99 questions/70B to 73

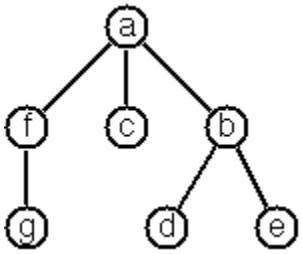
From HaskellWiki

< 99 questions

This is part of Ninety-Nine Haskell Problems, based on Ninety-Nine Prolog Problems (https://prof.ti.bfh.ch/hew1/informatik3/prolog/p-99/) .

1 Multiway Trees

A multiway tree is composed of a root element and a (possibly empty) set of successors which are multiway trees themselves. A multiway tree is never empty. The set of successor trees is sometimes called a forest.



2 Problem 70B

(*) Check whether a given term represents a multiway tree.

In Prolog or Lisp, one writes a predicate to check this.

Example in Prolog:

```
?- istree(t(a,[t(f,[t(g,[])]),t(c,[]),t(b,[t(d,[]),t(e,[])])])).
Yes
```

In Haskell, we define multiway trees as a datatype, as in the module Data.Tree (http://www.haskell.org/ghc/docs/latest/html/libraries/containers/Data-Tree.html) :

```haskell
data Tree a = Node a [Tree a]
        deriving (Eq, Show)
```

Some example trees:

```haskell
tree1 = Node 'a' []
```

```
tree2 = Node 'a' [Node 'b' []]

tree3 = Node 'a' [Node 'b' [Node 'c' []]]

tree4 = Node 'b' [Node 'd' [], Node 'e' []]

tree5 = Node 'a' [
                Node 'f' [Node 'g' []],
                Node 'c' [],
                Node 'b' [Node 'd' [], Node 'e' []]
                ]
```

The last is the tree illustrated above.

As in problem 54A, all members of this type are multiway trees; there is no use for a predicate to test them.

3 Problem 70C

(*) Count the nodes of a multiway tree.

Example in Haskell:

```
Tree> nnodes tree2
2
```

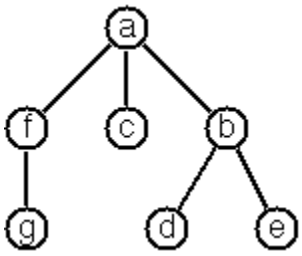
Solutions

4 Problem 70

(**) Tree construction from a node string.

We suppose that the nodes of a multiway tree contain single characters. In the depth-first order sequence of its nodes, a special character ^ has been inserted whenever, during the tree traversal, the move is a backtrack to the previous level.

By this rule, the tree below (`tree5`) is represented as: `afg^^c^bd^e^^^`



Define the syntax of the string and write a predicate tree(String,Tree) to construct the Tree when the String is given. Make your predicate work in both directions.

Example in Haskell:

```
Tree> stringToTree "afg^^c^bd^e^^^"
Node 'a' [Node 'f' [Node 'g' []],Node 'c' [],Node 'b' [Node 'd' [],Node 'e' []]]

Tree> treeToString (Node 'a' [Node 'f' [Node 'g' []],Node 'c' [],Node 'b' [Node 'd' [],Node '
"afg^^c^bd^e^^^"
```

Solutions

5 Problem 71

(*) Determine the internal path length of a tree.

We define the internal path length of a multiway tree as the total sum of the path lengths from the root to all nodes of the tree. By this definition, `tree5` has an internal path length of 9.

Example in Haskell:

```
Tree> ipl tree5
9
Tree> ipl tree4
2
```

Solutions

6 Problem 72

(*) Construct the bottom-up order sequence of the tree nodes.

Write a predicate bottom_up(Tree,Seq) which constructs the bottom-up sequence of the nodes of the multiway tree Tree.

Example in Haskell:

```
Tree> bottom_up tree5
"gfcdeba"
```

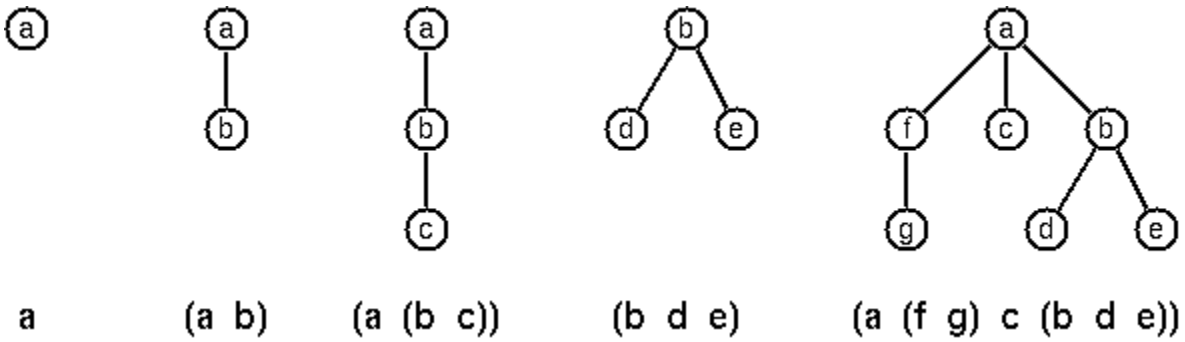
Solutions

7 Problem 73

(**) Lisp-like tree representation.

There is a particular notation for multiway trees in Lisp. Lisp is a prominent functional programming language, which is used primarily for artificial intelligence problems. As such it is one of the main competitors of Prolog. In Lisp almost everything is a list, just as in Prolog everything is a term.

The following pictures show how multiway tree structures are represented in Lisp.



Note that in the "lispy" notation a node with successors (children) in the tree is always the first element in a list, followed by its children. The "lispy" representation of a multiway tree is a sequence of atoms and parentheses '(' and ')', which we shall collectively call "tokens". We can represent this sequence of tokens as a Prolog list; e.g. the lispy expression (a (b c)) could be represented as the Prolog list ['(', a, '(', b, c, ')', ')']. Write a predicate tree_ltl(T,LTL) which constructs the "lispy token list" LTL if the tree is given as term T in the usual Prolog notation.

(The Prolog example given is incorrect.)

Example in Haskell:

```
Tree> display lisp tree1
"a"
Tree> display lisp tree2
"(a b)"
Tree> display lisp tree3
"(a (b c))"
Tree> display lisp tree4
"(b d e)"
Tree> display lisp tree5
"(a (f g) c (b d e))"
```

As a second, even more interesting exercise try to rewrite tree_ltl/2 in a way that the inverse conversion is also possible.

Solutions

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