FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE - CS161

Fall 2014

Programming Assignment 1 - Due 11:55pm October 16, 2014

Homework Guidelines:

* Submit your commented LISP program in a file named hw1.lsp via CCLE.
* In a separate file named test.txt, submit via CCLE a sample execution showing the values your programs return for the test cases indicated below.
* Your programs should be written in good style. In LISP, a comment is any characters following a semicolon (;) on a line. Provide an overall comment explaining your solutions. Furthermore, every function should have a header comment explaining precisely what its arguments are, and what value it returns in terms of its arguments. In addition, you should use meaningful variable names.
* The physical layout of the code on the page is very important for making LISP programs readable. Make sure that you use blank lines between functions and indent properly. Programming style will be a major consideration in grading the assignment.
* You are restricted to using the following functions, predicates, and operators introduced in class: quote ['], car, cdr [cadadr, etc.], first, second [third, etc.], rest, cons, list, append, length, numberp, stringp, listp, atom, symbolp, oddp, evenp, null, not, and, or, cond, if, equal, defun, let, let\*, =, <, >, +, -, \*, /. Note: you are not permitted to use setq.
* You may assume that all input to your functions are legal; i.e. you do not need to validate inputs.
* Do not write any additional helper functions for your code unless this is explicitly allowed. Test functions are OK.
* Your function declarations should look exactly as specified in this assignment. Make sure the functions are spelled correctly, take the correct number of arguments, and those arguments are in the correct order.
* Even if you are not able to implement working versions of these functions, please include a correct skeleton of each. Some of these assignments are auto graded and having missing functions is problematic.

An ordered tree is either a number n or a list (L m R), where

* L and R are ordered trees
* m is a number
* all numbers appearing in L are smaller than m
* all numbers appearing in R are larger than m

Some examples of ordered trees: 3, (1 2 3), ((1 2 3) 7 8), ((1 2 3) 5 (6 8 (9 10 (11 12 13)))).

1. Write a single Boolean LISP function, called TREE-CONTAINS, which takes two arguments N and TREE, and checks whether number N appears in the ordered tree TREE.

For example,

(TREE-CONTAINS 3 '((1 2 3) 7 8)) returns T

(TREE-CONTAINS 4 '((1 2 3) 7 8)) returns NIL

2. Write a single LISP function, called TREE-MAX, which takes one argument TREE, and returns the maximum number appearing in the ordered tree TREE.

For example,

(TREE-MAX '((1 2 3) 7 8)) returns 8

3. Write a single LISP function, called TREE-ORDER, which takes one argument TREE, and returns

an in-ordered list of the numbers appearing in ordered tree TREE.

For example,

(TREE-ORDER 3) returns (3)

(TREE-ORDER '((1 2 3) 7 8)) returns (1 2 3 7 8)

4. Write a single LISP function, called SUB-LIST, that takes a list L and two non-negative integers START and LEN, and returns the sub-list of L starting at position START and having length LEN. Assume that the first element of L has position 0.

For example,

(SUB-LIST ‘(a b c d) 0 3) returns (a b c)  
(SUB-LIST ‘(a b c d) 3 1) returns (d)

(SUB-LIST ‘(a b c d) 2 0) returns NIL

5. Write a single LISP function, called SPLIT-LIST, that takes a list L, and returns a list of two lists L1 and L2, in that order, such that

* L is the result of appending L1 and L2
* Length of L2 minus length of L1 is 0 or 1.

For example,

(SPLIT-LIST ‘(a b c d)) returns ((a b) (c d))  
(SPLIT-LIST ‘(a b c d e)) returns ((a b) (c d e)) NOTE: ((a b c) (d e)) is incorrect;  
(SPLIT-LIST ‘(a b c d e f)) returns ((a b c) (d e f))

You can call the function SUB-LIST from SPLIT-LIST.

A binary tree is one in which each node has 0 or 2 children. A node that has 0 children is called a leaf node. A node that has 2 children is called an internal node. A binary tree can be represented as follows:

* + A leaf node N is represented by atom N.
  + An internal node N is represented by a list (L R), where L represents the left child of N and R represents the right child of N.

6. Write a single LISP function, called LIST2BTREE, that takes a non-empty list of atoms LEAVES, and returns a binary tree such that

- The tree leaves are the elements of LEAVES

- For any internal (non-leaf) node in the tree, the number of leaves in its right branch minus the number of leaves in its left branch is 0 or 1.

For example,

(LIST2BTREE '(1)) returns 1  
 (LIST2BTREE '(1 2)) returns (1 2)

(LIST2BTREE '(1 2 3)) returns (1 (2 3))

(LIST2BTREE '(1 2 3 4)) returns ((1 2) (3 4))

(LIST2BTREE '(1 2 3 4 5 6 7)) returns ((1 (2 3)) ((4 5) (6 7)))  
 (LIST2BTREE '(1 2 3 4 5 6 7 8)) returns (((1 2) (3 4)) ((5 6) (7 8)))

You can call the function SPLIT-LIST from LIST2BTREE.

7. Write a single LISP function, called BTREE2LIST, that takes a binary tree TREE, and returns a list of atoms (assume TREE follows the constraints we defined earlier).

* As the input is a binary tree, each node has at most 2 children.
* This function is the inverse of LIST2BTREE. That is, (BTREE2LIST (LIST2BTREE X)) = X for all lists of atoms X.

For example,

(BTREE2LIST 1) returns (1)  
 (BTREE2LIST '(1 2)) returns (1 2)

(BTREE2LIST '(1 (2 3))) returns (1 2 3)

(BTREE2LIST '((1 2) (3 4))) returns (1 2 3 4)

(BTREE2LIST '((1 (2 3)) ((4 5) (6 7)))) returns (1 2 3 4 5 6 7)  
 (BTREE2LIST '(((1 2) (3 4)) ((5 6) (7 8)))) returns (1 2 3 4 5 6 7 8)