What makes a tree 'balanced'?

In this chapter, we are going to study what makes a tree balanced. We are also going to look at a high-level description of the algorithm used to determine if a given tree is balanced.

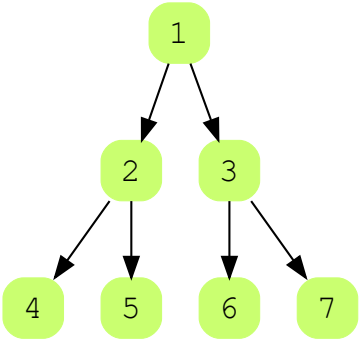
We'll cover the following

Introduction

A binary tree is height-balanced if, for each node in the tree, the difference between the height of the right subtree and the left subtree is at most one.

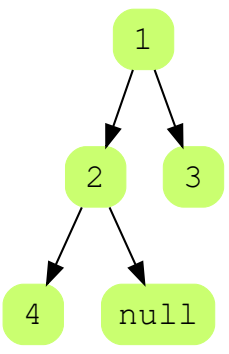
$$|Height(LeftSubTree) - Height(RightSubTree)| <= 1$$

Look at the illustration below of a height-balanced tree. Notice how the left and right sub-trees all appear at the same height.



Checking if a binary tree is balanced

Try to guess if the following tree is balanced or not before looking at the answer!



Hide Hint

$$|Height(LeftSubTree) - Height(RightSubTree)| <= 1$$

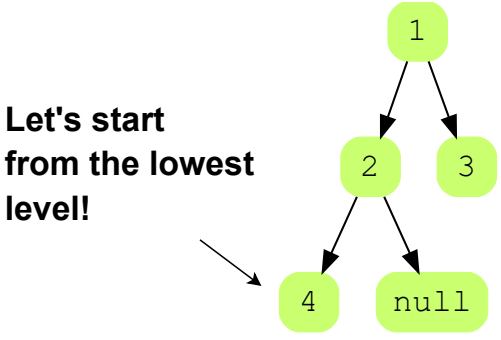
This tree is height-balanced! How did we determine that? Lets go through break our thought process down into a series of steps to find out.

High-level Algorithm to determine if a tree is height-balanced

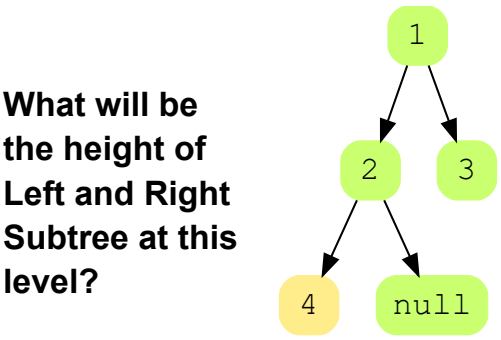
1. Start from the leaf nodes and move towards the root
2. Along with traversing the tree, compute heights of the *left-subtree* and *right-subtree* of each node. The height of a leaf node is always **0**
3. At each node, check if the difference between the height of the left and right sub-tree is more than **1**, if so, it means that the tree is not balanced.
4. If you have completely traversed the tree and haven't caught the above condition, then the tree is balanced.

Example

Implementing what we learned from the above four steps in the illustration below. Here, *HLT* means the height of the Left Tree and *HRT* means the height of the right tree:

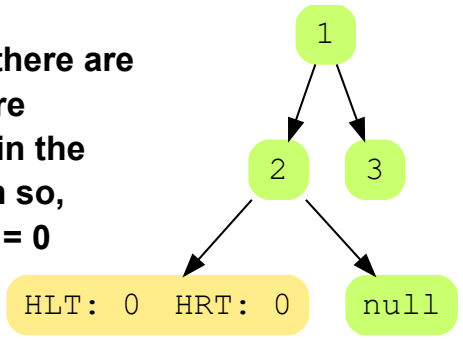


1 of 11



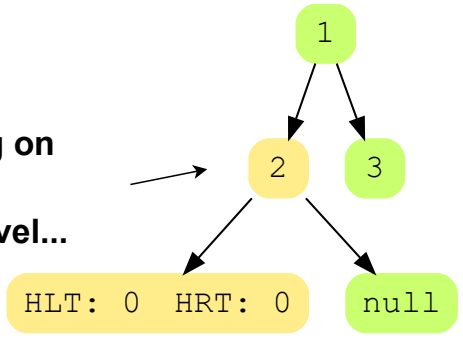
2 of 11

Since there are no more levels in the bottom so, height = 0

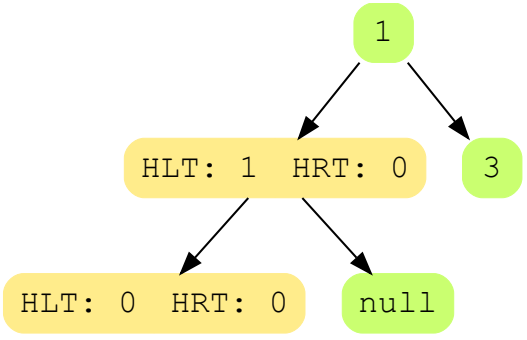


3 of 11

Moving on to the next level...

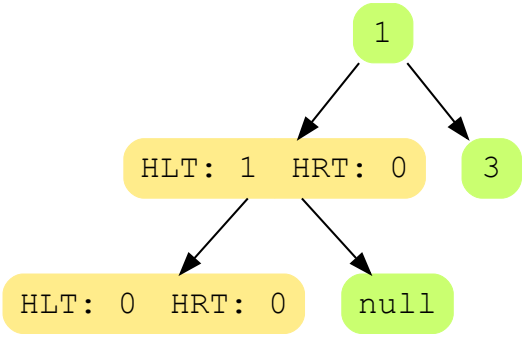


4 of 11



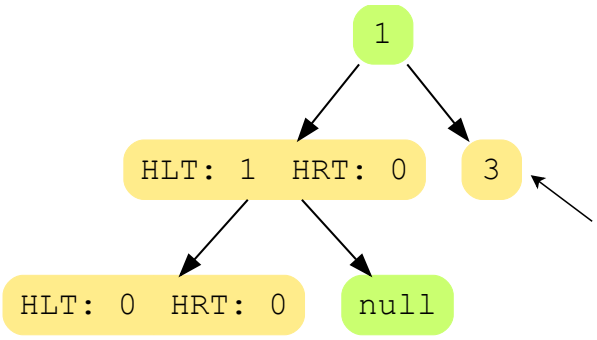
At this level, the node has a left child but no right child

5 of 11



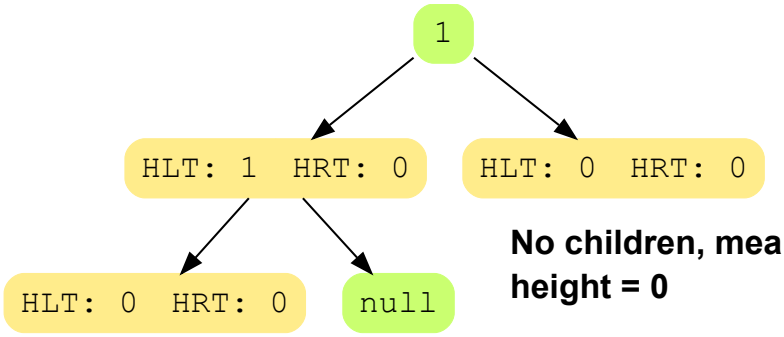
So, HLT will be 1 and HRT will be 0!

6 of 11



What will be the height at this level?

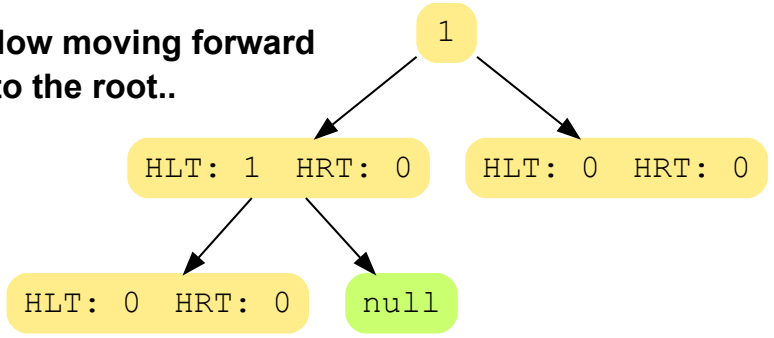
7 of 11



No children, means height = 0

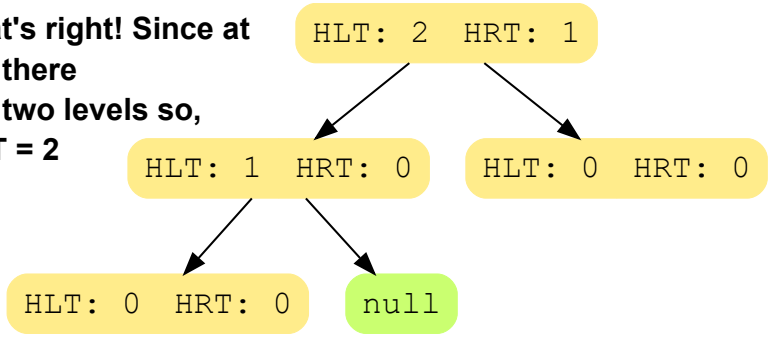
8 of 11

Now moving forward to the root..

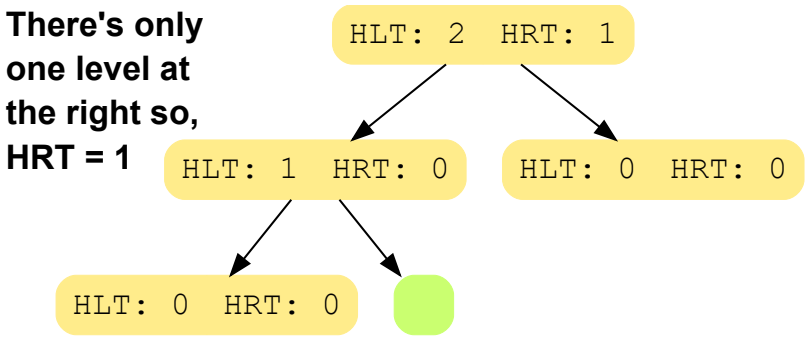


9 of 11

That's right! Since at left there are two levels so, HLT = 2

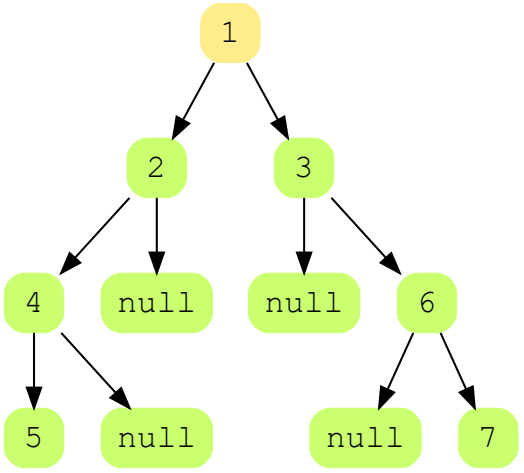


10 of 11



Quiz:

Now, to test your concept about checking if a tree is balanced or not, see the example below and try to solve it on a piece of paper. For help, you have a hint down below, but try to do it yourself first!



Q Is the above tree balanced?

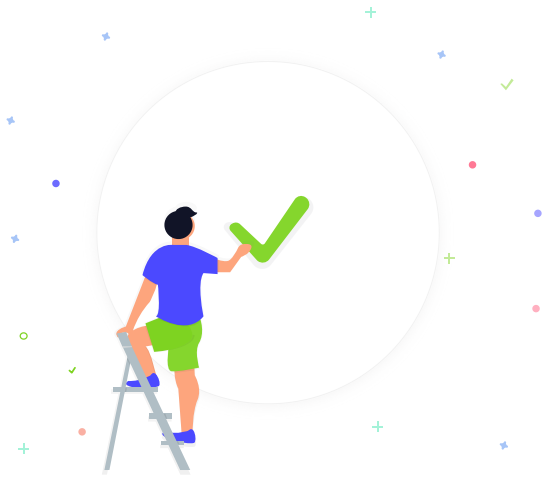
A) Yes

Your Answer

B) No

Explanation

Observe Node 2.



Great, you got it right!

Retake Quiz

In the upcoming lessons, we will go through a bunch of different types of trees one at a time, starting from Binary Tree, some further types to their more complex versions like 2-3 and AVL Trees etc.

Back

Trees and their Basic Properties!

Next

What is a Binary Tree?

Mark as Completed