Försättsblad till skriftlig tentamen vid Linköpings Universitet

Datum för tentamen	2011-04-27
Sal (1) Om tentan går i flera salar ska du bifoga ett försättsblad till varje sal och <u>ringa in</u> vilken sal som avses	TER4
Tid	8-12
Kurskod	TDDD08
Provkod	TEN1
Kursnamn/benämning **Provnamn/benämning**	Logikprogrammering Skriftlig tentamen
Institution	IDA
Antal uppgifter som ingår i tentamen	9
Jour/Kursansvarig Ange vem som besöker salen	Ulf Nilsson
Telefon under skrivtiden	076 8601935
Besöker salen ca kl.	10
Kursadministratör/kontaktperson (namn + tfnr + mailaddress)	Gunilla Mellheden, 22 97, gunilla.mellheden@liu.se
Tillåtna hjälpmedel	Inga
Övrigt	
Vilken typ av papper ska användas, rutigt eller linjerat	Valfritt
Antal exemplar i påsen	

Exam in TDDD08 LOGIC PROGRAMMING

Wednesday 27 April, 2011, 8:00–12:00, Room TER4

No means of assistance (inga hjälpmedel)!
Grading will rely on the following limits (out of max 36):

Grade	3	4	5
Points	≥ 18	≥ 24	≥ 30

Ulf Nilsson can be reached on phone 076–8601935 during the exam.
You may answer in English or in Swedish as you prefer.
REMEMBER TO GIVE MOTIVATIONS TO ALL ANSWERS!!!

---

1. Determine which of the following pairs of formulas that are unifiable, and give the mgu in case there is one:

   ```
   | ?- p(f(X0,X1),f(X1,X2)) = p(X2, X0).
   | ?- p(f(X1, X0), f(X0, a)) = p(Y, Y).
   | ?- p(f(X0,X1), f(X1, X2)) = p(X2, f(X0, a)).
   | ?- [X1,X2|X1] = [X, X].
   ```

   (4 points)

2. Write a Prolog program for reversing lists in linear time. That is, the number of calls (or unifications if you like) is proportional to the length of the list.

   (4 points for a reasonable program)

3. Consider the following definite program P:

   ```
   p(a,X,X).
   p(f(X),Y,f(Z)) :- p(X,Y,Z).
   ```

   What is the Herbrand universe and Herbrand base of the program assuming that there are no non-logical symbols but those used in P? Then sketch the construction of the least Herbrand model M_P of P using the immediate consequence operator T_P (Hint: M_P is infinite).

   (4 points)

4. Given a fixed computation rule $\Re$, a definite program P and an initial goal G_0, describe (1) how the order among clauses, and (2) how the order among subgoals in the body of each clause affect (a) the structure of the SLD-tree, and (b) the number of refutations for G_0. Illustrate your answers by means of (small) examples.

5. Compile the following DCG into a Prolog program (using the idea emplyed by most Prolog systems):

```
p(0)      --> [].
p(s(X,Y)) --> q(X), p(Y).
q(X)      --> [X].
```

Use the resulting program to show that the "string" [a,a,b] belongs to the language of p(s(a,s(a,s(b,0)))). That is, sketch the corresponding refutation.

(4 points)

6. Consider the following Prolog program.

```
p(X) :- q(X), r(X).    % (*)
p(X) :- q(X).
q(X) :- s(X).
q(X) :- t(X).
r(X) :- t(X).
r(X) :- u(X).
s(a).
t(b).
u(c).
```

In what places in the clause marked (*) can you place a cut, so that Prolog finds exactly one answer to the goal :- p(X). (Draw the SLD-tree.)

(4 points)

7. Consider the following general program:

```
p(X) :- \+ s(X).
q(a,b).
q(b,a).
r(X) :- q(X,X).
r(X) :- q(X,Y).
s(X) :- q(X,X).
s(X) :- \+ r(X).
```

Draw the SLDNF-forest of the goal :- p(a) given that Prolog's computation rule is used.

(4 points)

8. Write a Prolog program that takes a binary tree of integers with the representation

```
btree([]).
btree(node(N,Left,Right)) :-
     integer(N),
     btree(Left),
     btree(Right).
```

och replaces the value in each node by the largest value in the tree.

(4 points for a solution that solves the problem in a single traversal)

9. Every definite program P has a least Herbrand model M_P. Let $\mathfrak{S}$ be a Herbrand interpretation of P such that $M_P \subseteq \mathfrak{S}$. Is it true that $\mathfrak{S}$ must be a Herbrand model of P? Provide a proof or a counter-example.

(4 points)