

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 with flow model (i, o):

$f([], -1).$

$f([H|T], S) :- \underline{f(T, S1)}, S1 < 1, S \text{ is } S1 - H, !.$

$f([_|T], S) :- \underline{f(T, S)}.$

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

B. Given a nonlinear list that contains numerical and non-numerical atoms, write a LISP program that builds a list that has the same structure as the initial list, but each (sub)list contains a single element on the superficial level, and that element is computed as the difference between the maximum and the minimum values on the superficial level of the corresponding (sub)list in the initial list. It is guaranteed that each (sub)list contains at least a numerical atom. For example, for the list (F A 12 13 (B 11 (A D 15) C 3 C (1 F 6) 1) 18 11 D (A 7 F 9) F)) the result will be (7 (10 (0) (5)) (2)) (7 is the difference between 18 and 11, 10 is the difference between 11 and 1, 0 is the difference between 15 and 15, etc.).

C. Write a PROLOG program that generates the list of all subsets with values between $[a, b]$ interval with an even numbers of even values and an odd number of odd values from each subset. Write the mathematical models and flow models for the predicates used. For example, for $\mathbf{a}=2$ and $\mathbf{b}=4 \Rightarrow [[2,3,4]]$.

D. Given a nonlinear list, write a Lisp function to return the list with all occurrences of the element **e** replaced by the value **e1**. **A MAP function shall be used.**

Example **a)** if the list is (1 (2 A (3 A)) (A)), **e** is A and **e1** is B => (1 (2 B (3 B)) (B))

b) if the list is (1 (2 (3))) and **e** is A => (1 (2 (3)))