AE4B33ZUI – Introduction to Artificial Intelligence

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The deadline for this assignment is Sunday 2nd May 23:59. The deadline is firm.

Task 1.   Automated reasoning (4 points)

During the tutorials, we have been using an *automated theorem prover* called *Prover9*, which uses *resolution* in *first-order logic (FOL)*. Your task is to do a survey:

Can you find some other techniques of *automated reasoning*? Have any of them already been applied in practice? If you were to use your chosen technique(s) in a software project, what problems and limitations should you consider? You can focus on discussing reliability, scalability, accuracy, possibility of reusing an existing implementation, amount of automation, etc.

You are not expected to mention every technique of automated reasoning you find, but to choose one (or a few) and to describe it in details. Please do not forget to cite the sources you used.

Task 2.   Resolution (6 points)

Suppose there is a binary relation $P(\cdot\,,\cdot)$, which has the following properties:

(1) P is total: $\forall x \, \exists \, y \, P(x,y)$.   (2) P is transitive.
(3) P is symmetric.   (4) P is reflexive.

Your task is to:

1. Formalize statements (2) – (4) into first-order logic. Number (1) has already been done for you.

   (2 points)

2. Using resolution, prove that (4) follows from (1) – (3).[1]

   Make sure it is clear which clauses and literals are being resolved and the substitution is always stated.[2] It might help you to *standardize-apart* all variables after each step.

   (4 points: normalizing the clauses + correctness & conciseness of the proof)

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[1] You might need to skolemize the clauses to remove $\exists$. The general formula for skolemization is:
Rewrite $\forall a, b, ..., k \; \exists l \; \forall m, n, ..., z \; P(l)$ into $\forall a, b, ..., k, m, n, ..., z \; P(f(a, b, ..., k))$, where f is fresh.

[2] You are free to use an automated prover for this task. However if you do so, make sure to add the substitutions in your solution.