CSE 473: Artificial Intelligence

Practice Questions on Propositional and First-Order Logic

1. A knowledge base has the following statements:
   - If there is gas in the tank and the fuel line is okay, then there is gas in the engine;
   - If there is gas in the engine and a good spark, the engine runs;
   - If there is power to the plugs and the plugs are clean, a good spark is produced;
   - If the battery is charged and the cables are okay, then there is power to the plugs.

   a. Convert the rules above to CNF using proposition symbols such as GasInTank, FuelLineOK, GasInEngine, etc.
   b. Suppose that you are given the facts that there is gas in the tank, the battery is charged, the fuel line and cables are both okay, and the plugs are clean. Using resolution, prove that the engine runs.
   c. Now write the four rules above as Horn clauses (as in Figure 7.16 in the text) using the same proposition symbols as in (a).
   d. Construct an AND-OR graph (as in Figure 7.16 in the text) based on (c).
   e. Given the same facts as in (b), prove using Forward Chaining that the engine runs: show the contents of the queue *agenda* in the forward chaining algorithm in Figure 7.15 in the AIMA text (3rd ed.), after initialization and after each iteration of the ***for*** loop.

2. Exercise 7.4 (use truth table enumeration).

3. Exercise 7.10.

4. Exercise 8.24.
   [Solutions: see next page]

5. A knowledge base contains the following statements:
   Everyone who loves all animals is loved by someone.
   Anyone who kills an animal is loved by no one.
   Jack loves all animals.
   Either Jack or Curiosity killed Tuna, the cat.
   a. Convert these statements into FOL.
   b. Convert each FOL statement in (a) to CNF.
   c. Using resolution, prove that Curiosity killed the cat.

   [Solution: See page 349 in the textbook]

a. Some students took French in spring 2001.
$\exists x \;\; Student(x) \wedge Takes(x, F, Spring2001).$

b. Every student who takes French passes it.
$\forall x, s \;\; Student(x) \wedge Takes(x, F, s) \;\Rightarrow\; Passes(x, F, s).$

c. Only one student took Greek in spring 2001.
$\exists x \;\; Student(x) \wedge Takes(x, G, Spring2001) \wedge \forall y \;\; y \neq x \Rightarrow \neg Takes(y, G, Spring2001).$

d. The best score in Greek is always higher than the best score in French.
$\forall s \;\; \exists x \;\; \forall y \;\; Score(x, G, s) > Score(y, F, s).$

e. Every person who buys a policy is smart.
$\forall x \;\; Person(x) \wedge (\exists y, z \;\; Policy(y) \wedge Buys(x, y, z)) \;\Rightarrow\; Smart(x).$

f. No person buys an expensive policy.
$\forall x, y, z \;\; Person(x) \wedge Policy(y) \wedge Expensive(y) \;\Rightarrow\; \neg Buys(x, y, z).$

g. There is an agent who sells policies only to people who are not insured.
$\exists x \;\; Agent(x) \wedge \forall y, z \;\; Policy(y) \wedge Sells(x, y, z) \;\Rightarrow\; (Person(z) \wedge \neg Insured(z)).$

h. There is a barber who shaves all men in town who do not shave themselves.
$\exists x \;\; Barber(x) \wedge \forall y \;\; Man(y) \wedge \neg Shaves(y, y) \;\Rightarrow\; Shaves(x, y).$