Rheinische Friedrich-Wilhelms-Universität Bonn
Institut für Informatik III
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Advanced Logic Programming
Summer Semester 2011
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Assignment 2

Due: Monday, 25.04.2011, 23:59:59 via SVN

For help, contact alp-staff@lists.iai.uni-bonn.de (staff only) or alp-course@lists.iai.uni-bonn.de (staff and participants).

Start working on the exercises early enough so that you can contact the staff in time in case of problems. Don't expect them to be available during weekends!

Task 1. *Declarative semantics* (6 Points)

```
connected(a, b).
connected(c, d).
connected(d, e).
reachable(X,Y) :- connected(X,Y).
reachable(X,Y) :- connected(X,Z), reachable(Z,Y).
```

For the above program write down

a) (2 Points) its translation to first order logic (quantified implications, not normalized form).
b) (1 Points) its Herbrand universe.
c) (2 Points) its Herbrand base.
d) (2 Points) its Herbrand model (its logical consequences).

Tip: See lecture slides 2-36 to 2-44 (numbers refer to restructured slides of April 15, 2011).

Task 2. *Declarative semantics* (4 Points)

```
connected(point(a), point(b)).
connected(point(c), point(d)).
connected(point(d), point(e)).
reachable(X,Y) :- connected(X,Y).
reachable(X,Y) :- connected(X,Z), reachable(Z,Y).
```

For the above, slightly modified, program write down

a) (1 Points) its Herbrand universe.
b) (2 Points) its Herbrand model .
c) What difficulty did you encounter in point a)? Make a general statement about the effect of function symbols on the Herbrand universe.
d) How does the effect described in c) affect the Herbrand model?

Task 3. *Declarative semantics* (2 Points)

Consider the Herbrand universe and Herbrand model of the following program and compare them to your findings in Task 2, point c) and d).

```
natural(0).
natural( s(X) ) :- natural(X).
```

Task 4. *Normalization: Elementary Junctor Form* (2 Points)

Complete the following truth table. The greek symbols Φ (read as "Phi") and Ψ (read as "Psi") represent arbitrary formulas.

Φ	Ψ	$\neg\Phi$	$\neg\Phi \vee \Psi$	$\Phi \Longrightarrow \Psi$
false	false			
false	true			
true	false			
true	true			

Task 5. *Normalization: Negation Form* (4 Points)

For each of the normalization rules for the "Negation Form", give an informal example that illustrates the respective rule.

As an example, consider the first rule, "$\neg\neg\Phi \rightleftharpoons \Phi$". If we assume the formula Φ means 'Dogs bite' then the rule says: " 'It is <u>not</u> true that dogs do <u>not</u> bite.' means the same as 'Dogs bite.' ".

Task 6. *Normalization* (4 Points)

$$\exists\, Z\colon [\, \neg \exists\, X\colon \Big(\, p(X,Z) \vee\ \forall\, Y\colon q\big(X, f(Y)\big)\Big) \vee\ \forall\, Y\colon p(g(Z,Y),Z)]$$

Transform the above formula into:

1. Disjunct Variable Form.
2. Prenex Normal Form.
3. Skolem Normal Form .
4. Conjunctive Normal Form.

Task 7. *Horn clauses and Prolog Clauses* (2 Points)

After the translation to CNF the formula from Task 6 should be a conjunction of Horn clauses. Write down the Prolog program that corresponds to the formula.