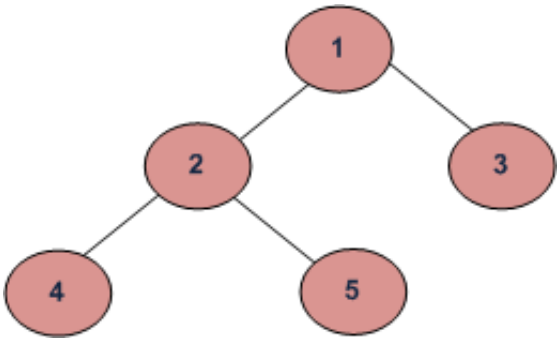
Level Order Tree Traversal

Level order traversal of a tree is breadth first traversal for the tree.



Example Tree

Level order traversal of the above tree is 1 2 3 4 5

METHOD 1 (Use function to print a given level)

Algorithm:

There are basically two functions in this method. One is to print all nodes at a given level (printGivenLevel), and other is to print level order traversal of the tree (printLevelorder). printLevelorder makes use of printGivenLevel to print nodes at all levels one by one starting from root.

```
/*Function to print level order traversal of tree*/
printLevelorder(tree)
for d = 1 to height(tree)
   printGivenLevel(tree, d);

/*Function to print all nodes at a given level*/
printGivenLevel(tree, level)
if tree is NULL then return;
if level is 1, then
    print(tree->data);
else if level greater than 1, then
    printGivenLevel(tree->left, level-1);
```

```
    printGivenLevel(tree->right, level-1);
```

Implementation:

C

```
// Recursive C program for level order traversal of Binary Tree
#include <stdio.h>
#include <stdlib.h>

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

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

/* Function to print level order traversal a tree*/
void printLevelOrder(struct node* root)
{
    int h = height(root);
    int i;
    for (i=1; i<=h; i++)
        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");
    printLevelOrder(root);

    return 0;
}
```

Run on IDE

Java

```
// Recursive Java program for level order traversal of Binary Tree

/* Class containing left and right child of current
   node and key value*/
class Node
{
    int data;
    Node left, right;
    public Node(int item)
    {
        data = item;
        left = right = null;
    }
}

class BinaryTree
{
    // Root of the Binary Tree
    Node root;

    public BinaryTree()
    {
        root = null;
    }

    /* function to print level order traversal of tree*/
```

```
    void printLevelOrder()
    {
        int h = height(root);
        int i;
        for (i=1; i<=h; i++)
            printGivenLevel(root, i);
    }

    /* 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 root)
    {
        if (root == null)
           return 0;
        else
        {
            /* compute  height of each subtree */
            int lheight = height(root.left);
            int rheight = height(root.right);

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

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

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

Run on IDE

Python

```
# Recursive Python program for level order traversal of Binary Tree
```

```
# A node structure
class Node:

    # A utility function to create a new node
    def __init__(self, key):
        self.data = key
        self.left = None
        self.right = None


# Function to  print level order traversal of tree
def printLevelOrder(root):
    h = height(root)
    for i in 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 "%d" %(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 -"
printLevelOrder(root)

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

Run on IDE

Output:

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

Time Complexity: O(n^2) in worst case. 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 (Use Queue)

Algorithm:

For each node, first the node is visited and then it's child nodes are put in a FIFO queue.

```
printLevelorder(tree)
1) Create an empty queue q
2) temp_node = root /*start from root*/
3) Loop while temp_node is not NULL
    a) print temp_node->data.
    b) Enqueue temp_node's children (first left then right children) to q
    c) Dequeue a node from q and assign it's value to temp_node
```

Implementation:

Here is a simple implementation of the above algorithm. Queue is implemented using an array with maximum size of 500. We can implement queue as linked list also.

C

```
// Iterative Queue based C program to do level order traversal
// of Binary Tree
#include <stdio.h>
#include <stdlib.h>
#define MAX_Q_SIZE 500

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

/* frunction prototypes */
struct node** createQueue(int *, int *);
void enQueue(struct node **, int *, struct node *);
```

```
struct node *deQueue(struct node **, int *);

/* Given a binary tree, print its nodes in level order
   using array for implementing queue */
void printLevelOrder(struct node* root)
{
    int rear, front;
    struct node **queue = createQueue(&front, &rear);
    struct node *temp_node = root;

    while (temp_node)
    {
        printf("%d ", temp_node->data);

        /*Enqueue left child */
        if (temp_node->left)
            enQueue(queue, &rear, temp_node->left);

        /*Enqueue right child */
        if (temp_node->right)
            enQueue(queue, &rear, temp_node->right);

        /*Dequeue node and make it temp_node*/
        temp_node = deQueue(queue, &front);
    }
}

/*UTILITY FUNCTIONS*/
struct node** createQueue(int *front, int *rear)
{
    struct node **queue =
        (struct node **)malloc(sizeof(struct node*)*MAX_Q_SIZE);

    *front = *rear = 0;
    return queue;
}

void enQueue(struct node **queue, int *rear, struct node *new_node)
{
    queue[*rear] = new_node;
    (*rear)++;
}

struct node *deQueue(struct node **queue, int *front)
{
    (*front)++;
    return queue[*front - 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");
    printLevelOrder(root);

    return 0;
}
```

Run on IDE

C++

```
/* C++ program to print level order traversal using STL */
#include <iostream>
#include <queue>
using namespace std;

// A Binary Tree Node
struct Node
{
    int data;
    struct Node *left, *right;
};

// Iterative method to find height of Bianry Tree
void printLevelOrder(Node *root)
{
    // Base Case
    if (root == NULL)  return;

    // Create an empty queue for level order tarversal
    queue<Node *> q;

    // Enqueue Root and initialize height
    q.push(root);

    while (q.empty() == false)
    {
        // Print front of queue and remove it from queue
        Node *node = q.front();
        cout << node->data << " ";
        q.pop();

        /* Enqueue left child */
        if (node->left != NULL)
            q.push(node->left);

        /*Enqueue right child */
        if (node->right != NULL)
            q.push(node->right);
    }
}

// Utility function to create a new tree node
Node* newNode(int data)
{
    Node *temp = new Node;
    temp->data = data;
```

```
    temp->left = temp->right = NULL;
    return temp;
}

// Driver program to test above functions
int main()
{
    // Let us create binary tree shown in above diagram
    Node *root = newNode(1);
    root->left = newNode(2);
    root->right = newNode(3);
    root->left->left = newNode(4);
    root->left->right = newNode(5);

    cout << "Level Order traversal of binary tree is \n";
    printLevelOrder(root);
    return 0;
}
```

Run on IDE

Java

```
// Iterative Queue based Java program to do level order traversal
// of Binary Tree

/* importing the inbuilt java classes required for the program */
import java.util.Queue;
import java.util.LinkedList;

/* Class to represent Tree node */
class Node {
    int data;
    Node left, right;

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

/* Class to print Level Order Traversal */
class BinaryTree {

    Node root;

    /* Given a binary tree. Print its nodes in level order
     using array for implementing queue  */
    void printLevelOrder()
    {
        Queue<Node> queue = new LinkedList<Node>();
        queue.add(root);
        while (!queue.isEmpty())
        {

            /* poll() removes the present head.
            For more information on poll() visit
            http://www.tutorialspoint.com/java/util/linkedlist_poll.htm */
            Node tempNode = queue.poll();
            System.out.print(tempNode.data + " ");
```

```
            /*Enqueue left child */
            if (tempNode.left != null) {
                queue.add(tempNode.left);
            }

            /*Enqueue right child */
            if (tempNode.right != null) {
                queue.add(tempNode.right);
            }
        }
    }

    public static void main(String args[])
    {
        /* creating a binary tree and entering
         the nodes */
        BinaryTree tree_level = new BinaryTree();
        tree_level.root = new Node(1);
        tree_level.root.left = new Node(2);
        tree_level.root.right = new Node(3);
        tree_level.root.left.left = new Node(4);
        tree_level.root.left.right = new Node(5);

        System.out.println("Level order traversal of binary tree is - ");
        tree_level.printLevelOrder();
    }
}
```

Run on IDE

Python

```
# Python program to print level order traversal using Queue

# A node structure
class Node:
    # A utility function to create a new node
    def __init__(self ,key):
        self.data = key
        self.left = None
        self.right = None

# Iterative Method to print the height of binary tree
def printLevelOrder(root):
    # Base Case
    if root is None:
        return

    # Create an empty queue for level order traversal
    queue = []

    # Enqueue Root and initialize height
    queue.append(root)

    while(len(queue) > 0):
        # Print front of queue and remove it from queue
        print queue[0].data,
        node = queue.pop(0)

        #Enqueue left child
        if node.left is not None:
            queue.append(node.left)
```

```
        # Enqueue right child
        if node.right is not None:
            queue.append(node.right)

#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 -"
printLevelOrder(root)
#This code is contributed by Nikhil Kumar Singh(nickzuck_007)
```

Run on IDE

Output:

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

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

References:

http://en.wikipedia.org/wiki/Breadth-first_traversal

Please write comments if you find any bug in the above programs/algorithms or other ways to solve the same problem.

205 Comments Category: Queue Trees

Related Posts:

- Minimum time required to rot all oranges
- How to efficiently implement k Queues in a single array?
- An Interesting Method to Generate Binary Numbers from 1 to n
- Iterative Method to find Height of Binary Tree
- Construct Complete Binary Tree from its Linked List Representation
- Find the first circular tour that visits all petrol pumps
- Implement Stack using Queues
- Find the largest multiple of 3

(Login to Rate and Mark)

2.1 Average Difficulty : **2.1/5.0**
Based on **26** vote(s)

Add to TODO List

Mark as DONE

Writing code in comment? Please use code.geeksforgeeks.org, generate link and share the link here.