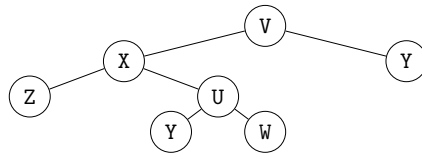


COMPUTER SCIENCE TRIPOS Part IA – 2020 – Paper 1

7 Algorithms (fms27)

Consider binary trees whose nodes have three fields: key (a single character between U and Z), left subtree, right subtree, with the two subtrees either both empty or both non-empty. Assuming suitable constructors, indicate an empty tree as $T()$ and a non-empty tree as $T(\text{key}, \text{leftSubtree}, \text{rightSubtree})$.

- (a) Define unambiguous pre-order, in-order and post-order representations for such a tree \mathbf{t} , called $r_{pre}(\mathbf{t})$, $r_{in}(\mathbf{t})$, $r_{post}(\mathbf{t})$, consisting of strings over the $\{U, V, W, X, Y, Z, (,)\}$ alphabet, with balanced brackets, with three characters (two brackets and a letter) for each node, starting and finishing with a bracket unless \mathbf{t} is empty. Formally describe your three representations for a generic tree \mathbf{t} , then produce the corresponding strings for the following tree. [6 marks]



- (b) In this obfuscated pseudocode, the input $v0$ is a syntactically correct $r_{post}(\mathbf{t})$. Clearly explain (i) the purpose of the code; (ii) how it works; and (iii) how one should invoke it. Substitute meaningful explanatory identifiers for those T_x , v_y and m_z . Identifiers $v4$ and $v6$ are worth more marks than the others. [7 marks]

```
0 class T1:
1     # data members of objects of type T1
2     v2: T14 of T3
3     v4: T12
4     v6: T13
5
6     def m5(v0):
7         if v0 is "":
8             return T3()
9         else:
10            for v9 in v0:
11                m10(v9)
12            return v2.pop()
13
14     def m10(v11):
15         if v11 is one of {"U", "V", "W", "X", "Y", "Z"}:
16             v6 = v4 is ")"
17         else if v11 is "(":
18             if v6:
19                 v8 = v2.pop(); v7 = v2.pop()
20             else:
21                 v8 = null; v7 = null
22             v2.push(T3(v4, v7, v8))
23         v4 = v11
```

- (c) Explain in detail (i) how line 16 works, and (ii) why $v4$ will never be uninitialised when line 16 is executed. [4 marks]
- (d) Write clear pseudocode that takes a Tree \mathbf{t} and returns $r_{in}(\mathbf{t})$. [3 marks]