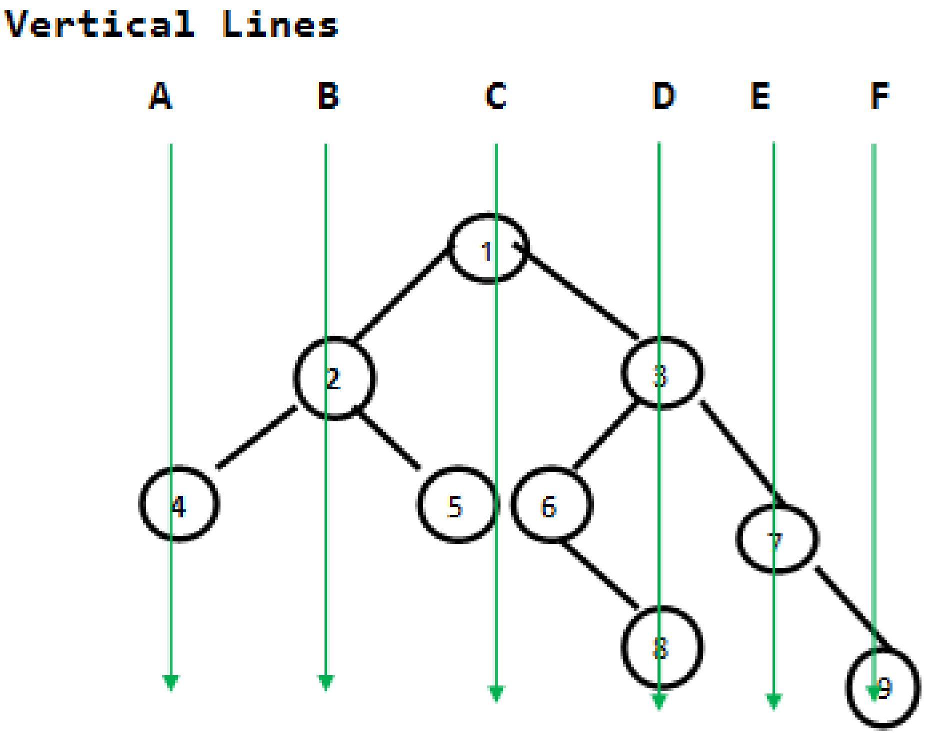
Print a Binary Tree in Vertical Order | Set 1

Given a binary tree, print it vertically. The following example illustrates vertical order traversal.

```
           1
        /    \
       2      3
      / \    / \
     4   5  6   7
             \   \
              8   9
```

```
The output of print this tree vertically will be:
4
2
1 5 6
3 8
7
9
```



Vertical order traversal is:

A- 4

B- 2

C- 1 5 6

D- 3 8

D- 3 8

E- 7

F- 9

We strongly recommend to minimize the browser and try this yourself first.

The idea is to traverse the tree once and get the minimum and maximum horizontal distance with respect to root. For the tree shown above, minimum distance is -2 (for node with value 4) and maximum distance is 3 (For node with value 9).
Once we have maximum and minimum distances from root, we iterate for each vertical line at distance minimum to maximum from root, and for each vertical line traverse the tree and print the nodes which lie on that vertical line.

Algorithm:

```
// min --> Minimum horizontal distance from root
// max --> Maximum horizontal distance from root
// hd  --> Horizontal distance of current node from root
findMinMax(tree, min, max, hd)
     if tree is NULL then return;

     if hd is less than min then
           min = hd;
     else if hd is greater than max then
          *max = hd;

     findMinMax(tree->left, min, max, hd-1);
     findMinMax(tree->right, min, max, hd+1);
```

```
printVerticalLine(tree, line_no, hd)
     if tree is NULL then return;

     if hd is equal to line_no, then
           print(tree->data);
     printVerticalLine(tree->left, line_no, hd-1);
     printVerticalLine(tree->right, line_no, hd+1);
```

Implementation:

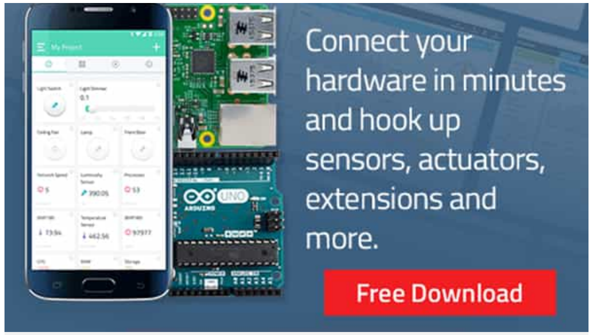
Following is the implementation of above algorithm.

C++ Java Python

```
#include <iostream>
using namespace std;

// A node of binary tree
struct Node
{
    int data;
    struct Node *left, *right;
};

// A utility function to create a new Binary Tree node
Node* newNode(int data)
{
    Node *temp = new Node;
    temp->data = data;
    temp->left = temp->right = NULL;
    return temp;
```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```
}

// A utility function to find min and max distances with
// to root.
void findMinMax(Node *node, int *min, int *max, int hd)
{
    // Base case
    if (node == NULL) return;

    // Update min and max
    if (hd < *min)  *min = hd;
    else if (hd > *max) *max = hd;

    // Recur for left and right subtrees
    findMinMax(node->left, min, max, hd-1);
    findMinMax(node->right, min, max, hd+1);
}

// A utility function to print all nodes on a given line_
// hd is horizontal distance of current node with respect
void printVerticalLine(Node *node, int line_no, int hd)
{
    // Base case
    if (node == NULL) return;

    // If this node is on the given line number
    if (hd == line_no)
        cout << node->data << " ";

    // Recur for left and right subtrees
    printVerticalLine(node->left, line_no, hd-1);
    printVerticalLine(node->right, line_no, hd+1);
}

// The main function that prints a given binary tree in
// vertical order
void verticalOrder(Node *root)
{
    // Find min and max distances with resepect to root
    int min = 0, max = 0;
```

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```
    findMinMax(root, &min, &max, 0);

    // Iterate through all possible vertical lines starti
    // from the leftmost line and print nodes line by lir
    for (int line_no = min; line_no <= max; line_no++)
    {
        printVerticalLine(root, line_no, 0);
        cout << endl;
    }
}

// Driver program to test above functions
int main()
{
    // Create binary tree shown in above figure
    Node *root = newNode(1);
    root->left = newNode(2);
    root->right = newNode(3);
    root->left->left = newNode(4);
    root->left->right = newNode(5);
    root->right->left = newNode(6);
    root->right->right = newNode(7);
    root->right->left->right = newNode(8);
    root->right->right->right = newNode(9);

    cout << "Vertical order traversal is \n" ;
    verticalOrder(root);

    return 0;
}
```

Run on IDE

Output:

```
Vertical order traversal is
```

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```
4
2
1 5 6
3 8
7
9
```

Time Complexity: Time complexity of above algorithm is O(w*n) where w is width of Binary Tree and n is number of nodes in Binary Tree.
can be O(n) (consider a complete tree for example) and time complexity can become O(n^2).

This problem can be solved more efficiently using the technique discussed in this post. We will soon be discussing complete algorithm and implementation of more efficient method.

This article is contributed by **Shalki Agarwal**. Please write comments if you find anything incorrect, or you want to share more information about the topic discussed above

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