# CS 171, Intro to A.I., Winter Quarter, 2020 — Quiz # 2 — 25 minutes

NAME: _____ UCINetID _____

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

**NOTE:** For this quiz, each point value is stated as **(M pts, blank=N)** where N is the expected value of random guessing. If you don't know the answer, you can leave it blank and receive N points. The intent is to discourage random guessing. Your expected performance measure is the same whether you guess or not, because N was chosen that way. However, leaving it blank has a lower variance than guessing, and so a more reliable score.

**1. (30 pts, blank=15) CNF.** Convert the following sentence to CNF. **SHOW YOUR WORK.**

$A \Leftrightarrow (B \wedge C)$

**2. (30 pts total, 5 pts each; blank=15 pts total, 2.5 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."

| | | | |
|---|---|---|---|
| . . | $\forall b \exists f$ Butterfly(b) $\Rightarrow$ [ Flower(f) $\wedge$ FeedsOn(b, f) ] | A | Every butterfly feeds on every flower. |
| | $\exists f \forall b$ Flower(f) $\wedge$ [ Butterfly(b) $\Rightarrow$ FeedsOn(b, f) ] | B | For every flower, there is some butterfly who feeds on that flower. |
| | $\forall f \exists b$ Flower(f) $\Rightarrow$ [ Butterfly(b) $\wedge$ FeedsOn(b, f) ] | C | There is some butterfly who feeds on some flower. |
| | $\exists b \forall f$ Butterfly(b) $\wedge$ [ Flower(f) $\Rightarrow$ FeedsOn(b, f) ] | D | For every butterfly, there is some flower that the butterfly feeds on. |
| | $\forall b \forall f$ [ Butterfly(b) $\wedge$ Flower(f) ] $\Rightarrow$ FeedsOn(b, f) | E | There is some butterfly who feeds on every flower. |
| | $\exists b \exists f$ Butterfly(b) $\wedge$ Flower(f) $\wedge$ FeedsOn(b, f) | F | There is some flower that every butterfly feeds on. |

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**3. (40 pts, blank=20) Resolution Theorem Proving.** Your Knowledge Base (KB) is:

A  $A \Rightarrow (B \vee C)$  $B \Rightarrow D$  $(C \vee D) \Rightarrow F$

You are asked to prove that F is true, that is, your query sentence is F. In CNF your KB plus negated query is:

A  $(\neg A \vee B \vee C)$  $(\neg B \vee D)$  $(\neg C \vee F)$  $(\neg D \vee F)$  $\neg F$

Obviously, F must be true. **Produce a Resolution Proof that F is true, ending with ( ) to indicate a contradiction.** The first one is done for you as an example. *Think about it, then find a proof that mirrors how you think.*

The shortest proof I know of is only five lines long. Longer proofs are OK provided they are correct. It is OK if you omit the logical OR connectives ($\vee$) in your answer; we know they are there.

Resolve A with $(\neg A \vee B \vee C)$ to produce: $(B \vee C)$

Resolve _____ with _____ to produce: _____

Resolve _____ with _____ to produce: _____

Resolve _____ with _____ to produce: _____

Resolve _____ with _____ to produce: _____

Resolve _____ with _____ to produce: _____

Resolve _____ with _____ to produce: _____

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**Scratch Paper (1) Please Do Not Detach from Test**

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**Scratch Paper (2) Please Do Not Detach from Test**