CS-171, Intro to A.I. — Quiz#3 — Fall Quarter, 2014 — 20 minutes

YOUR NAME: ____

YOUR ID: ________ ID TO RIGHT: ________ ROW: _____ NO. FROM RIGHT: _____

1. (35 pts total, -5 pts for each error, but not negative) The Knowledge Engineering process. Your book identifies seven sequential steps in the knowledge engineering process, which are given below. Unfortunately, the order of the steps has been scrambled. Please, straighten them out.

A. Pose queries to the inference procedure and get answers
B. Encode a description of the specific problem instance
C. Identify the task
D. Encode general knowledge about the domain
E. Decide on a vocabulary of predicates, functions, and constants
F. Debug the knowledge base
G. Assemble the relevant knowledge

Fill in the blanks with the letters A, B, C, D, E, F, and G, all in the proper sequence.

_______ _______ _______ _______ _______ _______ _______.

2. (30 pts total, 5 pts each) Logic-To-English. For each of the following FOPC sentences on the left, write the letter corresponding to the best English sentence on the right. Use these intended interpretations: (1) "Butterfly(x)" is intended to mean "x is a butterfly." (2) "Flower(x)" is intended to mean "x is a flower." (3) "FeedsOn(x, y)" is intended to mean "x feeds on y."

	∀b ∃f Butterfly(b) ⇒ [Flower(f) ∧ FeedsOn(b, f)]	A	Every butterfly feeds on every flower.
	∃f ∀b Flower(f) ∧ [Butterfly(b) ⇒ FeedsOn(b, f)]	B	For every flower, there is some butterfly who feeds on that flower.
	∀f ∃b Flower(f) ⇒ [Butterfly(b) ∧ FeedsOn(b, f)]	C	There is some butterfly who feeds on some flower.
	∃b ∀f Butterfly(b) ∧ [Flower(f) ⇒ FeedsOn(b, f)]	D	For every butterfly, there is some flower that the butterfly feeds on.
	∀b ∀f [Butterfly(b) ∧ Flower(f)] ⇒ FeedsOn(b, f)	E	There is some butterfly who feeds on every flower.
.	∃b ∃f Butterfly(b) ∧ Flower(f) ∧ FeedsOn(b, f)	F	There is some flower that every butterfly feeds on.

****** TURN PAGE OVER. QUIZ CONTINUES ON THE REVERSE ******

3. (35 pts total, -5 for each error, but not negative) RESOLUTION THEOREM PROVING. You are engaged in Knowledge Engineering for the Wumpus Cave. You have interviewed an expert on the Wumpus Cave who told you, among other things, "A stench in square (1,2) is equivalent to a wumpus in square (1,1) or (2,2) or (1,3). A stench in square (2,1) is equivalent to a wumpus in square (1,1) or (2,2) or (3,1)." You translated this into propositional logic as

$(S12 \Leftrightarrow W11 \vee W22 \vee W13)$ $(S21 \Leftrightarrow W11 \vee W22 \vee W31)$

and then into Conjunctive Normal Form (CNF) as

$(\neg S12 \vee W11 \vee W22 \vee W13) \wedge (S12 \vee \neg W11) \wedge (S12 \vee \neg W22) \wedge (S12 \vee \neg W13)$

$(\neg S21 \vee W11 \vee W22 \vee W31) \wedge (S21 \vee \neg W11) \wedge (S21 \vee \neg W22) \wedge (S21 \vee \neg W31)$

Now it is time for the first "live" test of your system. An agent has been lowered down into the Wumpus cave, and reports back by radio, "Square (1,1) has no wumpus and no stench. Square (1,2) has a stench. Square (2,1) has no stench." You translate this knowledge into CNF as "$(\neg W11) \wedge (\neg S11) \wedge (S12) \wedge (\neg S21)$" and add it to your knowledge base.

Next the agent asks by radio, "Is it true that square (1,3) has a wumpus?" You translate this query into propositional logic as the goal sentence "(W13)." You form the negated goal as "$(\neg W13)$." Now your knowledge base plus the negated goal, expressed in clausal form, is:

$(\neg S12\ W11\ W22\ W13)$		$(\neg S21\ W11\ W22\ W31)$		
$(S12\ \neg W11)$	$(S12\ \neg W22)$	$(S12\ \neg W13)$		
$(S21\ \neg W11)$	$(S21\ \neg W22)$	$(S21\ \neg W31)$		
$(\neg W11)$	$(\neg S11)$	$(S12)$	$(\neg S21)$	$(\neg W13)$

Run resolution on this knowledge base until you produce the null clause, "( )", thereby proving that the goal sentence is true. The shortest proof I know of is only five lines long. It is OK to use more lines, if your proof is correct.

Repeatedly choose two clauses, write one clause in the first blank space on a line, and the other clause in the second. Apply resolution to them. Write the resulting clause in the third blank space, and insert it into the knowledge base.

Think about what you are trying to prove, and find a proof that mirrors how you think. You know S12 and $(S12 \Rightarrow W11 \vee W22 \vee W13)$. You know $(\neg W11)$. It is easy to prove $(\neg W22)$, so (W13) is the only possibility left. Your negated goal is $(\neg W13)$. You seek ( ). Think about it.

Resolve ________________________ and __________________ to give __________________

Resolve ________________________ and __________________ to give __________________

Resolve ________________________ and __________________ to give __________________

Resolve ________________________ and __________________ to give __________________

Resolve ________________________ and __________________ to give __________________

Resolve ________________________ and __________________ to give __________________