Homework2 — Graduate AI Class Fall 1999

available points: 60
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7) Do excercise 7.2 in our textbook [11 points]

8) RESOLUTION PROOFS [35 points]

a) What is the role of the empty clause in a resolution proof? What is the role of the unification method in a resolution proof? What is the role of Skolem functions in the resolution method? [3]

b) Prove using Resolution and not other methods [6]:
(A1) $\forall x(Q(x,5) \ \rightarrow \ S(5,x,x))$
(A2) $\forall x \exists y(P(x) \ \rightarrow \ Q(x,y))$
(A3) $\forall x \exists y \exists z(P(x) \ \rightarrow \ S(x,y,z))$
(A4) $\forall x \forall y \exists u((Q(x,y) \ \vee R(x)) \ \rightarrow \ S(x,u,u))$
$\vdash$
(A) $\forall x \exists z(P(x) \ \rightarrow \ S(x,z,z))$

c) Prove using resolution (and not other methods!) [10]
$A1, A2, A3, A4, A5 \ \vdash \ A!$

(A1) "Every student owns at least one car."
(A2) "Everybody, who owns a red car, is rich."
(A3) "Some students own a blue car"
(A4) "Fred is a student."
(A5) "Fred owns a red car"
(A) "Some students are rich."

d) Prove using resolution (and not other methods!) $A1, A2, A3, A4 \ \vdash \ A$ [7]:

(A1) "Every man loves at least one woman."
(A2) "Every woman loves at least one man."
(A3) "Women do not love men that are not intelligent."
(A4) "Vanessa is an intelligent woman."
(A) "There is at least one intelligent man in the world."

Predicate calculus formulas for the above statements:

e) Is it possible that a theorem prover runs forever, when trying to prove statement (A) in problem d? If your answer is no, give reasons for your answer! If your answer is yes, explain under which circumstances the theorem prover might run forever. What are the theoretical implications of your answer for FOPL theorem provers in general? [9]

9) FRAME-BASED SYSTEMS [6 points]
Frame-based systems gained some popularity in recent years in artificial intelligence programming. Explain! Which features make frame-based system attractive for the development of large software system? Limit your answers to 80 words (students that submit longer answers will be penalized!).

10) UNIFICATION ALGORITHM [8 points]
Have a closer look to the unification algorithm in section 10.2 of the textbook and answer the following questions:
If the algorithm is called with x=(P $a $a) and y=(P 4 $b), what will be result of running the unification algorithm? If we switch x and y is the result the same? If the results are not the same does this cause any problems for resolution theorem prover? If the algorithm would be run for x=(P $a $a) and y=(P 4 2) how does the algorithm make sure that the two terms do not unify?