**CS 771 Artificial Intelligence**
**Spring 2019 Homework 5 (85 points)**

**Assigned: Monday, April 08, 2019**
**Due: Monday, April 15, 2019**

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1. (25 points) Consider the following predicates :

   T(x): x is taking CS771;
   C(x): x has a cell phone;
   F(x): x has seen a foreign film;
   Fr(x, y): x is a friend of y;

   Now express the following sentences in first order logic.

   (a) Someone taking CS771 class has seen a foreign film.

   (b) Everyone taking CS771 class has a cell phone.

   (c) Everyone who is either taking CS771 or has a cell phone has a friend who hasn't watched a foreign film.

   (d) No one is simultaneously taking CS771, has a call phone and has watched a foreign film.

   (e) Everyone who has a cell phone has a friend a who has a cell phone.

2. (50 points) For this problem consider the following predicates :

   Animal(x): x is an animal;
   Horse(x): x is a horse;
   HeadOf(h, x): h is the head of x;

   The goal of this exercise is to show that from "Horses are animals" it follows that "The head of a horse is the head of an animal".

   (a) First,express the following in first order logic using the predicates given above: "Horses are animals". This forms your KB.

   (b) Now, express the following in first order logic using the predicates above: "The head of a horse is the head of an animal". This is the statement $\alpha$ that you need to prove.

   (c) Negate $\alpha$ and convert $\neg\alpha$ into conjunctive normal form (CNF). Remember, resolution proves $KB \models \alpha$ by proving $KB \vee \neg\alpha$ is unsatisfiable. If you do everything right, there will be four clauses in the $KB \wedge \neg\alpha$ CNF, one for $KB$ and three for $\neg\alpha$.

   (d) Now, use resolution and part(c) to show $KB \wedge \neg\alpha$ is unsatisfiable, that is by deriving an empty clause.

3. (2 points) Suppose a knowledge base has just one sentence , $\exists\, x \;\; AsHighAs(x, Everest)$. Which of the following is a legitimate result of applying Existential instantiation?

   (a) $AsHighAs(Everest, Everest)$.

   (b) $AsHighAs(Kilimanjaro, Everest)$.

4. (8 points) For each pair of atomic sentences, give a unifier if it exists. If no unifier exists, explain why not.

   (a) $Q(y, G(A, B)), Q(G(x, x), y)$.

   (b) $P(A, B, B), P(x, y, z)$

   (c) $Knows(Father(y), y), Knows(x, x)$.

   (d) $Older(Father(y), y), Older(Father(x), John)$.