CS-171, Intro to A.I. — Quiz#3 — Fall Quarter, 2013 — 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 steps are below. Unfortunately, the order of the steps has been scrambled. Please, straighten them out.

See Section 8.4

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

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

__C__ __G__ __E__ __D__ __B__ __A__ __F__.

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) "Person(x)" is intended to mean "x is a person." (2) "Flavor(x)" is intended to mean "x is a flavor." (3) "Likes(x, y)" is intended to mean "x likes y."

D	$\forall p\ \exists f\ Person(p) \Rightarrow [\ Flavor(f) \wedge Likes(p, f)\ ]$	A	Every person likes every flavor.
F	$\exists f\ \forall p\ Flavor(f) \wedge [\ Person(p) \Rightarrow Likes(p, f)\ ]$	B	For every flavor, there is some person who likes that flavor.
B	$\forall f\ \exists p\ Flavor(f) \Rightarrow [\ Person(p) \wedge Likes(p, f)\ ]$	C	There is some person who likes some flavor.
E	$\exists p\ \forall f\ Person(p) \wedge [\ Flavor(f) \Rightarrow Likes(p, f)\ ]$	D	For every person, there is some flavor that the person likes.
A	$\forall p\ \forall f\ [\ Person(p) \wedge Flavor(f)\ ] \Rightarrow Likes(p, f)$	E	There is some person who likes every flavor.
C	$\exists p\ \exists f\ Person(p) \wedge Flavor(f) \wedge Likes(p, f)$	F	There is some flavor that every person likes.

See Section 8.2.6

Note that ⇒ is the natural connective to use with ∀.

Note that ∧ is the natural connective to use with ∃.

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

3. (35 pts total, -5 pts for each error, but not negative) Cake Theft. (http://www.brainbashers.com)
Chief Inspector Parker interviewed five local burglars to identify who stole Mrs. Archer's cake.

See Section 7.5.2

<u>**It was well known that each suspect told exactly one lie:**</u>

Arnold: *It was not Edward. It was Brian.*
Brian: *It was not Charlie. It was not Edward.*
Charlie: *It was Edward. It was not Arnold.*
Derek: *It was Charlie. It was Brian.*
Edward: *It was Derek. It was not Arnold.*

Use these propositional variables:

A=It was Arnold. **B**=It was Brian. **C**=It was Charlie. **D**=It was Derek. **E**=It was Edward.

You translate the evidence into propositional logic (<u>recall that each suspect told exactly one lie</u>):

Arnold: $(E \land B) \lor (\neg E \land \neg B)$
Brian: $(C \land \neg E) \lor (\neg C \land E)$
Charlie: $(\neg E \land \neg A) \lor (E \land A)$
Derek: $(\neg C \land B) \lor (C \land \neg B)$
Edward: $(\neg D \land \neg A) \lor (D \land A)$

At most one burglar stole the cake:

$(A \Rightarrow \neg B \land \neg C \land \neg D \land \neg E)$ $(B \Rightarrow \neg A \land \neg C \land \neg D \land \neg E)$ $(C \Rightarrow \neg A \land \neg B \land \neg D \land \neg E)$
$(D \Rightarrow \neg A \land \neg B \land \neg C \land \neg E)$ $(E \Rightarrow \neg A \land \neg B \land \neg C \land \neg D)$

After converting to Conjunctive Normal Form, your Knowledge Base (KB) consists of:

$(E \lor \neg B)$ $(\neg E \lor B)$ $(C \lor E)$ $(\neg C \lor \neg E)$ $(\neg E \lor A)$ $(E \lor \neg A)$
$(\neg C \lor \neg B)$ $(C \lor B)$ $(\neg D \lor A)$ $(D \lor \neg A)$
$(\neg A \lor \neg B)$ $(\neg A \lor \neg C)$ $(\neg A \lor \neg D)$ $(\neg A \lor \neg E)$ $(\neg B \lor \neg C)$
$(\neg B \lor \neg D)$ $(\neg B \lor \neg E)$ $(\neg C \lor \neg D)$ $(\neg C \lor \neg E)$ $(\neg D \lor \neg E)$

From Brian, it was Charlie or Edward. From Derek, it was Charlie or Brian. Thus, it was Charlie.
You will be asked to prove, **"It was Charlie."** The goal is (C). You adjoin the negated goal to your KB:
$(\neg C)$

Produce a resolution proof, using KB and the negated goal, that "It was Charlie."
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. Continue until you produce ( ). If you cannot produce ( ), then you have made a mistake. The shortest proof I know is only three lines. It is OK to use more lines, if your proof is correct.

It is OK if you used abbreviated CNF, i.e., (¬ A ¬ B) instead of (¬ A ˅ ¬ B). It is OK to omit the parentheses.

Resolve ______ $(\neg B \lor \neg E)$ ______ and ______ $(C \lor E)$ ______ to give ______ $(\neg B \lor C)$ ______.

Resolve ______ $(\neg B \lor C)$ ______ and ______ $(C \lor B)$ ______ to give ______ $(C \lor C) = (C)$.

Resolve ______ (C) ______ and ______ $(\neg C)$ ______ to give ______ ( ) ______.

Resolve ______

Resolve ______

Resolve ______

Resolve ______

Other proofs are OK as long as they are correct. For example, another proof is:
Resolve (¬ C) and (C ˅ B) to give (B).
Resolve (B) and (¬ B ˅ ¬ E) to give (¬ E).
Resolve (¬ E) and (C ˅ E) to give (C).
Resolve (C) and (¬ C) to give ( ).

Yet another is:
Resolve (¬ C) and (C ˅ E) to give (E).
Resolve (¬ C) and (C ˅ B) to give (B).
Resolve (E) and (¬ B ˅ ¬ E) to give (¬ B).
Resolve (B) and (¬ B) to give ( ).