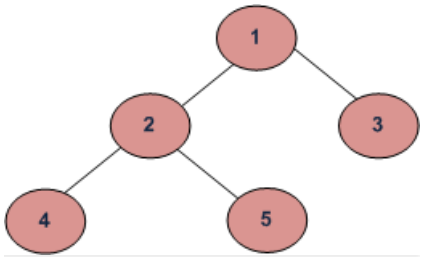
Reverse Level Order Traversal

We have discussed level order traversal of a post in previous post. The idea is to print last level first, then second last level, and so on. Like Level order traversal, every level is printed from left to right.



Example Tree

Reverse Level order traversal of the above tree is “4 5 2 3 1".

Both methods for normal level order traversal can be easily modified to do reverse level order traversal.

METHOD 1 (Recursive function to print a given level)

We can easily modify the method 1 of the normal level order traversal. In method 1, we have a method printGivenLevel() which prints a given level number. The only thing we need to change is, instead of calling printGivenLevel() from first level to last level, we call it from last level to first level.

C

```
// A recursive C program to print REVERSE level order traversal
#include <stdio.h>
#include <stdlib.h>

/* A binary tree node has data, pointer to left and right child */
struct node
{
    int data;
    struct node* left;
    struct node* right;
};

/*Function protoypes*/
void printGivenLevel(struct node* root, int level);
int height(struct node* node);
struct node* newNode(int data);

/* Function to print REVERSE level order traversal a tree*/
void reverseLevelOrder(struct node* root)
{
    int h = height(root);
    int i;
    for (i=h; i>=1; i--) //THE ONLY LINE DIFFERENT FROM NORMAL LEVEL ORDER
        printGivenLevel(root, i);
}

/* Print nodes at a given level */
void printGivenLevel(struct node* root, int level)
{
    if (root == NULL)
        return;
    if (level == 1)
        printf("%d ", root->data);
    else if (level > 1)
    {
```

```
        printGivenLevel(root->left, level-1);
        printGivenLevel(root->right, level-1);
    }
}

/* Compute the "height" of a tree -- the number of
    nodes along the longest path from the root node
    down to the farthest leaf node.*/
int height(struct node* node)
{
    if (node==NULL)
        return 0;
    else
    {
        /* compute the height of each subtree */
        int lheight = height(node->left);
        int rheight = height(node->right);

        /* use the larger one */
        if (lheight > rheight)
            return(lheight+1);
        else return(rheight+1);
    }
}

/* Helper function that allocates a new node with the
   given data and NULL left and right pointers. */
struct node* newNode(int data)
{
    struct node* node = (struct node*)
                        malloc(sizeof(struct node));
    node->data = data;
    node->left = NULL;
    node->right = NULL;

    return(node);
}

/* Driver program to test above functions*/
int main()
{
    struct node *root = newNode(1);
    root->left        = newNode(2);
    root->right       = newNode(3);
    root->left->left  = newNode(4);
    root->left->right = newNode(5);

    printf("Level Order traversal of binary tree is \n");
    reverseLevelOrder(root);

    return 0;
}
```

Java

```
// A recursive java program to print reverse level order traversal

// A binary tree node
class Node
{
    int data;
    Node left, right;

    Node(int item)
    {
        data = item;
        left = right;
    }
}

class BinaryTree
```

```
class BinaryTree
{
    Node root;

    /* Function to print REVERSE level order traversal a tree*/
    void reverseLevelOrder(Node node)
    {
        int h = height(node);
        int i;
        for (i = h; i >= 1; i--)
        //THE ONLY LINE DIFFERENT FROM NORMAL LEVEL ORDER
        {
            printGivenLevel(node, i);
        }
    }

    /* Print nodes at a given level */
    void printGivenLevel(Node node, int level)
    {
        if (node == null)
            return;
        if (level == 1)
            System.out.print(node.data + " ");
        else if (level > 1)
        {
            printGivenLevel(node.left, level - 1);
            printGivenLevel(node.right, level - 1);
        }
    }

    /* Compute the "height" of a tree -- the number of
     nodes along the longest path from the root node
     down to the farthest leaf node.*/
    int height(Node node)
    {
        if (node == null)
            return 0;
        else
        {
            /* compute the height of each subtree */
            int lheight = height(node.left);
            int rheight = height(node.right);

            /* use the larger one */
            if (lheight > rheight)
                return (lheight + 1);
            else
                return (rheight + 1);
        }
    }

    // Driver program to test above functions
    public static void main(String args[])
    {
        BinaryTree tree = new BinaryTree();

        // Let us create trees shown in above diagram
        tree.root = new Node(1);
        tree.root.left = new Node(2);
        tree.root.right = new Node(3);
        tree.root.left.left = new Node(4);
        tree.root.left.right = new Node(5);

        System.out.println("Level Order traversal of binary tree is : ");
        tree.reverseLevelOrder(tree.root);
    }
}

// This code has been contributed by Mayank Jaiswal
```

Python

```
# A recursive Python program to print REVERSE level order traversal

# A binary tree node
class Node:

    # Constructor to create a new node
    def __init__(self, data):
        self.data = data
        self.left = None
        self.right = None

# Function to print reverse level order traversal
def reverseLevelOrder(root):
    h = height(root)
    for i in reversed(range(1, h+1)):
        printGivenLevel(root,i)

# Print nodes at a given level
def printGivenLevel(root, level):

    if root is None:
        return
    if level ==1 :
        print root.data,

    elif level>1:
        printGivenLevel(root.left, level-1)
        printGivenLevel(root.right, level-1)

# Compute the height of a tree-- the number of
# nodes along the longest path from the root node
# down to the farthest leaf node
def height(node):
    if node is None:
        return 0
    else:

        # Compute the height of each subtree
        lheight = height(node.left)
        rheight = height(node.right)

        # Use the larger one
        if lheight > rheight :
            return lheight + 1
        else:
            return rheight + 1

# Driver program to test above function
root = Node(1)
root.left = Node(2)
root.right = Node(3)
root.left.left = Node(4)
root.left.right = Node(5)

print "Level Order traversal of binary tree is"
reverseLevelOrder(root)

# This code is contributed by Nikhil Kumar Singh(nickzuck_007)
```

Output:

```
Level Order traversal of binary tree is
4 5 2 3 1
```

Time Complexity: The worst case time complexity of this method is O(n^2). For a skewed tree, printGivenLevel() takes O(n) time where n is the number of nodes in the skewed tree. So time complexity of printLevelOrder() is O(n) + O(n-1) + O(n-2) + .. + O(1) which is O(n^2).

METHOD 2 (Using Queue and Stack)

The method 2 of normal level order traversal can also be easily modified to print level order traversal in reverse order. The idea is to use a stack to get the reverse level order. If we do normal level order traversal and instead of printing a node, push the node to a stack and then print contents of stack, we get "5 4 3 2 1" for above example tree, but output should be "4 5 2 3 1". So to get the correct sequence (left to right at every level), we process children of a node in reverse order, we first push the right subtree to stack, then left subtree.

C++

```
// A C++ program to print REVERSE level order traversal using stack and queue
// This approach is adopted from following link
// http://tech-queries.blogspot.in/2008/12/level-order-tree-traversal-in-reverse.html
#include <iostream>
#include <stack>
#include <queue>
using namespace std;

/* A binary tree node has data, pointer to left and right children */
struct node
{
    int data;
    struct node* left;
    struct node* right;
};

/* Given a binary tree, print its nodes in reverse level order */
void reverseLevelOrder(node* root)
{
    stack <node *> S;
    queue <node *> Q;
    Q.push(root);

    // Do something like normal level order traversal order. Following are the
    // differences with normal level order traversal
    // 1) Instead of printing a node, we push the node to stack
    // 2) Right subtree is visited before left subtree
    while (Q.empty() == false)
    {
        /* Dequeue node and make it root */
        root = Q.front();
        Q.pop();
        S.push(root);

        /* Enqueue right child */
        if (root->right)
            Q.push(root->right); // NOTE: RIGHT CHILD IS ENQUEUED BEFORE LEFT

        /* Enqueue left child */
        if (root->left)
            Q.push(root->left);
    }

    // Now pop all items from stack one by one and print them
    while (S.empty() == false)
    {
        root = S.top();
        cout << root->data << " ";
        S.pop();
    }
}

/* Helper function that allocates a new node with the
   given data and NULL left and right pointers. */
node* newNode(int data)
{
    node* temp = new node;
    temp->data = data;
    temp->left = NULL;
    temp->right = NULL;
```

```
    return (temp);
}

/* Driver program to test above functions*/
int main()
{
    struct 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);

    cout << "Level Order traversal of binary tree is \n";
    reverseLevelOrder(root);

    return 0;
}
```

Java

```
// A recursive java program to print reverse level order traversal
// using stack and queue

import java.util.LinkedList;
import java.util.Queue;
import java.util.Stack;

/* A binary tree node has data, pointer to left and right children */
class Node
{
    int data;
    Node left, right;

    Node(int item)
    {
        data = item;
        left = right;
    }
}

class BinaryTree
{
    Node root;

    /* Given a binary tree, print its nodes in reverse level order */
    void reverseLevelOrder(Node node)
    {
        Stack<Node> S = new Stack();
        Queue<Node> Q = new LinkedList();
        Q.add(node);

        // Do something like normal level order traversal order.Following
        // are the differences with normal level order traversal
        // 1) Instead of printing a node, we push the node to stack
        // 2) Right subtree is visited before left subtree
        while (Q.isEmpty() == false)
        {
            /* Dequeue node and make it root */
            node = Q.peek();
            Q.remove();
            S.push(node);

            /* Enqueue right child */
            if (node.right != null)
                // NOTE: RIGHT CHILD IS ENQUEUED BEFORE LEFT
                Q.add(node.right);
```

```
            /* Enqueue left child */
            if (node.left != null)
                Q.add(node.left);
        }

        // Now pop all items from stack one by one and print them
        while (S.empty() == false)
        {
            node = S.peek();
            System.out.print(node.data + " ");
            S.pop();
        }
    }

    // Driver program to test above functions
    public static void main(String args[])
    {
        BinaryTree tree = new BinaryTree();

        // Let us create trees shown in above diagram
        tree.root = new Node(1);
        tree.root.left = new Node(2);
        tree.root.right = new Node(3);
        tree.root.left.left = new Node(4);
        tree.root.left.right = new Node(5);
        tree.root.right.left = new Node(6);
        tree.root.right.right = new Node(7);

        System.out.println("Level Order traversal of binary tree is :");
        tree.reverseLevelOrder(tree.root);

    }
}

// This code has been contributed by Mayank Jaiswal
```

Python

```
# Python program to print REVERSE level order traversal using
# stack and queue

# A binary tree node
class Node:

    # Constructor to create a new node
    def __init__(self, data):
        self.data = data
        self.left = None
        self.right = None


# Given a binary tree, print its nodes in reverse level order
def reverseLevelOrder(root):
    S = []
    Q = []
    Q.append(root)

    # Do something like normal level order traversal order.
    # Following are the differences with normal level order
    # traversal:
    # 1) Instead of printing a node, we push the node to stack
    # 2) Right subtree is visited before left subtree
    while(len(Q) > 0 ):

        # Dequeue node and make it root
        root = Q.pop(0)
        S.append(root)

        # Enqueue right child
        if (root.right):
            Q.append(root.right)

        # Enqueue left child
        if (root.left):
            Q.append(root.left)

    # Now pop all items from stack one by one and print them
    while(len(S) > 0):
        root = S.pop()
        print root.data,

# Driver program to test above function
root = Node(1)
root.left = Node(2)
root.right = Node(3)
root.left.left = Node(4)
root.left.right = Node(5)
root.right.left = Node(6)
root.right.right = Node(7)

print "Level Order traversal of binary tree is"
reverseLevelOrder(root)

# This code is contributed by Nikhil Kumar Singh(nickzuck_007)
```

Output:

```
Level Order traversal of binary tree is
4 5 6 7 2 3 1
```

Time Complexity: O(n) where n is number of nodes in the binary tree.