This assignment will be graded anonymously, so please don't list your name, but only your MAC ID.

As noted by the syllabus as well as in class, the scope and content of assignments are set by lectures, instead of any specific textbook. Please beware that different textbooks may use different symbolism or definitions. Lemmon's as a very old textbook, for example, uses soundness and validity differently from the lectures.

Assignments are meant to be challenging! It's okay if you don't know the answers right away. In that case, **first look at your class notes, notes posted in the shared folder, or textbooks**. Try different answers to see if anything works. You are encouraged to discuss your answers with other students (but write up your own answers individually).

1. (1 point) Is $\exists x(F(x) \rightarrow G(x))$ is adequate for symbolizing "some F are G"? If not, why not? Is $\forall x(F(x) \wedge G(x))$ is adequate for "all F are G"? If not? Explain as we did in class.

2. (1 point) Which of the following expressions has a free variable? Identify the free variable if there is one. Assume **F( )** is a one-place predicate, and **G( )** is a two-place predicate.

(1) $F(a)$

(2) $F(x)$

(3) $G(x, a)$

(4) $\exists x F(x)$

(5) $\forall x G(x, a)$

(6) $\forall x G(x, y)$

(7) $\forall x(F(x) \rightarrow G(x, a))$

(8) $\forall x F(x) \rightarrow G(x, a)$

(9) $\forall x F(x) \rightarrow \forall x G(x, a)$

(10) $\forall x(F(x) \rightarrow G(x, y))$

3. (3 points) Formalize the following sentences in predicate logic—use quantifiers if needed. You can use one-letter notations for predicates and individual names; specify what they stand for. Indicate cases of ambiguity and formalize the various readings.

(1) Nothing is tasty.

(2) Not everything is tasty.

(3) All physical objects are subject to gravity.

(4) Everyone is happy.

(5) Some birds can fly.

(6) Some dogs don't bark.

(7) Some mammals lay eggs, and some mammals do not.

(8) No cute animal is gonna survive in the desert.

(9) Not every baby cries in the middle of the night.

(10) There are no Martians.

(11) All students who like Jack do not like Harry.

(12) "There are some who remain proud and fierce even in hell." (Fyodor Dostoevsky, *The Brothers Karamazov*)

Give the following a try. We'll do similar exercises in class on Dec. 2; you can finish these afterward.

(13) Everyone loves someone.

(14) There is at least one person who knows everyone.

(15) Only Martians are aliens.

Optional:

(16) All and only Martians are aliens.

(17) Every happy dog is liked by some happy human.

(18) Someone is not taller than Steve.

(19) Abe owns a house which no one likes.

(20) Bonnie will not show up unless some friend of hers does.

(21) No one means all he says.

4.(Optional) Translate the following sentences, using predicates, **individual constants**, and connectives. The translation is to be based on the assumption that the sentences are interpreted in a universe consisting of six people: Jack, David, and Harry are American; Claire, Ann, and Edith are Canadian. (Please do **not use quantifiers** yet.)

When you find a sentence ambiguous, give its possible translations and explain their non-equivalence by showing the existence of interpretations under which they get different truth-values.

(1) Some Canadians, who do not like themselves, like David.

(2) Claire likes an American who likes Edith.

(3) Unless liked by a Canadian, no American is happy.

5. (Optional) Formalize the following sentences in predicate logic.

(1) Claire and Edith like the same person.

(2) Harry likes a woman who likes all happy cats.

(3) Some people likes all women who like themselves.

(4) Ann is liked by every comedian who likes some old movies.

(5) Each state can have for enemies only other states, and not men.

(6) You can fool some of the people all the time, or all the people some of the time, but you cannot fool all people all time.

(7) Someone says all he means.

(8) Unless liked by a voter, no politician is happy.

(9) "Some of them lived nobly and showed great qualities of soul, nevertheless they have lost their empire or have been killed by subjects who have conspired against them." (Machiavelli, *The Prince*)