Assignment 1

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Download all latex-tikz codes from

```
https://github.com/Krati012/C−and−DS/tree/main/
    Assignment1
```

1 Problem

(Q. 20) The postorder traversal of a binary tree is 8,9,6,7,4,5,2,3,1. The inorder traversal of the same tree is 8,6,9,4,7,2,5,1,3. The height of a tree is the length of the longest path from the root to any leaf. The height of the binary tree above is _____?

2 Solution

Answer: The height of the above binary tree is 4.
Explanation: **Postorder traversal** of a binary tree is a depth-first search in which we first traverse the left subtree, then traverse the right subtree, and finally visit the root node. Whereas in **inorder traversal** we first traverse the left subtree, visit the root and then traverse the right subtree.
If there are n nodes in binary tree, maximum height of the binary tree is $n-1$.
A complete binary tree will have minimum height for given n number of nodes. Then height h will lie in the range:

$$2^h \le n \le 2^{h+1} - 1 \tag{2.0.1}$$

Thus, solving this inequality we get:

$$h \le log_2 n, h \ge log_2(n+1) - 1 \tag{2.0.2}$$

Since h is an integer, we finally get,

$$h = floor(log_2 n) = ceil(log_2(n+1) - 1) \tag{2.0.3}$$

Therefore, for a binary tree maximum height is $n-1$ and minimum height is $floor(log_2 n)$. For given problem, n=9, so maximum height of the binary tree possible is 8 and minimum height possible is 3.
The following algorithm allows us to construct the binary tree from given $inorder = [8,6,9,4,7,2,5,1,3]$ and $postorder = [8,9,6,7,4,5,2,3,1]$:

- First find the last node in postorder[], as root always appear in the end of postorder traversal. The root is ”1” in this problem.
- Search “1” in inorder[] to find left and right subtrees of root. Everything on left of “1” in inorder[] is in left subtree and everything on right is in right subtree.
- Recur the above process for following two:
  - Recur for $inorder = [8,6,9,4,7,2,5]$ and $postorder = [8,9,6,7,4,5,2]$. The created tree will be left child of root.
  - Recur for $inorder = [3]$ and $postorder = [3]$. The created tree will be right child of root.

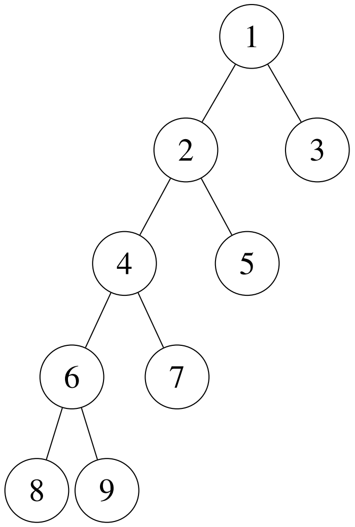

Fig. 0: Constructed Binary Tree

The following code uses the above algorithm to construct the tree and prints the height of the tree as output.

```
codes/height_bst.py
```

The constructed tree from above algorithm is shown in Fig. 0
Thus, we can see that the height of the tree is 4.