

CSI 30, Homework 4 on Section 1.4

Due by Wed, Sept 30.

Please use lots of space and explain your answers, showing clearly any work you had to do. Each question is worth 3 points.

Section 1.4 Predicates and quantifiers, continued

De Morgan's laws:

$$\begin{array}{ll} \neg(P \wedge Q) \equiv \neg P \vee \neg Q & \neg(\forall x P(x)) \equiv \exists x \neg P(x) \\ \neg(P \vee Q) \equiv \neg P \wedge \neg Q & \neg(\exists x P(x)) \equiv \forall x \neg P(x) \end{array}$$

- (1) Let $P(x)$ say " $x^2 = 9$ " and let $Q(x)$ say " $x \geq 1$ ". Let the domain of discourse be the integers. Find the truth values of these statements and explain your answers.
- (a) $\forall x Q(x)$
 - (b) $\exists x (P(x) \wedge Q(x))$
 - (c) $\forall x (P(x) \vee \neg P(x))$
- (2) Translate these sentences into logical expressions using quantifiers and propositional functions. Make sure you say what the domain of discourse is.
- (a) All fish can swim.
 - (b) Someone in this class speaks Japanese.
 - (c) Everyone in this class speaks Japanese or does not enjoy logic questions.
- (3) For each part of Question 2, write the negation of each statement with propositions and quantifiers using De Morgan's laws so that no negation is to the left of a quantifier.
- (4) Express your negations in Question 3 in simple English in your own words.
(Hint: the first negation should be "There exists a fish that cannot swim".)
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If you're stuck on a question:

- Ask me about it after class.
- Come to my office hours: Mon 12:00 - 1:00, Wed 12:00 - 1:00 in CP 317.
- Go to the Math Tutorial Lab in-person in CP 303 or online.