EECS 391: Introduction to AI (Spring 2016) Written Homework 3  (Max Points: 100)

Assigned Tuesday February 25, due midnight Tuesday March 15. Write your answers neatly and remember to show all relevant work. If a pair of you did this assignment together, both your names and IDs should appear on the front page. You may only turn in an assignment as a pair if both of you have contributed equally to it.

1. Suppose an FOL KB has only two sentences: \( P(e) \) and \( P(b) \). Does this KB entail \( \forall x P(x) \)? (5 points)

2. Write down a FOL statement such that every world in which it is true has exactly one object. (5 points)

3. Write FOL statements to represent the following. Define your own sensible vocabulary. (15 points)
   (a) There is a barber who shaves all men in town who do not shave themselves.
   (b) A person born outside the country of Florin, one of whose parents is a Florin citizen by birth, is a Florin citizen by descent.
   (c) 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.

4. Derive the most general unifier if it exists: (i) \( Q(y, G(A, B)) \), \( Q(G(x, x), y) \), (ii) \( \text{Knows(Father}(y), y) \), \( \text{Knows}(x, x) \). Here \( x \) and \( y \) are variables and \( A, B \) are constants. (10 points)

5. Suppose we omit the occurs check from the unification algorithm, so that it allows a literal like \( P(x, f(x)) \) to be unified with \( P(r, r) \). Show that this allows the conclusion \( \exists r P(r, r) \) to be inferred from \( \forall x \exists y P(x, y) \). Give an intuitive example of a predicate \( P \) where this is not sound, i.e. \( \forall x \exists y P(x, y) \) is true but \( \exists r P(r, r) \) is false. (10 points)

6. Solve the riddle “Brothers and sisters have I none, but that man’s father is my father’s son” to find the identity of “that man” using resolution. Use the rules of the kinship domain in Section 8.3.2 of the book. (15 points)

7. Suppose a KB has just the following formulae:
   \( \text{Ancestor(Mother}(x), x) \)
   \( \text{Ancestor}(x, y) \land \text{Ancestor}(y, z) \Rightarrow \text{Ancestor}(x, z) \)

   Can resolution prove \( \neg \text{Ancestor}(\text{John}, \text{John}) \) from this KB? Explain how or why not. (10 points)

8. The monkey-and-bananas problem is the following: An AI monkey is in a room with a box and some bananas hanging from the ceiling. The box and the monkey have height \( \text{Short} \), but if the monkey climbs on the box it will have height \( \text{Tall} \). The bananas have the height \( \text{Tall} \). The monkey can \( \text{Go} \) from one place to another, \( \text{Push} \) an object, \( \text{ClimbUp} \) or \( \text{ClimbDown} \) from an
object and *Grab* or *Drop* an object. The result of a *Grab* is the monkey holds the object if they are at the same place at the same height. The monkey wants to get the bananas. Write this as a STRIPS planning problem. (10 points)

9. Explain why dropping negative effects from action schemas results in a relaxed problem. (10 points)

10. When we covered search, we talked briefly about bidirectional search in class. Could bidirectional search be used in (i) state space planning and (ii) plan space planning? Describe how if so. (10 points)