Third Exam
Logic Programming, LVA 703113

October 2, 2015

Name: **Studentnumber**:

The exam consists of 6 exercises with a total of 100 points. Please fill out your name and credentials *before* you start the exam.

1	2	3	4	5	6	Sum

0–49:	**5**	50–59:	**4**	60–74:	**3**	75–89:	**2**	90–100:	**1**

1. Consider the directed graph $G = (\{a, b, c, d, e, f, g\}, E)$ with the following set of edges:

$$E = \{(a, b), (a, c), (b, d), (c, d), (d, e), (f, g)\} \ .$$

   – Represent G in Prolog and implement a relation *connected*/2 that expresses that two nodes are connected in G. (4 pts)

   – Show that for any graph G the *size* of the search tree for a ground query is bounded quadratic in the number of vertices of G. (6 pts)

   – Is the above estimate on the size of the search tree also true for non-ground queries? (4 pts)

2. Implement a predicate *duplicate*/3 that duplicates the elements of a list a given number of times. For example the query duplicate([a,b,c],2, Xs) should deliver the answer Xs = [a, a, b, b, c, c]. Use difference-lists in your implementation, where you can assume that \ seperates difference lists. (15 pts)

3. Implement a predicate *isotree*($Tree_1$,$Tree_2$) which holds if $Tree_1$, $Tree_2$ are isomorphic binary trees. (6 pts)

   Hint: You can use any suitable representation of binary trees.

4. Consider the following grammar for propositional formulas over the atoms p, q, and r:

$$P \to \mathsf{true} \mid \mathsf{false} \qquad P \to \neg P$$
$$P \to (P \land P) \qquad P \to (P \lor P)$$

   – Write a DCG that generates the languages by *directly* encoding the grammar and builds an expression tree for the formula parsed. (10 pts)

   – Improve your implementation by taking into account the following precedence of connectives $\neg > \land > \lor$, so that brackets can be dropped. Furthermore prevent the left-recursion in the grammar. (15 pts)

5. Implement (part of) the *Knight's tour problem*: how can a knight jump on an $N \times N$ chessboard in such a way that it visits every square exactly once?

   Hint: Represent the squares by pairs of their coordinates of the form X/Y, where X and Y are integers between 1 and N. It suffices to implement the relation jump(N,X/Y,U/V) to express the fact that a knight can jump from X/Y to U/V on a $N \times N$ chessboard. (20 pts)

6. Determine whether the following statements are true or false. Every correct answer is worth 2 points, every wrong answer -1 points. (The worst that can happen is that you get zero points for this exercise.) (20 pts)

statement	**yes**	**no**
A rule is a universally quantified logical formula of the form $A \leftarrow B_1, B_2, \ldots, B_n$, where A is a goal and for all $i = 1, \ldots, n$: B_i is a goal.	☐	☐
An SLD-refutation is a finite SLD-derivation ending in the goal to be proven.	☐	☐
Logic programming is a declarative programming paradigm, that is, the computation of a function is made a first-class citizen.	☐	☐
The declarative semantics of a program P is the minimal model of P.	☐	☐
The order of goals is irrelevant in the computation model of logic programming, but not the order of rules.	☐	☐
A search tree is the same as an SLD tree.	☐	☐
Prolog is a language without types and the main technique to manipulate data is unification.	☐	☐
Difference lists are ineffective if the generation of different sections of a list depend on each other.	☐	☐
A meta-interpreter in Prolog interprets Prolog terms on the Warren abstract machine.	☐	☐
The predicate *bagof*(*Template*,*Goal*,*Bag*) unifies *Bag* with the alternatives of *Goal* that meet *Template*.	☐	☐