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Construct Binary Tree from Inorder and Preorder

Let us consider the below traversals:

- Inorder sequence: D B E A F C
- Preorder sequence: A B D E C F

subtree and elements on right in the right subtree. So we know the below structure now.

```
      A
    /   \
  /       \
D B E     F C
```

We recursively follow the above steps and get the following tree.

```
         A
       /   \
     /       \
    B         C
   / \        /
 /     \    /
D       E  F
```

Algorithm:

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1. Pick an element from Preorder. Increment a Preorder Index Variable (preIndex in below code) to pick the next element in the next recursive call.
2. Create a new tree node tNode with the data as the picked element.
3. Find the picked element's index in Inorder. Let the index be inIndex.
4. Call buildTree for elements before inIndex and make the built tree as a left subtree of tNode.
5. Call buildTree for elements after inIndex and make the built tree as a right subtree of tNode.
6. return tNode.

We store indexes of inorder traversal in a hash table. So that search can be done O(1) time.

C++ Java

```
 /* Java program to construct tree using inorder
and preorder traversals */
import java.io.*;
import java.util.*;

/* A binary tree node has data, pointer to left child
and a pointer to right child */
class Node
{
char data;
Node left,right;
Node(char item)
{
    data = item;
    left = right = null;
}
}
```

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```
class Tree
{

public static Node root;

// Store indexes of all items so that we
// we can quickly find later
static HashMap<Character,Integer> mp = new HashMap<>();
static int preIndex = 0;

/* Recursive function to construct binary of size
    len from Inorder traversal in[] and Preorder traversal
    pre[]. Initial values of inStrt and inEnd should be
    0 and len -1. The function doesn't do any error
    checking for cases where inorder and preorder
    do not form a tree */
public static Node buildTree(char[] in, char[] pre, int inStrt, int inEnd)
{

    if(inStrt > inEnd)
    {
    return null;
    }

    /* Pick current node from Preorder traversal using preIndex
        and increment preIndex */
    char curr = pre[preIndex++];
    Node tNode;
    tNode = new Node(curr);
```

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```
    /* If this node has no children then return */
    if (inStrt == inEnd)
    {
    return tNode;
    }

    /* Else find the index of this node in Inorder traversal */
    int inIndex = mp.get(curr);

    /* Using index in Inorder traversal, construct left and
        right subtress */
    tNode.left = buildTree(in, pre, inStrt, inIndex - 1);
    tNode.right = buildTree(in, pre, inIndex + 1, inEnd);
    return tNode;
}

// This function mainly creates an unordered_map, then
// calls buildTree()
public static Node buldTreeWrap(char[] in, char[] pre, int len)
{
    for(int i = 0; i < len; i++)
    {
    mp.put(in[i], i);
    }
    return buildTree(in, pre, 0, len - 1);
}

/* This function is here just to test buildTree() */
```

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```
static void printInorder(Node node)
{
    if(node == null)
    {
    return;
    }
    printInorder(node.left);
    System.out.print(node.data + " ");
    printInorder(node.right);
}
```

```
public static void main (String[] args)
{
    char[] in = {'D', 'B', 'E', 'A', 'F', 'C'};
    char[] pre = {'A', 'B', 'D', 'E', 'C', 'F'};
    int len = in.length;

    Tree.root=buldTreeWrap(in, pre, len);

    /* Let us test the built tree by printing
        Inorder traversal */
    System.out.println("Inorder traversal of the constructed tree is");
    printInorder(root);
}
}

// This code is contributed by avanitrachhadiya2155
```

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Output

```
Inorder traversal of the constructed tree is
D B E A F C
```

Time Complexity: O(n)
Auxiliary Space: O(n), The extra space is used to store the elements in the map also due to recursive function call stack.

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