Information page for written examinations at Linköping University

Examination date	2011-12-12
Room (2) If the exam is given in different rooms you have to attach an information paper for each room and mark intended place	T1 T2
Time	14-18
Course code	TDDD08
Exam code	TEN1
Course name **Exam name**	Logikprogrammering Skriftlig tentamen
Department	IDA
Number of questions in the examination	9
Teacher responsible/contact person during the exam time	Ulf nilsson
Contact number during the exam time	0768601935
Visit to the examination room approx.	15
Name and contact details to the course administrator (name + phone nr + mail)	Gunilla Mellheden, 2297
Equipment permitted	Inga
Other important information	
Which type of paper should be used, cross-ruled or lined	
Number of exams in the bag	

Exam in TDDD08 LOGIC PROGRAMMING

Monday 12 December, 2011, 14:00–18:00, Room T1/T2

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!!!

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

```
| ?- p(f(X),X,f(Y)) = p(Y,f(Z),Z).
| ?- p(f(X),f(Y),X) = p(Z,Z,W).
| ?- p(X1,X2,X3) = p(f(X2,X2),f(X3,X3),a).
| ?- [X,Y|X] = [f(Z),X,X].
```

(4 points)

2. Write a Prolog program that defines a predicate `between(X,Y,Z)` which holds if the arguments are integers and $\mathtt{X} \leq \mathtt{Y} \leq \mathtt{Z}$. Given the goal `:- between(1,N,5)` the program should generate (one-by-one) all integers in the closed interval $1-5$.

(4 points for a reasonable program)

3. Consider the following definite program P:

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

Which of the following Herbrand interpretations are models of P?

$$
\begin{aligned}
I_1 &= \{\mathtt{q}(\mathtt{f}(t), t) \mid t \in U_P\} \\
I_2 &= I_1 \cup \{\mathtt{r}(\mathtt{f}^{2n}(\mathtt{a})) \mid n \geq 0\} \\
I_3 &= I_1 \cup \{\mathtt{r}(\mathtt{f}^{n}(\mathtt{a})) \mid n \geq 0\} \\
I_4 &= I_1 \cup \{\mathtt{p}(\mathtt{a})\} \cup \{\mathtt{r}(\mathtt{f}^{n}(\mathtt{a})) \mid n \geq 0\}
\end{aligned}
$$

Hint: The notation $\mathtt{f}^2(\mathtt{a})$ is a shorthand for $\mathtt{f}(\mathtt{f}(\mathtt{a}))$, and $\mathtt{f}^0(\mathtt{a})$ denotes $\mathtt{a}$.

(4 points)

4. Give short but precise descriptions of the following notions to demonstrate that you understand them:

   - Stratified logic program,
   - Closed world assumption,
   - Least Herbrand model,
   - Occur check.

(4 points)

5. Write a DCG that recognizes the following language:

$$L = \{a^i b^j c^k \mid 0 \leq i < j < k\}$$

   Compile the DCG into a Prolog program and show—by means of an SLD-refutation— that the string "bcc" belongs to L.

(4 points)

6. Let P be the following general program:

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

   Construct $comp(P)$ (except for the equality axioms) and show that $comp(P) \models s(a)$.

(4 points)

7. To place a cut in a (correct) definite program may affect the completeness but it never affects the soundness. However, the latter is not true for general logic programs. Give an example of a general logic program containing a cut, such that $\leftarrow A$ has a refutation (using SLDNF-resolution extended with the cut rule) but A is not a logical consequence of the completion of the program.

(4 points)

8. Assume that the standard definition of append/3 is given:

```
append([], Xs, Xs).
append([X|Xs], Ys, [X|Zs]) :- append(Xs, Ys, Zs).
```

   Define each of the following relations using exactly one definite clause (i.e. you are not allowed to use disjunction or negation):

`last(X, List)`	`X` is the last element in `List`.
`member(X, List)`	`X` is a member in `List`.
`copies(List)`	`List` contains several occurrences of some element.
`prefix(L, List)`	`L` is a prefix of `List`.

(4 points for reasonable solutions)

9. Let P be a definite program and $\Im_1, \Im_2$ Herbrand models of P. Prove that also $\Im_1 \bigcap \Im_2$ must be a Herbrand model of P.

(4 points)