Information page for written examinations at Linköping University

Examination date	2012-08-17
Room (1) If the exam is given in different rooms you have to attach an information paper for each room and mark intended place	TER4
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	076 8601935
Visit to the examination room approx.	15
Name and contact details to the course administrator (name + phone nr + mail)	Gunilla Mellheden
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

Friday 17 August, 2012, 14:00–18:00, 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(X,g(Y)),Z) = p(f(Z,Z),g(a)).
| ?- p(f(g(X,Y),Z),X) = p(f(Z,X),Y).
| ?- p([],[X|Y],Y) = p(Z,[Y],W).
| ?- p(a,f(X,Y),b) = p(Y,f(Z,Z),Y).
```

(4 points)

2. Consider the following definite program P:

$$p(X) \leftarrow q(X).$$
$$p(f(X)) \leftarrow p(X).$$
$$q(a).$$
$$q(g(a)).$$

Which of the following Herbrand interpretations are models of P?

$$\Im_1 = \{q(t) \mid t \in U_P\}$$
$$\Im_2 = \{q(t) \mid t \in U_P\} \cup \{p(f^n(a) \mid n \geq 0\}$$
$$\Im_3 = \{q(t) \mid t \in U_P\} \cup \{p(f^n(t)) \mid t \in \{a, g(a)\}, n \geq 0\}$$
$$\Im_4 = \{q(t) \mid t \in U_P\} \cup \{p(t) \mid t \in U_P\}$$

Hint: The notation $f^3(a)$ is a shorthand for $f(f(f(a)))$ and $f^0(a)$ is a shorthand for a.

(4 points)

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

(Note: the prefixes of `[a,b,c]` are `[]`, `[a]`, `[a,b]`, and `[a,b,c]`.)

(4 points for reasonable solutions)

4. Translate the following DCG into a Prolog program (using the translation used in most Prolog systems):

```
fib(0) --> [1].
fib(s(0)) --> [1].
fib(s(s(X))) --> fib(s(X)),fib(X).
```

Use the resulting Prolog program to prove that the string `[1,1,1,1,1]` belongs to the language of `fib(s(s(s(s(0)))))`. That is, draw the refutation.

(4 points)

5. Consider the following Prolog program:

```
p(X,Z) :- q(X,Y), !, r(Y,Z).
p(a,c).
q(a,b).
q(c,b).
r(X,Y) :- s(X,Y).
s(b,a).
s(b,b).
```

Draw the SLD-tree of the goal `:- p(X,Y)`. What answers are computed? What answers would be obtained if cut (i.e. `!`) is removed from the first clause?

(4 points)

6. Consider the following general program:

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

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

(4 points)

7. Consider the following general logic program:

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

Prove that the program does not have a least Herbrand model.

(4 points)

8. Write a Prolog program that defines a predicate `between(X,Y,Z)` which holds if the arguments are integers and $X \leq Y \leq Z$. 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)

9. Let P be a definite program, I a Herbrand interpretation of P and M the least Herbrand model of P. Decide if the following is valid

$$M \subseteq I \text{ iff } I \text{ is a Herbrand model of } P.$$

Prove the statement or give a counter example.

(4 points)