

TREES

INORDER SUCCESSOR OF BINARYTREE

[Exchange the Leaf Nodes](#)

[Sum of the Longest Bloodline of a Tree](#)

[Remove Half Nodes](#)

[Leaves to DLL](#)

[Check if Tree is Isomorphic](#)

[***Vertical sum \(Special Algo\)](#)

<http://www.geeksforgeeks.org/lowest-common-ancestor-in-a-binary-search-tree/>

<http://www.geeksforgeeks.org/diagonal-sum-binary-tree/>

<http://www.geeksforgeeks.org/diameter-of-a-binary-tree/>

[Serialize and Deserialize a Binary Tree](#)

*******Diameter of tree**

Views of tree:

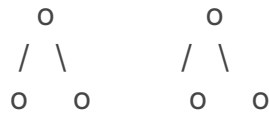
- ☐ <https://www.geeksforgeeks.org/print-right-view-binary-tree-2/>
- ☐ <https://www.geeksforgeeks.org/print-nodes-top-view-binary-tree/>
- ☐ <https://www.geeksforgeeks.org/bottom-view-binary-tree/>
- ☐ <https://www.geeksforgeeks.org/print-left-view-binary-tree/>
- ☐ <https://www.geeksforgeeks.org/print-binary-tree-vertical-order/>
- ☐ [Diagonal Traversal of tree](#)

1. [Maximum sum path](#)
2. [Root to leaf paths sum](#)
3. <http://www.geeksforgeeks.org/find-maximum-path-sum-two-leaves-binary-tree/>

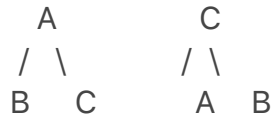
Enumeration of Binary Trees

A Binary Tree is labeled if every node is assigned a label and a Binary Tree is unlabeled if nodes are not assigned any label.

Below two are considered same unlabeled trees



Below two are considered different labeled trees

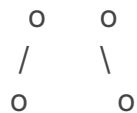


How many different Unlabeled Binary Trees can be there with n nodes?

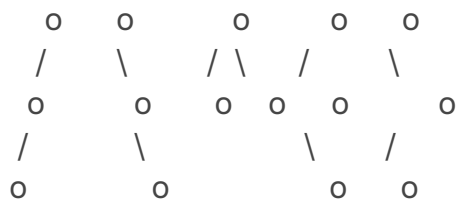
For $n = 1$, there is only one tree



For $n = 2$, there are two trees



For $n = 3$, there are five trees



The idea is to consider all possible pair of counts for nodes in left and right subtrees and multiply the counts for a particular pair. Finally add results of all pairs.

For example, let $T(n)$ be count for n nodes.

$T(0) = 1$ [There is only 1 empty tree]

$T(1) = 1$

$T(2) = 2$

$$T(3) = T(0)*T(2) + T(1)*T(1) + T(2)*T(0) = 1*2 + 1*1 + 2*1 = 5$$

$$\begin{aligned}
 T(4) &= T(0)*T(3) + T(1)*T(2) + T(2)*T(1) + T(3)*T(0) \\
 &= 1*5 + 1*2 + 2*1 + 5*1 \\
 &= 14
 \end{aligned}$$

The above pattern basically represents n 'th Catalan Numbers.

SERIES

First few catalan numbers are 1 1 2 5 14 42 132 429 1430 4862,...

$$T(n) = \sum_{i=1}^n T(i-1)T(n-i) = \sum_{i=0}^{n-1} T(i)T(n-i-1) = C_n$$

Here,

T(i-1) represents number of nodes on the left-sub-tree

T(n-i-1) represents number of nodes on the right-sub-tree

n'th Catalan Number can also be evaluated using direct formula.

$$T(n) = (2n)! / (n+1)!n!$$

```
class Solution {
public:
    int numTrees(int n) {
        int g[n+1];
        for(int i=0;i<n+1;i++){
            g[i]=0;
        }
        g[0]=1;
        g[1]=1;
        for(int i=2;i<n+1;i++){
            for(int j=0;j<i;j++){
                g[i]+=g[j]*g[i-j-1];
            }
        }
        return g[n];
    }
};
```