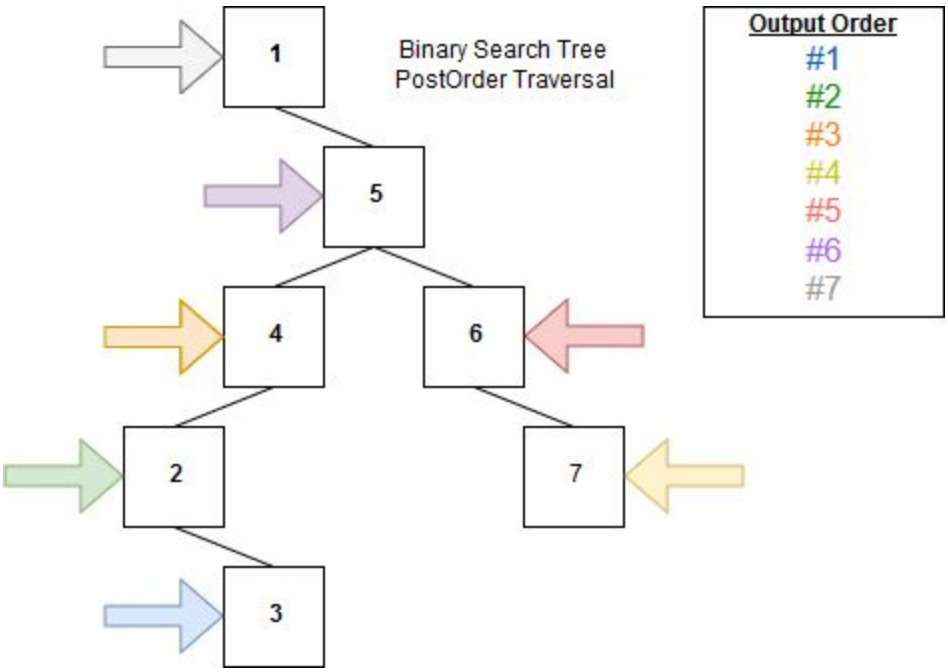
PreOrder Diagram (1 of 2):



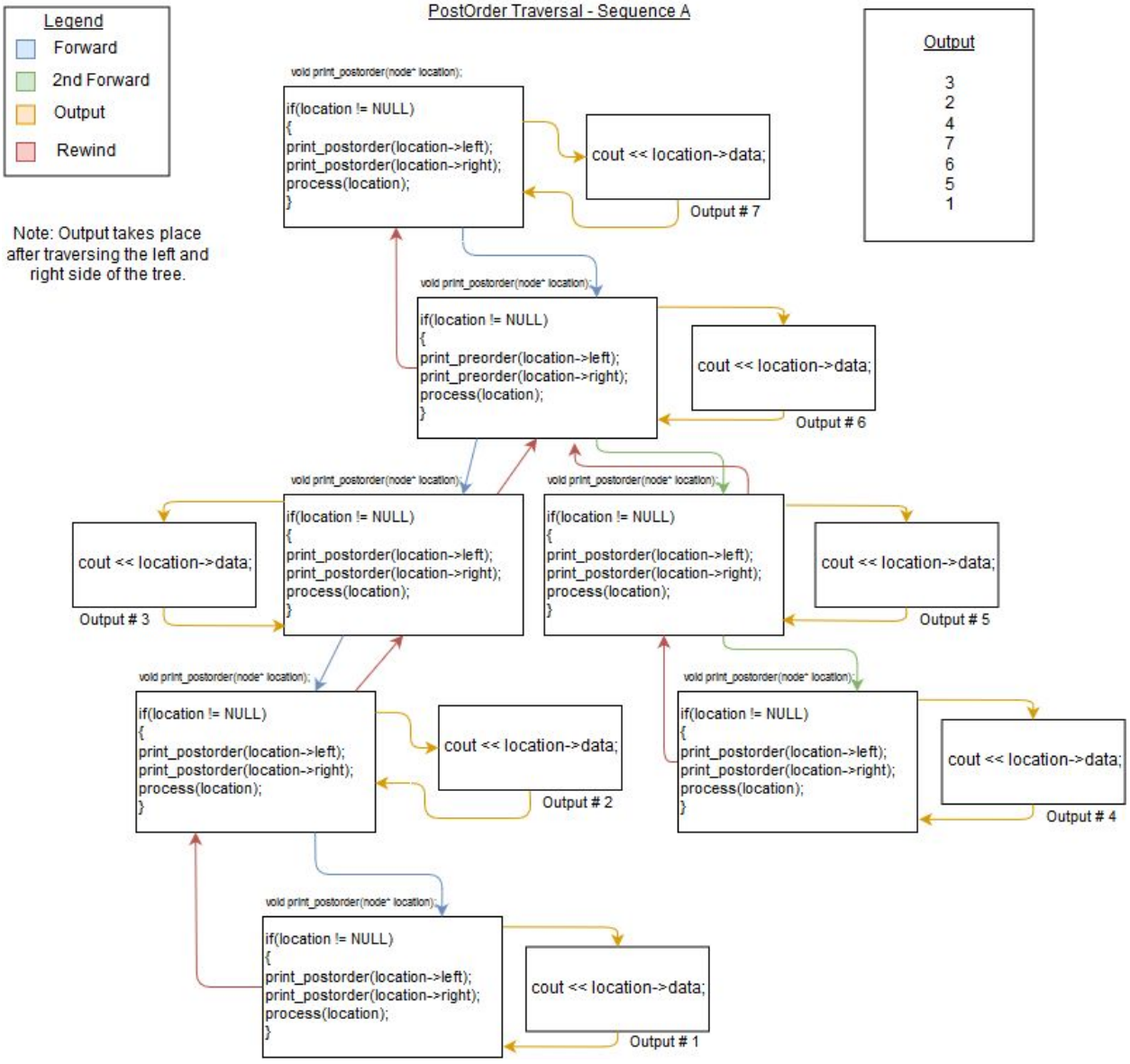
PreOrder Diagram (2 of 2):



PostOrder Diagram (1 of 2):



PostOrder Diagram (2 of 2):



Conclusion

This assignment was awesome! Binary search trees is something that we just barely talked about in my previous programming class, where they seemed quite complex. However, after implementing one I realize that all it is, is a linked list where each node has two forward links instead of one, and where the data is sorted in some manner. Looking forward to what we are going to learn next!