

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 both numerical and non-numerical atoms, write a LISP program that builds a list that contains on even levels the greatest numerical atom, and for odd levels the lowest numerical atom (we assume that each level of the list contains at least a numerical atom), but in reverse order (so the minimum on level 1 is the last element, the maximum on level 2 is the penultimate element, etc.). For example, for the list (A B 12 (5 D (A F (10 B) D (5 F) 1)) C 9 (F 4 (D) 9 (F (H 7) K) (P 4)) X) the result will be (10 1 9 9). You are not allowed to use function *reverse* from Lisp.

C. Write a PROLOG program that generates the list of all arrangements of k elements with the value of sum of all elements from each arrangement equal with a given S , from a list of integers. Write the mathematical models and flow models for the predicates used. For example, for the list $[6, 5, 3, 4]$, $k=2$ and $S=9 \Rightarrow [[6,3],[3,6],[5,4],[4,5]]$ (not necessarily in this order).

D. An n-ary tree is represented in Lisp as (node subtree1 subtree2 ...). Write a Lisp function to determine the path from the root to a given node. **A MAP function shall be used.**

Example for the tree (a (b (g)) (c (d (e)) (f)))

(a) nod=e => (a c d e) **(b)** nod=v => ()