Homework Week 11

1. Give a valid interpretation in first-order logic of

   "Every martian can fool some of the people all of the time (and these can be different subsets of people for each martian)"

   Use both ForAll (∀)and Exists (∃) quantifiers, and assume predicates Martian(?v), Person(?v), Time(?v), and Fools(?v_1,?v_2,?v_3), where the first three are probably clear, and the latter is ?v_1 fools ?v_2 at time ?v_3 .

ForAll(x), [Martian(x) -> Exists(y)[Person(y) AND ForAll(t)[Time(t) -> Fools(x,y,t)]]]

ForAll(x), Exists(y) ForAll(t) [Martian(x) -> Person(y) AND Time(t) -> Fools(x,y,t)]

2. Consider the following propositional KB

1. handEmpty → ~holding-A;
2. handEmpty → ~holding-B;
3. handEmpty → ~holding-C;
4. holding-A → ~handEmpty;
5. holding-B → ~handEmpty;
6. holding-C → ~handEmpty;
7. on-A-B → ~clear-B;
8. on-B-C → ~clear-C;
9. on-C-D → ~clear-D

(a) Give a single first-order rule to replace propositional rules 1-3. Show quantifiers. You can use "Exists" and "ForAll" (as in problem 1) instead of the usual symbols.

ForAllx, (handEmpty -> ~holding(x))

(b) Give a single first-order rule that replaces propositional rules 4-6.

ForAllx, (holding(x) -> ~ handEmpty(x))

(c) Give a single first-order rule that replaces propositional rules 7-9. Show quantifiers.

ForAllx, ForAlly, (on(x, y) -> ~clear(y))
ForAllx, ForAlly, (~on(x, y) V ~clear(y))
ForAllx, ForAlly, (~(on(x, y) ^ clear(y)))
~(Existsx, Existsy, (on(x, y) ^ clear(y)))

3. Given the axioms:

A,B are constants

?x's, ?y's, and ?z's are (universally-quantified) variables

ontable(A)
~clear(A)
~above(?x1, ?y1) or below(?y1,?x1)
~below(?x2, ?y2) or above(?y2, ?x2)
~on(?x3, ?y3) or above(?x3, ?y3)
~on(?x4, ?y4) or ~above(?y4, ?z4) or above(?x4, ?z4)
clear(?x5) or on(B, ?x5)
~ontable(?x6) or ~holding(?x6)
~ontable(?x7) or ~on(?x7, ?y7)

Give a *refutation resolution* proof of **below(A, B)**.

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ontable(A)
~clear(A)
~~~above(?x1, ?y1) or below(?y1,?x1)~~
~~~below(?x2, ?y2) or above(?y2, ?x2)~~
~on(?x3, ?y3) or above(?x3, ?y3)
~~~on(?x4, ?y4) or ~above(?y4, ?z4) or above(?x4, ?z4)~~
~~clear(?x5) or on(B, ?x5)~~
~~~ontable(?x6) or ~holding(?x6)~~
~ontable(?x7) or ~on(?x7, ?y7)

Give a *refutation resolution* proof of **below(A, B)**.

[-below(A, B)] [-above(?x1, ?y1) or below(?y1, ?x1)]
{A/x1, B/y1}
-above(B, A) [-below(?x2, ?y2) or above(?y2, ?x2)]
{B/y2, A/x2}
-below(A, B) = [ontable(-below(A, B))] [-ontable(?x6) or -holding(?x6)]
-holding(-below(A, B)) = -holding(-below(-clear(-below(A, B)))) [clear(?x5) or on(B, ?x5)]
-holding(-below(on(B, -below(A, B)))) [-on(?x4, ?y4) or -above(?y4, ?z4) or above(?x4, ?z4)]
-holding(-below(-above(on(B, -below(A, B))) or above(on(B, ~~-below~~ (A, B)))) [-on(?x3, ?y3) or above(?x3, ?y3)]
-holding(-below({}))

4. Show the result of resolving **P(?y, ?x, B, ?y) or Q(?x, ?y, ?x, A)** with **~P(?z, ?z, ?w, A)**.

Q(A, A, A, A)

{z/y, y/A, w/B, x/A}