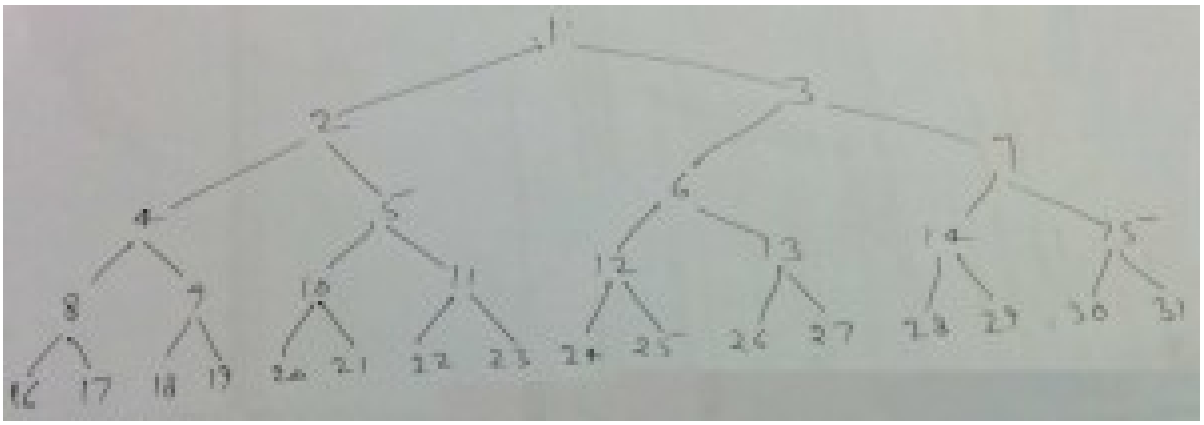
Perfect Binary Tree Specific Level Order Traversal

Given a Perfect Binary Tree like below:

(click on image to get a clear view)



Print the level order of nodes in following specific manner:

```
1 2 3 4 7 5 6 8 15 9 14 10 13 11 12 16 31 17 30 18 29 19 28 20 27 21 26  22 25 23 24
```

i.e. print nodes in level order but nodes should be from left and right side alternatively. Here 1st and 2nd levels are trivial.

While 3rd level: 4(left), 7(right), 5(left), 6(right) are printed.

While 4th level: 8(left), 15(right), 9(left), 14(right), .. are printed.

While 5th level: 16(left), 31(right), 17(left), 30(right), .. are printed.

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

In standard Level Order Traversal, we enqueue root into a queue 1st, then we dequeue ONE node from queue, process (print) it, enqueue its children into queue. We keep doing this until queue is empty.

Approach 1:

We can do standard level order traversal here too but instead of printing nodes directly, we have to store nodes

in current level in a temporary array or list 1st and then take nodes from alternate ends (left and right) and print nodes. Keep repeating this for all levels.
This approach takes more memory than standard traversal.

Approach 2:
The standard level order traversal idea will slightly change here. Instead of processing ONE node at a time, we will process TWO nodes at a time. And while pushing children into queue, the enqueue order will be: 1st node's left child, 2nd node's right child, 1st node's right child and 2nd node's left child.

C++

```
/* C++ program for special order traversal */
#include <iostream>
#include <queue>
using namespace std;

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

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

/* Given a perfect binary tree, print its nodes in specific
   level order */
void printSpecificLevelOrder(Node *root)
{
    if (root == NULL)
        return;

    // Let us print root and next level first
    cout << root->data;

    // / Since it is perfect Binary Tree, right is not checked
    if (root->left != NULL)
      cout << " " << root->left->data << " " << root->right->data;

    // Do anything more if there are nodes at next level in
    // given perfect Binary Tree
    if (root->left->left == NULL)
        return;

    // Create a queue and enqueue left and right children of root
    queue <Node *> q;
    q.push(root->left);
    q.push(root->right);
```

```
    // We process two nodes at a time, so we need two variables
    // to store two front items of queue
    Node *first = NULL, *second = NULL;

    // traversal loop
    while (!q.empty())
    {
       // Pop two items from queue
       first = q.front();
       q.pop();
       second = q.front();
       q.pop();

       // Print children of first and second in reverse order
       cout << " " << first->left->data << " " << second->right->data;
       cout << " " << first->right->data << " " << second->left->data;

       // If first and second have grandchildren, enqueue them
       // in reverse order
       if (first->left->left != NULL)
       {
           q.push(first->left);
           q.push(second->right);
           q.push(first->right);
           q.push(second->left);
       }
    }
}

/* Driver program to test above functions*/
int main()
{
    //Perfect Binary Tree of Height 4
    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->left->left->left  = newNode(8);
    root->left->left->right  = newNode(9);
    root->left->right->left  = newNode(10);
    root->left->right->right  = newNode(11);
    root->right->left->left  = newNode(12);
    root->right->left->right  = newNode(13);
    root->right->right->left  = newNode(14);
    root->right->right->right  = newNode(15);

    root->left->left->left->left  = newNode(16);
    root->left->left->left->right  = newNode(17);
    root->left->left->right->left  = newNode(18);
    root->left->left->right->right  = newNode(19);
    root->left->right->left->left  = newNode(20);
    root->left->right->left->right  = newNode(21);
    root->left->right->right->left  = newNode(22);
    root->left->right->right->right  = newNode(23);
    root->right->left->left->left  = newNode(24);
    root->right->left->left->right  = newNode(25);
    root->right->left->right->left  = newNode(26);
    root->right->left->right->right  = newNode(27);
    root->right->right->left->left  = newNode(28);
```

```
    root->right->right->left->right  = newNode(29);
    root->right->right->right->left  = newNode(30);
    root->right->right->right->right  = newNode(31);

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

    return 0;
}
```

Run on IDE

Java

```
// Java program for special level order traversal

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

/* 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 {

    static Node root;

    /* Given a perfect binary tree, print its nodes in specific
     level order */
    void printSpecificLevelOrder(Node node) {
        if (node == null) {
            return;
        }

        // Let us print root and next level first
        System.out.print(node.data);

        //  Since it is perfect Binary Tree, right is not checked
        if (node.left != null) {
            System.out.print(" " + node.left.data + " " + node.right.data);
        }

        // Do anything more if there are nodes at next level in
        // given perfect Binary Tree
        if (node.left.left == null) {
            return;
        }

        // Create a queue and enqueue left and right children of root
        Queue<Node> q = new LinkedList<Node>();
        q.add(node.left);
        q.add(node.right);
```

```
        // We process two nodes at a time, so we need two variables
        // to store two front items of queue
        Node first = null, second = null;

        // traversal loop
        while (!q.isEmpty()) {
            // Pop two items from queue
            first = q.peek();
            q.remove();
            second = q.peek();
            q.remove();

            // Print children of first and second in reverse order
            System.out.print(" " + first.left.data + " " + second.right.data);
            System.out.print(" " + first.right.data + " " + second.left.data);

            // If first and second have grandchildren, enqueue them
            // in reverse order
            if (first.left.left != null) {
                q.add(first.left);
                q.add(second.right);
                q.add(first.right);
                q.add(second.left);
            }
        }
    }

    // driver program to test for 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);
        tree.root.right.left = new Node(6);
        tree.root.right.right = new Node(7);

        tree.root.left.left.left = new Node(8);
        tree.root.left.left.right = new Node(9);
        tree.root.left.right.left = new Node(10);
        tree.root.left.right.right = new Node(11);
        tree.root.right.left.left = new Node(12);
        tree.root.right.left.right = new Node(13);
        tree.root.right.right.left = new Node(14);
        tree.root.right.right.right = new Node(15);

        tree.root.left.left.left.left = new Node(16);
        tree.root.left.left.left.right = new Node(17);
        tree.root.left.left.right.left = new Node(18);
        tree.root.left.left.right.right = new Node(19);
        tree.root.left.right.left.left = new Node(20);
        tree.root.left.right.left.right = new Node(21);
        tree.root.left.right.right.left = new Node(22);
        tree.root.left.right.right.right = new Node(23);
        tree.root.right.left.left.left = new Node(24);
        tree.root.right.left.left.right = new Node(25);
        tree.root.right.left.right.left = new Node(26);
        tree.root.right.left.right.right = new Node(27);
        tree.root.right.right.left.left = new Node(28);
        tree.root.right.right.left.right = new Node(29);
        tree.root.right.right.right.left = new Node(30);
        tree.root.right.right.right.right = new Node(31);
```

```
        System.out.println("Specific Level Order traversal of binary tree is ");
        tree.printSpecificLevelOrder(root);
    }
}

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

Run on IDE

Python

```
# Python program for special order traversal

# A binary tree ndoe
class Node:
    # A constructor for making a new node
    def __init__(self, key):
        self.data = key
        self.left = None
        self.right = None

# Given a perfect binary tree print its node in
# specific order
def printSpecificLevelOrder(root):
    if root is None:
        return

    # Let us print root and next level first
    print root.data,

    # Since it is perfect Binary tree,
    # one of the node is needed to be checked
    if root.left is not None :
        print root.left.data,
        print root.right.data,

    # Do anythong more if there are nodes at next level
    # in given perfect Binary Tree
    if root.left.left is None:
        return

    # Create a queue and enqueue left and right
    # children of root
    q = []
    q.append(root.left)
    q.append(root.right)

    # We process two nodes at a time, so we need
    # two variables to stroe two front items of queue
    first = None
    second = None

    # Traversal loop
    while(len(q) > 0):

        # Pop two items from queue
        first = q.pop(0)
        second = q.pop(0)

        # Print children of first and second in reverse order
        print first.left.data,
```

```
        print second.right.data,
        print first.right.data,
        print second.left.data,

        # If first and second have grandchildren,
        # enqueue them in reverse order
        if first.left.left is not None:
            q.append(first.left)
            q.append(second.right)
            q.append(first.right)
            q.append(second.left)

# Driver program to test above function

# Perfect Binary Tree of Height 4
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)

root.left.left.left  = Node(8)
root.left.left.right  = Node(9)
root.left.right.left  = Node(10)
root.left.right.right  = Node(11)
root.right.left.left  = Node(12)
root.right.left.right  = Node(13)
root.right.right.left  = Node(14)
root.right.right.right  = Node(15)

root.left.left.left.left  = Node(16)
root.left.left.left.right  = Node(17)
root.left.left.right.left  = Node(18)
root.left.left.right.right  = Node(19)
root.left.right.left.left  = Node(20)
root.left.right.left.right  = Node(21)
root.left.right.right.left  = Node(22)
root.left.right.right.right  = Node(23)
root.right.left.left.left  = Node(24)
root.right.left.left.right  = Node(25)
root.right.left.right.left  = Node(26)
root.right.left.right.right  = Node(27)
root.right.right.left.left  = Node(28)
root.right.right.left.right  = Node(29)
root.right.right.right.left  = Node(30)
root.right.right.right.right  = Node(31)

print "Specific Level Order traversal of binary tree is"
printSpecificLevelOrder(root);

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

Run on IDE

Output:

```
Specific Level Order traversal of binary tree is
```

```
1 2 3 4 7 5 6 8 15 9 14 10 13 11 12 16 31 17 30 18 29 19 28 20 27 21 26 22 25 23 24
```

Followup Questions:

1. The above code prints specific level order from TOP to BOTTOM. How will you do specific level order traversal from BOTTOM to TOP (Amazon Interview | Set 120 – Round 1 Last Problem)
2. What if tree is not perfect, but complete.
3. What if tree is neither perfect, nor complete. It can be any general binary tree.

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

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Shambhavi Shinde • a month ago

http://ideone.com/G57iSs, easier to understand

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Saurabh Vats • a month ago

Your code as per the approach is quite complex :

Simplified one:

```
void printSpecificLevelOrder(Node *root)
{
if (root == NULL) return;
// Let us print root and next level first
cout << root->data;
// Create a queue and enqueue left and right children of root
queue <node *=""> q;
q.push(root->left);
q.push(root->right);
// We process two nodes at a time, so we need two variables
// to store two front items of queue
Node *first = NULL, *second = NULL;
// traversal loop
```

see more

1 • Reply • Share ›

wilson • 2 months ago

using recursion

```
void level(struct tree *r,struct tree *r1,int l,int levl)
{
if(r==NULL)
return;
if(l==levl)
{
cout<<r->data<<" "<<r1->data<<" ";
}
level(r->left,r1->right,l,levl+1);
level(r->right,r1->left,l,levl+1);
}
void find(struct tree *r)
{
int i,h=height(r);
if(!r)
return;
cout<<r->data<<" ";
for(i=0;i<=h;i++)
level(r->left,r->right,i,0);
}
```

1 ^ | v • Reply • Share ›

nitin • 4 months ago

Recursive Solution using map to store the level result for Perfect Binary Tree-

http://ideone.com/EhRmCi

^ | v • Reply • Share ›

ravi • 4 months ago

what is the answer if the tree having only one node. Will it won't throw any exception?

^ | v • Reply • Share ›

cold breeze • 5 months ago

Why first->left->left != NULL ?

```
if (first->left->left != NULL)
{
q.push(first->left);
q.push(second->right);
q.push(first->right);
q.push(second->left);
}
```

• Reply • Share ›

tarun • 5 months ago

This will work for all kinds of trees:perfect/complete or any general Binary Tree

http://code.geeksforgeeks.org/...

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Gaurav Gupta • 6 months ago

Approach 3: Normal level order with space complexity: O(1) if space required for recursion is not considered.

http://code.geeksforgeeks.org/...

• Reply • Share ›

TheCoder • 6 months ago

Specific tree traversal using simple level order
http://ideone.com/U12Ext

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Billionaire • 7 months ago

Nice Hack! **@GeeksforGeeks**

1 • Reply • Share ›

Unique • 9 months ago

The bottom up can be done in O(n) time using a stack.We do the level order traversal as above with the help of queue and for each level insert the nodes in the stack in reverse order and then after complete traversal, print all the elements from stack.

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Raj • 9 months ago

A simple C++ implementation using two queues
http://ideone.com/nR8Wix

Along with formation of your own tree:-
http://ideone.com/oRMPgS

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Anshu Singh • 9 months ago

https://ideone.com/ElSkSJ

C implementation :).

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Rashmi Dewangan • 9 months ago

another method can be - maintain two queues ,one for left subtree of root and other for right subtree of root . for left subtree of root we do normal level order traversal , for right subtree also we do level order traversal but we push right child before left child . After the traversal is finished we first print the root itself and then alternatively pop element from two queues and print it.

1 • Reply • Share ›

typing.. ➚ Rashmi Dewangan • 7 months ago

I also thought so, but with little different climax, instead of printing after traversing whole tree, print in parallel as soon as you pop, and notice, you should pop alternatively from both the queues.

1 • Reply • Share ›

ksk • 10 months ago

i think this simple recursion works without que() but O(n^2) running time

---

```
#include <iostream>

using namespace std;

struct node

{

node *lchild;

int data;

node *rchild;

node()

{
```

see more

1 • Reply • Share ›

NITIN PANCHAL • 10 months ago

following code also works

```
#include<iostream>

#include<stdio.h>

#include<stdlib.h>
```

```
#include<queue>

using namespace std ;

struct tree

{

int data ;

tree *left;

tree *right;
```

see more

• Reply • Share ›

rohit_90 • a year ago

Here is O(n) code for bottom up problem with O(n) space complexity. It is similar to code mentioned in this post.

Java Code: http://ideone.com/MpgrDj

• Reply • Share ›

sudheer • a year ago

Here is the java code

```
public void printSpecificLevelOrder( Node root ){

if( root==null )
return;

//Print the root
System.out.print(root.id+" ");

//Print the left and right node
if( root.left!=null )
System.out.print(root.left.id+" "+root.right.id+" ");
else
return;

//As it is a perfect binary tree so if left child is there than there will
//be full level

if( root.left.left == null)
```

see more

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Vikram Ojha • a year ago
try dis code http://ideone.com/3E2PFb
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Vikram Ojha • a year ago
Hi can any1 help me wid this code http://ideone.com/p46l43
Its repeating the o/p so can we use some condition for dis?
• Reply • Share ›

Ekta Goel • a year ago
Bottom up can be done this way : http://ideone.com/n9mdqN
And even if we store the top-bottom traversal in an array and then read the reverse in powers of two from end, we can get the same!!
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Ekta Goel ➚ Ekta Goel • a year ago
Or even this will work, without any space but complexity O(n^2)
http://ideone.com/NvHrB0
1 • Reply • Share ›

rohit_90 ➚ Ekta Goel • a year ago
I think your code is not correct because o/p of your code is 16 31 17 30 18 29 19 28 20 27 21 26 22 25 23 24 8 15 9 14 10 13 11 12 4 7 5 6 1
2 and 3 are missing from this output.
• Reply • Share ›

Jerry Goyal ➚ rohit_90 • a year ago
http://ideone.com/Ruo3SK now it's not.
• Reply • Share ›

shark • a year ago
Anyone with the answers to the follow-up questions?
• Reply • Share ›

Ekta Goel ➚ shark • a year ago
http://ideone.com/NvHrB0
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