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Section 1.5

4. Let  $P(x, y)$  be the statement “Student  $x$  has taken class  $y$ ,” where the domain for  $x$  consists of all students in your class and for  $y$  consists of all computer science courses at your school. Express each of these quantifications in English.

- a)  $\exists x \exists y P(x, y)$                       b)  $\exists x \forall y P(x, y)$                       c)  $\forall x \exists y P(x, y)$   
 d)  $\exists y \forall x P(x, y)$                       e)  $\forall y \exists x P(x, y)$                       f)  $\forall x \forall y P(x, y)$

10. Let  $F(x, y)$  be the statement “ $x$  can fool  $y$ ,” where the domain consists of all people in the world. Use quantifiers to express each of these statements.

- a) Everybody can fool Fred.  
 b) Evelyn can fool everybody.  
 c) Everybody can fool somebody.  
 d) There is no one who can fool everybody.  
 e) Everyone can be fooled by somebody.  
 f) No-one can fool both Fred and Jerry.  
 g) Nancy can fool exactly two people.  
 h) There is exactly one person whom everybody can fool.  
 i) No one can fool himself or herself.  
 j) There is someone who can fool exactly one person besides himself or herself.

26. Let  $Q(x, y)$  be the statement “ $x+y=x-y$ .” If the domain for both variables consists of all integers, what are the truth values?

- a)  $Q(1, 1)$                                   b)  $Q(2, 0)$                                   c)  $\forall y Q(1, y)$   
 d)  $\exists x Q(x, 2)$                               e)  $\exists x \exists y Q(x, y)$                           f)  $\forall x \exists y Q(x, y)$   
 g)  $\exists y \forall x Q(x, y)$                           h)  $\forall y \exists x Q(x, y)$                           i)  $\forall x \forall y Q(x, y)$

30. Rewrite each of these statements so that negations appear only within predicates (that is, so that no negation is outside a quantifier or an expression involving logical connectives).

- a)  $\neg \exists y \exists x P(x, y)$                           b)  $\neg \forall x \exists y P(x, y)$   
 c)  $\neg \exists y (Q(y) \wedge \forall x \neg R(x, y))$               d)  $\neg \exists y (\exists x R(x, y) \vee \forall x S(x, y))$   
 e)  $\neg \exists y (\forall x \exists z T(x, y, z) \vee \exists x \forall z U(x, y, z))$

Section 1.6

4. What rule of inference is used in each of these arguments?

- a) Kangaroos live in Australia and are marsupials. Therefore, kangaroos are marsupials.
- b) It is either hotter than 100 degrees today or the pollution is dangerous. It is less than 100 degrees outside today. Therefore, the pollution is dangerous.
- c) Linda is an excellent swimmer. If Linda is an excellent swimmer, then she can work as a lifeguard. Therefore, Linda can work as a lifeguard.
- d) Steve will work at a computer company this summer. Therefore, this summer Steve will work at a computer company or he will be a beach bum.
- e) If I work all night on this homework, then I can answer all the exercises. If I answer all the exercises, I will understand the material. Therefore, if I work all night on this homework, then I will understand the material.

10. For each of these sets of premises, what relevant conclusion or conclusions can be drawn? Explain the rules of inference used to obtain each conclusion from the premises.

- a) "If I play hockey, then I am sore the next day." "I use the whirlpool if I am sore." "I did not use the whirlpool."
- b) "If I work, it is either sunny or partly sunny." "I worked last Monday or I worked last Friday." "It was not sunny on Tuesday." "It was not partly sunny on Friday."
- c) "All insects have six legs." "Dragonflies are insects." "Spiders do not have six legs." "Spiders eat dragonflies."
- d) "Every student has an Internet account." "Homer does not have an Internet account." "Maggie has an Internet account."
- e) "All foods that are healthy to eat do not taste good." "Tofu is healthy to eat." "You only eat what tastes good." "You do not eat tofu." "Cheeseburgers are not healthy to eat."
- f) "I am either dreaming or hallucinating." "I am not dreaming." "If I am hallucinating, I see elephants running down the road."

16. For each of these arguments determine whether the argument is correct or incorrect and explain why.

- a) Everyone enrolled in the university has lived in a dormitory. Mia has never lived in a dormitory. Therefore, Mia is not enrolled in the university.
- b) A convertible car is fun to drive. Isaac's car is not a convertible. Therefore, Isaac's car is not fun to drive.
- c) Quincy likes all action movies. Quincy likes the movie *Eight Men Out*. Therefore, *Eight Men Out* is an action movie.
- d) All lobstermen set at least a dozen traps. Hamilton is a lobsterman. Therefore, Hamilton sets at least a dozen traps.

24. Identify the error or errors in this argument that supposedly shows that if  $\forall x(P(x) \vee Q(x))$  is true then  $\forall xP(x) \vee \forall xQ(x)$  is true.

1.  $\forall x(P(x) \vee Q(x))$      Premise
2.  $P(c) \vee Q(c)$          Universal instantiation from (1)
3.  $P(c)$                      Simplification from (2)
4.  $\forall xP(x)$                  Universal generalization from (3)
5.  $Q(c)$                      Simplification from (2)
6.  $\forall xQ(x)$                  Universal generalization from (5)
7.  $\forall xP(x) \vee \forall xQ(x)$    Addition from (4) and (6)

30. Show that the hypotheses “Allen is a bad boy or Hillary is a good girl” and “Allen is a good boy or David is happy” imply the conclusion “Hillary is a good girl or David is happy.”