CS-271P, Intro to A.I., Winter Quarter, 2018—Quiz # 3—20 minutes

NAME: ____

YOUR ID: ___________ ID TO RIGHT:__________ ROW NO.:_____ SEAT NO.:______

1. (60 pts total, 5 pts each) LOGIC CONCEPTS. For each of the following terms on the left, write in the letter corresponding to the best answer or the correct definition on the right. The first one is done for you as an example.

A	Agent	A	Perceives environment by sensors, acts by actuators.
C	Syntax	B	Chain of inference rule conclusions leading to a desired sentence.
I	Semantics	C	Specifies all the sentences in a language that are well formed.
L	Entailment	D	Describes a sentence that is true in all models.
J	Sound	E	Stands for a proposition that can be true or false.
K	Complete	F	Represented as a canonical conjunction of disjunctions.
E	Propositional Symbol	G	Possible world that assigns TRUE or FALSE to each proposition.
D	Valid	H	Describes a sentence that is false in all models.
M	Satisfiable	I	Defines truth of each sentence with respect to each possible world.
H	Unsatisfiable	J	An inference procedure that derives only entailed sentences.
B	Proof	K	An inference procedure that derives all entailed sentences.
G	Model	L	The idea that a sentence follows logically from other sentences.
F	Conjunctive Normal Form	M	Describes a sentence that is true in some model.

See Section 7.5.2 and Figure 7.13

2. (32 points total, 4 pts each) Label the following statements as T (= true) or F (= false).

2.a. __T__ $(A \Rightarrow B)$ is equivalent to $(\neg A \vee B)$.

2.b. __F__ $[(A \Rightarrow B) \wedge (\neg A)]$ entails $(\neg B)$.

2.c. __T__ $[(A \Rightarrow B) \wedge (\neg B)]$ entails $(\neg A)$.

2.d. __T__ $[(A \Rightarrow B) \wedge (\neg A \Rightarrow C) \wedge (\neg C)]$ entails B.

2.e. __T__ $[(A \Rightarrow B) \Rightarrow (\neg (A \Rightarrow \neg B))]$ is equivalent to A.

2.f. __T__ $(A \vee (B \wedge C))$ is equivalent to $(A \vee B) \wedge (A \vee C)$.

2.g. __T__ $(A \Leftrightarrow B)$ is equivalent to $(\neg A \Leftrightarrow \neg B)$.

2.h. __T__ $(A \Leftrightarrow B)$ is equivalent to $(\neg A \Rightarrow \neg B) \wedge (\neg B \Rightarrow \neg A)$.

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3. (20 pts total, -5 for each error, but not negative) RESOLUTION THEOREM PROVING. 5. (10 pts total) ONE FISH, TWO FISH, RED FISH, BLUE FISH. Resolution Theorem Proving. (With apologies to Dr. Seuss.)

Amy, Betty, Cindy, and Diane went out to lunch at a seafood restaurant. Each ordered one fish. Each fish was either a red fish or a blue fish. Their waiter reported:

See R&N Section 7.5.2.

"Amy and Betty had fish of different colors; I don't remember who had what.
Betty and Cindy had fish of different colors; I don't remember who had what.
Cindy and Diane had fish of different colors; I don't remember who had what.
Amy, Cindy, and Diane had exactly two red fish among them; I don't remember who had what."

You translate these facts into Propositional Logic (in infix form) as:

/* Ontology: Symbol A/B/C/D means that Amy/Betty/Cindy/Diane had a red fish. */

(A <=> (¬ B))   (B <=> (¬ C))   (C <=> (¬ D))

((A ∧ C ∧ (¬ D)) ∨ (A ∧ (¬ C) ∧ D) ∨ ((¬ A) ∧ C ∧ D))

Betty's daughter asked, "Is it true that my mother had a blue fish?"

You translate this query into Propositional Logic as "(¬ B)" and form the negated goal as "(B)".

Your resulting knowledge base (KB) plus the negated goal (in CNF clausal form) is:

(A B)	(A C)	(A D)
(B C)	(C D)	
((¬ A) (¬ B))	((¬ B) (¬ C))	((¬ C) (¬ D))
(B)		

Write a resolution proof that Betty had a blue fish.

For each step of the proof, fill in the first two blanks with CNF sentences from KB that will resolve to produce the CNF result that you write in the third (resolvent) blank. The resolvent is the result of resolving the first two sentences. Add the resolvent to KB, and repeat. Use as many steps as necessary, ending with the empty clause. The empty clause indicates a contradiction, and therefore that KB entails the original goal sentence.

The shortest proof that I know of is only three lines long. Longer proofs are OK provided they are correct. *Think about it, then find a proof that mirrors how you think. Obviously, the four of them must have had two red fish and two blue fish among them. Obviously, if Amy, Cindy, and Diane had two red fish among them, then Betty must have had a blue fish.*

Resolve (A C) with ((¬ C) (¬ D)) to produce: (A (¬ D))

Resolve (A (¬ D)) with (A D) to produce: (A)

Resolve (B) with ((¬ A) (¬ B)) to produce: (¬ A)

Resolve (A) with (¬ A) to produce: ( )

It is OK if you omitted the parentheses.

Resolve ______ with ______ to produce: ______

Resolve ______ with ______ to produce: ______

Resolve ______ with ______ to produce: ______

Resolve ______ with ______ to produce: ______

Resolve ______ with ______ to produce: ______

Resolve ______ with ______ to produce: ______

Twenty-nine bright and clever students found a 3-line proof shorter than I had been able to find. One student found both of the 3-line proofs below.

The first 3-line proof was:

Resolve (A C) with ((¬ B) (¬ C)) to produce: (A (¬ B))

Resolve (A (¬ B)) with ((¬ A) (¬ B)) to produce: (¬ B)

Resolve (¬ B) with (B) to produce: ( )

The second 3-line proof was:

Resolve (A C) with ((¬ A) (¬ B)) to produce: ((¬ B) C)

Resolve ((¬ B) C) with ((¬ B) (¬ C)) to produce: (¬ B)

Resolve (¬ B) with (B) to produce: ( )