CSci 5511 Fall 2014

2nd Midterm Exam

Thursday November 20
75 minutes == 75 points
Open book and notes

1. *10 points*
   You are given the following sentences: "If the maid stole the jewelry, then the butler is not guilty. Either the maid stole the jewelry, or she milked the cow. If the maid milked the cow, then the butler got the cream."

   1. Write the knowledge in propositional calculus, using the following propositions:
      MSJ (maid stole the jewelry), BG (butler is guilty), MMC (maid milked the cow), BGC (butler got the cream)
   2. Convert to CNF.
   3. Prove by resolution "If the butler is guilty then he got the cream."

2. *25 points*
   Use predicate calculus and resolution with refutation for this question.

   1. Represent the following set of axioms in predicate calculus:
      1. Anyone who has a pet loves it.
      2. Anyone who has a bird does not have any cat.
      3. Cats and birds are pets.
      4. John has a cat who ate a bird.
      5. John does not love pets who eat birds.
   2. Convert each of the statements above to conjunctive normal form, skolemizing as needed.
   3. Of the given set of statements, is there a subset of statements that is contradictory? If not, then what minimum facts do you need to add to the above to get a subset of statements that is contradictory? In either case, identify this subset, and then prove the unsatisfiability of this subset of clauses by using resolution with refutation.

3. *5 points*
   Write the following sentence in predicate calculus, choosing appropriate predicates: "Politicians can fool some of the people all of the time, and they can fool all of the people some of the time, but they cannot fool all of the people all of the time."

Turn to the next page for more questions

4. *10 points*
   For each of the following sentences, decide if the logic sentence given is a correct translation of the English sentence or not. If not explain briefly why not and correct it. There can be more than one mistake in each expression.

   1. Every city has a dogcatcher who has been bitten by every dog in town.
      $\forall x \forall y \ : \ City(x) \wedge DogCatcher(y) \ \Rightarrow \ \exists z Dog(z) \wedge LivesIn(z, x) \wedge BittenBy(y, z)]$
   2. Rich people have big houses.
      $\exists x \exists y \, Rich(x) \wedge HasHouse(x, y) \Rightarrow Big(y)$

5. *15 points*
   You have a train engine in Minneapolis and two boxcars, one at the Minneapolis train station and one in Milwaukee. There is a train track connecting Minneapolis to Milwaukee, and one connecting Milwaukee to Chicago.

   Your goal is to couple one boxcar with the engine, move the train to Chicago, and take the engine back to Minneapolis:

   $At(Engine1, Minneapolis) \wedge At(Boxcar1, Chicago)$

   A boxcar can be *coupled* with an engine if they are both at the same train station. You can couple one boxcar at a time with an engine. You can connect as many boxcars as you want to an engine. An engine can *move* from a station to another as long as there is a track connecting the stations, either directly or indirectly through another city. Boxcars can be moved only if coupled with an engine. You can *uncouple* a box car if it is coupled.

   Use the following predicates $Engine(e), Boxcar(b), Station(s), Coupled(b, e)$, $At(x, l)$, $Connected(city1, city2)$.

   Write action schemas for $Couple$, $Uncouple$, and $Move$ for this train domain. For this problem, you can assume a single boxcar needs to be coupled with an engine. You will get extra credit if you write more general action schemas that allow multiple boxcars to be coupled with the same engine.

6. *10 points*
   Answer these questions briefly but precisely.

   1. Is it true that in first-order logic, if a sentence is entailed, it can always be proven using resolution with refutation?
   2. When doing CSP, what are the advantages, if any, of including forward checking in backtracking search?
   3. If all the negative effects are removed from the effect of an action, can we say that this results in a relaxed problem? Why?

YOU REACHED THE END OF THE EXAM