Homework #4: Chapters 9 and 10

The following exercises are due at the beginning of class on Wednesday, March 21.

You must use SWI-Prolog to answer exercise 3. SWI-Prolog is free software and can be installed in a public Lehigh Lab via the "Install Software" feature or it can be downloaded from http://www.swi-prolog.org/ and installed on a personal machine. In addition to submitting your hardcopy homework, submit your Prolog program by e-mail to the TA at sil206@lehigh.edu. Please use "CSE327: HW #4" as your subject line and attach a file *userid*-hw4.pl where *userid* is your 6 character Lehigh user id such as aaa999. Also, attach a text file named *userid*-hw4-out.txt containing your output from 3(b).

1. *[10 points, 2 points each]* For each pair of atomic sentences, give the most general unifier if it exists. Assume that x, y, and z are variables, while other symbols are either predicates, constants, or functions as required by their use in the sentences. In order to avoid ambiguity, do not use a variable as a term if you have already specified a substitution for it.

   a) P(A,B,B), P(x,y,z)
   b) P(x,y), Q(A,B)
   c) Knows(Father(y),y), Knows(x,x)
   d) Q(y,G(A,B)), Q(G(x,z),y)
   e) P(f(x), y, g(B)), P(f(y), A, g(y))

2. *[30 points total]* Consider the first-order logic sentences defined below.

   $\forall x,y\ P(x,y) \Rightarrow T(x,y)$
   $\forall x,y\ P(x,y) \Rightarrow T(y,x)$
   $\forall x,y,z\ T(x,y) \wedge Q(y,z) \wedge S(z,x) \Rightarrow R(x,y,z)$
   P(Red,Blue)
   P(Green,Red)
   P(Blue,Green)
   Q(Blue,Green)
   Q(Green,Blue)
   Q(Red,Green)
   Q(Blue,Red)
   Q(Green,Red)
   S(Blue,Red)
   S(Green,Red)
   S(Green,Green)
   S(Green,Blue)

   Use backward chaining to find **ALL** answers for the following queries. When matching rules, proceed from top to bottom, and evaluate subgoals from left to right. You must show your search tree using the same form I did in class (that is, each node should contain a list of subgoals remaining to be proven, and each child is a subsequent recursive call). Note, the form of the proof tree shown in Fig. 9.7 of the book (p. 288) is unacceptable, because it does not show when backtracking occurs.

   a) *[10 points]* $\exists x\ T(x,Blue) \wedge Q(x,Green)$
   b) *[20 points]* $\exists x,y\ R(Red,x,y)$

3. *[45 points total]* In this exercise you will use Prolog to create a knowledge base about animals. Part (a) should be saved as a file named *userid*-hw4.pl. Please include an introductory comment with your name, the course number and date in it. As specified above, send an e-mail to the TA containing both your program and your output from part (b).

   a) *[30 points]* Create a Prolog program to reason with the knowledge provided below. Only include facts and rules that correspond to the information given here; do not encode any additional knowledge of animals that you may have. Hint: The Prolog program will be easier to write if you use unary predicates to represent categories.

   All Animals breathe oxygen. There are three types of Animal: Bird, Fish and Mammal. Birds are covered in feathers, have two legs, and move by flying. There are two kinds of Birds: Robins and Hawks. Robins eat worms and Hawks eat rodents. Fish are covered in scales and move by swimming. Mammals are covered in fur and move by walking. There are three kinds of Mammals: Apes, Cows, and Lions. Apes have two legs. Cows have four legs and eat grass. Lions have four legs and eat meat. Nemo is a Fish, Lee is a Hawk, Rob is a Robin, Kong is an Ape, Elsa is a Lion, and Bessie is a Cow.

   b) *[15 points]* Test your Prolog program by asking it the following questions. Note, in some cases, it may be impossible to avoid getting the same answer more than once for a query.

      i) Is Nemo covered in scales?
      ii) How many legs does Elsa have?
      iii) How does Bessie move?
      iv) Does Lee breathe oxygen?
      v) Do Bessie and Elsa eat the same thing?
      vi) Do Kong and Rob have the same number of legs?
      vii) Who are all of the individual mammals? (**not** what are the kinds of mammals)

      Include a printout that shows your Prolog query and the program's responses (you may simply copy this from SWI-Prolog's main window and paste it into a file for printing).

4. *[15 points]* Construct a semantic network representation for the following sentence: John bought a ticket to see The Police concert in Hershey this summer. Break the sentence down such that each object is represented by a separate bubble and each property of an object is represent by a different labeled link. See Figure 10.10 (p. 352) in the book for an example.