

## Homework #3: Chapters 7 and 8

The following exercises are due at the beginning of class on Friday, March 2.

1. [25 pts.] Consider a knowledge base  $KB$  that contains the following propositional logic sentences:

$$\begin{aligned} Q &\Rightarrow P \\ P &\Rightarrow \neg Q \\ Q &\vee R \end{aligned}$$

- Construct a truth table that shows the truth value of each sentence in  $KB$  and indicate the models in which the  $KB$  is true.
  - Does  $KB$  entail  $R$ ? Use the definition of entailment to justify your answer.
  - Does  $KB$  entail  $R \Rightarrow P$ ? Extend the truth table and use the definition of entailment to justify your answer.
  - Does  $KB$  entail  $\neg Q \wedge R$ ? Extend the truth table and use the definition of entailment to justify your answer.
2. [10 pts. total] In propositional logic, does an empty knowledge base (i.e., a knowledge base with no sentences in it) entail anything? Explain your answer.
3. [35 pts.] Building on the kinship domain (p. 254), use first-order logic to write axioms defining the binary (i.e., having arity 2) predicates *Daughter*, *Son*, *Wife*, *GrandChild*, *GreatGrandParent*, *Brother*, *Sister*, *Aunt*, *Uncle*, and *FirstCousin*. Here, a predicate of form  $Predicate(x,y)$  should be read in English as “ $x$  is the  $Predicate$  of  $y$ .” Only use these predicates and the predicates defined on p. 254-255 of the book in your definitions. Try to ensure that your definitions are as complete as possible without leading to false inferences. You may want to refer to a dictionary to ensure that you understand the full meaning of terms like aunt, uncle and first cousin.
4. [20 pts. total] Represent the following sentences in first order logic, assuming that the domain consists only of people. The only predicates you may use are  $loves(x,y)$ ,  $knows(x,y)$ , and  $avoids(x,y)$ , where a predicate of form  $Predicate(x,y)$  means that “ $x$   $Predicate$   $y$ .” Choose meaningful constants where appropriate.
- Somebody knows and loves Tim.
  - Everybody who knows Sue avoids Sue.
  - There is somebody that everybody loves.
  - Nobody knows everybody.
  - There are some people who love nobody but themselves.
5. [10 pts.] Write down a first-order logic sentence such that every world in which it is true contains exactly one object in its domain.