

Functional and logic programming

- written exam -

Important:

1. Subjects are graded as follows: of - 1p; A – 1.5p; B - 2.5p; C - 2.5p; D - 2.5p.
2. Prolog problems will be resolved using SWI Prolog. The following are required: (1) explanation of the code and of the reasoning behind it; (2) recursive model that solves the problem, for all the predicates used; (3) specification of every predicate (parameters and their meaning, flow model, type of the predicate - deterministic/non-deterministic).
3. Lisp problems will be resolved using Common Lisp. The following are required: (1) explanation of the code and of the reasoning behind it; (2) recursive model that solves the problem, for each function used; (3) specification of every function (parameters and their meaning).

A. Let L be a list of numbers and given the following PROLOG predicate definition **f(list, integer)**, with the flow model (i, o):

f([], -1).

f([H|T],S):-H>0, **f(T,S1)**,S1<H,!,S is H.

f([_|T],S):-**f(T,S1)**, S is S1.

Rewrite the definition in order to avoid the recursive call **f(T,S)** in both clauses. Do NOT redefine the predicate. Justify your answer.

B. Given a nonlinear list containing numerical and non-numerical atoms, write a LISP program that replaces non-numerical atoms with the number of occurrences of that atom at the level of the list on which it is located. For example, for the list (F A 12 13 (B 11 (A D 15) C C (F)) 18 11 D (A F) F), the result will be (2 1 12 13 (1 11 (1 1 15) 2 2 (1)) 18 11 1 (1 1) 2).

C. Write a PROLOG program that generates the list of all combinations of k elements with numbers from 1 to N , with the property that difference between two consecutive numbers from a combination has an even value. Write the mathematical models and flow models for the predicates used. For example, for the $\mathbf{N}=4$, $\mathbf{k}=2 \Rightarrow [[1,3],[2,4]]$ (not necessarily in this order).

D. An n-ary tree is represented in Lisp as (node subtree1 subtree2 ...). Write a function to replace all nodes on odd levels with a given value **e**. The root level is assumed zero. **A MAP function shall be used.**

Example for the tree (a (b (g)) (c (d (e)) (f))) and **e=h** => (a (h (g)) (h (d (h)) (h)))