Introduction to AI Spr2018 Quiz #2 6/11/2018 Solutions

1. [25%] A propositional KB contains these sentences:
A, B, P⇒Q, A∧M⇒P, L∧B⇒M, A∧B⇒L
(a) Convert them into CNF.
(b) Use resolution to prove Q.

(a) [R1] A [R2] B
[R3] P⇒Q → ¬P∨Q
[R4] A∧M⇒P → ¬(A∧M)∨Q → ¬A∨¬M∨Q
[R5] L∧B⇒M → ¬(L∧B)∨M → ¬L∨¬B∨M
[R6] A∧B⇒L → ¬(A∧B)∨L → ¬A∨¬B∨L

(b) [R7: R1+R4] ¬M∨Q
[R8: R1+R6] ¬B∨L
[R9: R2+R5] ¬L∨M
[R10: R2+R8] L
[R11: R9+R10] M
[R12: R7+R11] Q
[R12 + ¬Q (negated query)] false → contradiction → Q is true.

2. [30%] Convert the following English sentences to first-order logic sentences. Whenever possible, use the words in the original sentence as the names of predicates, functions, and constant terms.
(a) Some friends of Bob like baseball.
∃x Friend(Bob, x) ∧ Like(x, Baseball)
(b) A soccer fan is one who likes soccer.
∀x Fan(x, Soccer) ⇒ Like(x, Soccer) [It is ok to use "⇔" here.]
(c) Bob is the only one in his class who likes soccer. [You can use *Classmate* as a predicate here.]
∀x Classmate(Bob, x) ⇒ ¬Like(x, Soccer)

3. [25%] Given the FOL sentences in Prob. 2(b) and (c), and the following fact:
Jane is Bob's classmate.
Try to prove
Jane is not a soccer fan.
You can use any sound inference method. Specify the substitutions here.
We have the additional ground term: Classmate(Bob, Jane)
The queried term Q is: ¬Fan(Jane, Soccer)
The following procedure uses the resolution rule.
The CNF forms:
[R1] Classmate(Bob, Jane)
[R2] Fan(x, Soccer) ⇒ Like(x, Soccer) → ¬Fan(y, Soccer) ∨ Like(y, Soccer)
(The "standardizing apart" step is applied to avoid variable name clash.)
[R3] Classmate(Bob, x) ⇒ ¬Like(x, Soccer) → ¬Classmate(Bob, x) ∨ ¬Like(x, Soccer)
Resolution:
[R4: R1+R3] ¬Like(Jane, Soccer) (substitution: {x/Jane})
[R5: R2+R4] ¬Fan(Jane, Soccer) (substitution: {y/Jane})
[R5 + ¬Q] false → contradiction → Q is true.

4. [20%] Which of the following terms are suitable to be used as Functions in FOL, and which are not?
Brother, *Mother*, *Head*, *Hat*.
Give a brief explanation of your criterion.
Mother and *Head* are suitable as functions, and *Brother* and *Hat* are not.
This is because it is expected that only a single object can be someone's mother (or head), but an object can have multiple brothers (or hats).