CS-171, Intro to A.I. — Quiz #3 — Fall Quarter, 2017 — 20 minutes

YOUR NAME AND EMAIL ADDRESS: _____

YOUR ID: ______ ID TO RIGHT: ______ ROW #: _____ SEAT #: _____

1. (**42 pts total, 6 pts each**) **PROBABILITY FORMULAS.** Write out the following probability formulas. Below, "in terms of X" means X should appear in your answer. All answers should be formulas, not text.

1.a. (6 pts) Write the formula for $P(A \land B)$ in terms of $P(A \lor B)$ and possibly other terms.

 $P(A \land B) =$

1.b. (6 pts) Write the formula for the conditional probability P(A | B).

 $P(A \mid B) =$

1.c. (6 pts) Factor $P(A \land B \land C)$ completely using the Product Rule (or Chain Rule). You may use any variable ordering you wish.

 $P(A \land B \land C) =$

1.d. (6 pts) Given a joint probability distribution $P(A \land B \land C)$, use the Sum Rule (or Law of Total Probability) to write the marginal probability of P(A).

 $\mathbf{P}(\mathbf{A}) =$

1.e. (6 pts) Write Bayes' Rule (or Bayes' Theorem).

P(A | B) =

1.f. (6 pts) Assume that A and B are independent. Write $P(A \land B)$ in terms of P(A) and P(B) and possibly other terms.

 $P(A \land B) =$

1.g. (6 pts) Assume that A and B are conditionally independent given C. Write $P(A \land B | C)$ in terms of P(A | C) and P(B | C) and possibly other terms.

 $P(A \land B \mid C) =$

**** TURN PAGE OVER AND CONTINUE ON THE OTHER SIDE ****

2. (40 points total, 5 pts each) English to FOL Sentences. For each of the given English sentences below, write <u>C</u> if the FOL sentence <u>Correctly</u> expresses the English sentence; write <u>I</u> if it is syntactically <u>Invalid</u> and therefore meaningless; or <u>N</u> if it it is syntactically valid but does <u>Not</u> correctly express the English sentence. Note that \land is a stronger operator than is \Rightarrow . The first one is done for you as an example.

2.Example. "Paris and Marseilles are both in France."

A. (Example) I (Write C or I or N) $In(Paris \land Marseilles, France)$ $Paris \land Marseilles is a conjunction of terms, not a conjunction of truth values, and so is syntactically Invalid.$ $B. (Example) C (Write C or I or N) <math>In(Paris, France) \land In(Marseilles, France)$ Correct. Paris is in France, <u>AND</u> Marseilles is in France, $C. (Example) N (Write C or I or N) <math>In(Paris, France) \lor In(Marseilles, France)$ This sentence says that Paris is in France OR Marseilles is in France, a disjunction instead of a conjuction.

2.a. (20 pts total, 5 pts each) "There is a country that borders both Iraq and Pakistan."

2.b. (20 pts total, 5 pts each) "All countries that border Ecuador are in South America."

A. (5 pts)	(Write C or I or N) $\forall c \ Country(c) \land Borders(c, Ecuador) \Rightarrow In(c, SouthAmerica)$
B. (5 pts)	(Write C or I or N) $\forall c \ Country(c) \Rightarrow [Borders(c, Ecuador) \Rightarrow In(c, SouthAmerica)]$
C. (5 pts)	(Write C or I or N) $\forall c \ [Country(c) \Rightarrow Borders(c, Ecuador)] \Rightarrow In(c, SouthAmerica)$
D. (5 pts)	(Write C or I or N) $\forall c \ Country(c) \land Borders(c, Ecuador) \land In(c, SouthAmerica)$

3. (18 pts total, 3 pts each) LOGIC CONCEPTS. For each of the following terms on the left, write in the letter corresponding to the best answer or definition on the right. The first one is done for you as an example.

	. A .	Agent	. A .	Perceives environment by sensors, acts by actuators.
		Unsatisfiable	В	Describes a sentence that is true in all models.
		Sound	С	Describes a sentence that is false in all models.
		Complete	D	An inference procedure that derives only entailed sentences.
		Valid	Е	Describes a sentence that is true in some model.
		Satisfiable	F	The idea that a sentence follows logically from other sentences.
		Entailment	G	An inference procedure that derives all entailed sentences.