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Försättsblad till skriftlig tentamen vid Linköpings Universitet

Datum för tentamen	2015-01-09
Sal (1)	TER3
Tid	8-13
Kurskod	TDDD72
Provkod	TEN1
Kursnamn/benämning **Provnamn/benämning**	Logik En skriftlig tentamen
Institution	IDA
Antal uppgifter som ingår i tentamen	4
Jour/Kursansvarig Ange vem som besöker salen	Tommy Persson
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Tillåtna hjälpmedel	1.You can use your own copies of slides as well as an English-Swedish dictionary. 2. Exercises are formulated in English, but answers can be given in English or Swedish.
Övrigt	
Antal exemplar i påsen	

EXAM: TDDD72 (LOGIC)

9 JANUARY 2015

RULES

1. You can use your own copies of slides as well as an English-Swedish dictionary.
2. Exercises are formulated in English, but answers can be given in English or Swedish.
3. You are not allowed to:
   - use any writing material other than indicated in point 1;
   - use calculators, mobile phones or any other electronic devices;
   - lend/borrow/exchange anything during the exam.
4. If an exercise has not been specified completely as you see it, state which (reasonable) assumptions you have made.
5. Begin each exercise on a new sheet of paper. Write only on one side of the paper. Write clearly and make sure to give adequate explanations for all your answers.
6. There are 4 exercises, each exercise gives maximum 10 points (40 points together). Grading is provided in the following table.

number of points (n)	Swedish grade	ETCS grade
$34 \leq n \leq 40$	5	A
$27 \leq n < 34$	4	B
$20 \leq n < 27$	3	C
$n < 20$	not passed	F (not passed)

EXERCISES

EXERCISE 1

1. Prove the following propositional formula

$$\big[(\neg R \vee P) \wedge (\neg(P \vee Q) \vee R) \to (\neg Q \vee P)\big]$$

   (a) (*2 points*) using tableaux;

   (b) (*2 points*) using Gentzen system (as provided in the book or during lectures – up to your choice).

2. Prove the following formula of predicate logic, where a, b are constants:

$$\Big[\forall y Q(b,y) \wedge \forall x \forall y [Q(x,y) \to Q(s(x), s(y))]\Big] \to \exists z[Q(b,z) \wedge Q(z, s(s(b)))].$$

   (a) (*3 points*) using tableaux;

   (b) (*3 points*) using resolution.

EXERCISE 2

1. (*4 points*) Translate the following claims of L, T into a set of propositional formulas, where L, T and John are persons:

   - claims of L:

     "John rests on Saturdays."
     "John reads books and does not watch TV on Saturdays."

   - claims of T:

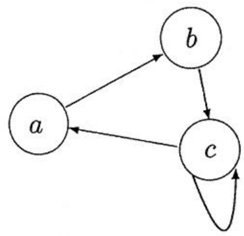
     "when John does not rest, he does not watch TV either."
     "on Saturdays John reads books or watches TV or cooks."

2. (*2 points*) Assuming that L always lies and T always tells the truth, hypothesize what is John's activity.

3. (*4 points*) Prove your claim formally using a proof system of your choice (tableaux, Gentzen system or resolution).

EXERCISE 3

Consider games, in which players move stones between places. A move from place p to place q is possible if there is an arrow between p and q. For example, in the game represented in the following figure,



there are moves from a to b, from b to c, from c to a and from c to c and there are no moves from b to a, from c to b, from a to a and from b to b.

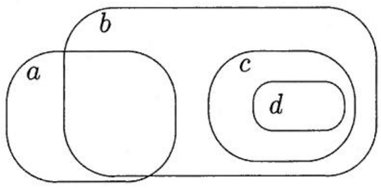
Different games are obtained by drawing different connections between places. A particular game can, for example, satisfy the following conditions:

(a) "From every place there is a move."
(b) "Every two places p, q have the property that whenever there is a move from p to q then there is also a move from q to p."
(c) "For every places p, q, r, if there are moves from p to q and from p to r then there is also a move from q to r."

1. (*3 points*) Express in predicate logic properties (a), (b) and (c).
2. (*2 points*) Check informally whether the conjunction of (a), (b) and (c) implies that "From every place there is a move to itself.".
3. (*5 points*) Verify your informal reasoning using resolution.

EXERCISE 4

1. *(2 points)* Design a Datalog database for storing information about regions on a map. Each region is characterized by its size (small, medium or large) and its characteristics (industrial, agricultural or nature). In addition, the database should contain information about *direct subregions*, denoted by $\sqsubset$. For example, in figure below we have regions a, b, c and d, and we have $c \sqsubset b$, $d \sqsubset c$ but it is not the case that $d \sqsubset b$ or $a \sqsubset b$.



2. *(1 point)* Express in predicate calculus the constraint:

   "every region has a unique (exactly one) size and a unique characteristics."

3. *(1 point)* Provide an exemplary integrity constraint concerning the relation $\sqsubset$.

4. Formulate in logic queries selecting:

   (a) *(2 points)* all large industrial direct subregions of region a;

   (b) *(4 points)* all small (not necessarily direct) subregions of medium agricultural regions, where region a is a *subregion* of b if $a \sqsubset b$ or there is $n \geq 1$ and regions $r_1, \ldots, r_n$ such that $a \sqsubset r_1 \sqsubset r_2 \sqsubset \ldots \sqsubset r_n \sqsubset b$.