CSE560: Homework 7

Disjunctive and Negative Knowledge

This is a continuation of a question from the previous homework.

If the unicorn is mythical, then it is immortal, but if it is not mythical, then it is a mortal mammal. If the unicorn is either immortal or a mammal, then it is horned. The unicorn is magical if it is horned.

Use the translation of the above into clauses from the answer key to the previous homework.

Question 1

Top-Down Proof

Prove that the unicorn is horned using a top-down proof strategy. Show all of your steps.

Difference with Datalog Explain what step that you did which is not allowed for the top-down proof procedure for datalog.

First Order Predicate Calculus

Question 2: Precedence

In arithmetic, '*' is of higher precedence than + and so (6*2)+3 can be written as 6*2+3; whereas for 6*(2+3), the brackets cannot be removed.

In class, we assumed a set of precedence rules for first order predicate calculus. Here are the rules in order.

1. $\neg$ is the highest level of precedence
2. $\vee$ and $\wedge$ are the next highest
3. $\leftarrow$
4. Quantifiers: $\forall$ and $\exists$

Use the rules to add in the missing brackets from each.

$\forall X \forall Y p(X,Z) \rightarrow q(X,Y) \vee r(Y,Z)$

$\neg \exists Y \forall X \neg p(X,Z) \rightarrow \neg q(X,Y) \wedge r(Y,Z)$

Question 3: Expressing Knowledge

Write the following expressions in First Order logic (using $\forall$, $\exists$, $\wedge$, $\vee$, $\leftarrow$). Make sure you use capital letters for variables. Also, you can use the above precedence rules in order not to show all brackets. For some of these, it might help to try to rephrase them. For example, "all boxes are red" can be rephrase as "if something is a box then it must be red", which can be rephrased as, "for everything in the domain, if it is a box then it must be red".

George is a male butcher.
Everybody likes George.
Everybody is a butcher.
Nobody is a butcher.
There is a male butcher.
No man is a butcher.

Every rabit is faster than every ant.

Question 4: Convert to CNF

Convert the following into conjunctive normal form. Show all steps.

Part a: $\neg(\exists$ X (boy(X)))

Part b: $\exists$ X ($\neg(\exists$ Y (likes(X,Y))))

Part c: $\forall$ X ($\neg(\forall$ Y (likes(X,Y) $\leftarrow$ mother(X,Y))))

Assumption Based Reasoning

Exercise 9.1 from the textbook.

Question 5: Exercise 9.1 part a

Question 6: Exercise 9.1 part b

Question 7: Setting up an Assumption-Based Problem

Canadians are typically not francophones (speak french).

All Québecois are Canadians (Quebec is a province in Canada).

Québecois are typically francophones.

Robert is a Québecois.

Express this using the assumption based framework (defining H and F). Use the predicate symbol c for Canadian, q for Québecois, and f for francophone, and use the constant r for randy.

Question 8: Multiple Explanations

Give a minimum explanation that Robert is a francophone, and a minimum explanation that he is not a francophone.

Question 9: Explanations

Revise one of your assumptions so that you can no longer give an explanation that Robert is not a francophone. Your revision should still allow robert to not be a francophone if this is explicitly known.

Prolog

Question 10: Step 2 of CNF

For disjunctive and negative knowledge, you previously gave the Prolog code for performing step 1. Now give step 2 in which you need to move all negatations inward onto the literals.

Question 11: Bonus: Step 3 of CNF

Distribute disjunction over conjunction. This one is tricky, much more tricky then step 1 and step 2. Step 1 and Step 2 can be done in a single pass. However, ni my version of step 3, I had to make multiple sweeps over it. I also had to make very careful use of the cut statement to prevent multiple answers (from pressing ';').

This can be turned in at anytime up to the midterm.