Försättsblad till skriftlig tentamen vid Linköpings Universitet

Datum för tentamen	2014-01-07
Sal (1)	G37
Tid	14-18
Kurskod	TDDD08
Provkod	TEN1
Kursnamn/benämning **Provnamn/benämning**	Logikprogrammering Skriftlig tentamen
Institution	IDA
Antal uppgifter som ingår i tentamen	10
Jour/Kursansvarig Ange vem som besöker salen	Victor Lagerkvist
Telefon under skrivtiden	0730817584
Besöker salen ca kl.	15:00
Kursadministratör/kontaktperson (namn + tfnr + mailaddress)	Liselotte Lundberg, tel 281278, liselotte.lundberg@liu.se
Tillåtna hjälpmedel	Ett papper med valfria anteckningar – 1 sida A4 eller 2 sidor A5. Anteckningarna ska signeras och bifogas tentamen vid inlämnandet.
Övrigt	
Vilken typ av papper ska användas, rutigt eller linjerat	rutigt
Antal exemplar i påsen	7

Exam, TDDD08 Logic Programming

Tuesday 2014-01-07, 14:00 – 18:00, G37.

Means of assistance (hjälpmedel): A sheet of notes – 2 sided A5 or 1 sided A4. The notes should be signed in the same way as the exam sheets and returned together with the exam.

You may answer in English or Swedish.

Grade limits: 3: 17 p, 4: 23 p, 5: 29 p (for total 35 p).

Remember to give motivations to all answers!
For instance, when you write a program you should explain the relations defined by the predicates of the program.

GOOD LUCK!

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1. Determine which of the following pairs of terms that are unifiable, and provide a most general unifier (mgu) in case there is one.

   a) $p(f(X), f(Y), X)$ and $p(Z, Z, W)$

   b) $p(f(X), X, f(Y))$ and $p(Y, f(Z), Z)$

   c) $[X, Y|X]$ and $[f(Z), X, X]$

   b) $p(X1, X2, X3)$ and $p(f(X2, X3), f(X3, X3), a)$.

   (4 points)

2. Explain the difference between the theoretical notion of unification and its implementation in Prolog. (2 points)

3. Write a logic program defining a predicate `thi/2` which is true when its arguments are lists, and the second list contains every third element of the first one, starting from the second element. For instance, `thi`$([a, b, c, d, e], [b, e])$.

   (3 points)

4. Consider binary ordered trees, in which each leaf contains a value, which may be an arbitrary term (and non-leaf nodes do not contain values). Design a representation of such trees as terms.

   Write a program checking that a tree is the symmetric image of another one.

   (A tree t is the symmetric image of a tree s iff 1. both consist of the same single leaf, or 2a. the left subtree of the root of t is the symmetric image of the right subtree of the root of s, and 2b. the right subtree of the root of t is the symmetric image of the left subtree of the root of s.)

   (4 points)

5. Consider the following definite program P:

$$p(g(X)).$$
$$p(f(X)) \leftarrow p(Y), q(Y, X).$$
$$q(g(f(Z)), f(Z)).$$
$$r(f(a)).$$
$$r(f(X)) \leftarrow q(X, Y), r(Y),$$

Assume that the vocabulary $\mathcal{A}$ contains one constant a and two one-argument function symbols f, g. What is the Herbrand universe $\mathbf{U}_\mathcal{A}$ corresponding to $\mathcal{A}$?

Is

$$I = \{\, p(t) \mid t \in \mathbf{U}_\mathcal{A} \,\} \cup \{\, q(t, s) \mid t, s \in \mathbf{U}_\mathcal{A} \,\}$$
$$\cup \{\, r(\underbrace{f(g(\cdots(f(g}_{n \text{ times}}(f(a)))\cdots))) \mid n \geq 0 \,\}$$

a Herbrand model of P?

Which of the following atoms are logical consequences of P?

1. $p(g(Y))$, 2. $p(f(Y))$, 3. $p(f(f(a)))$, 4. $r(f(g(f(g(f(a))))))$, 5. $r(f(g(f(Z))))$.

(5 points)

6. For the previous program and a chosen query build two SLD-trees (using different selection rules) – one finite and one infinite. (2 points)

7. The program SPLIT

$$split([\,], [\,], [\,]).$$
$$split([X|Xs], [X|Ys], Zs) \leftarrow split(Xs, Zs, Ys).$$

is intended to split a list into two lists of similar lengths. Prove that (in any answer of the program) the arguments of *split* are lists, and each element of the second and of the third argument is an element of the first one. To do this, express the required property as a formal specification S, and prove that the program is correct w.r.t. S. (4 points)

8. Translate the following DCG into a Prolog program (using a standard approach)

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

Show that $[a, b, a]$ is a member of the language of $p(s^3(0))$, by presenting a successful SLD-derivation.

Explain what is the language of $p(s^i(0))$. (4 points)

9. Consider the following general program:

$$e(0).$$
$$e(s(X)) \leftarrow \neg\, e(X).$$

(You may view the predicate name as an abbreviation for *even*.) Draw SLDNF-forests for queries $Q_1 = e(X)$ and $Q_2 = e(s^3(0))$. Mark which trees are finitely failed, which leaves are floundered, which branches are successful derivations, and what are their answers (or answer substitutions).

(4 points)

10. Choose three from the notions below and explain them.

Your explanation should be short but precise, and should show that you understand the notions. The chosen notions should not be explained in your sheet of notes.

(a) Model (of a formula). Here you are required to also explain the notion of interpretation.

(b) Logical consequence (of a set of formulae).

(c) Computed answer of a definite clause program.

(d) Proof tree.

(e) Least Herbrand model.

(f) Specification.

(g) Completeness (of a program).

(h) Incorrectness diagnosis, reason of incorrectness (or incorrectness error).

(i) Solution of a constraint.

(j) Negation as finite failure (NAF).

(3 points)