

CS470, Fall 2017

Homework 2. Logic

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1 Reminder

In this homework, a set of problems about propositional logic and first-order logic is given in the following sections. Solve the given set of problems and submit a report with your solutions via KLMS as a PDF attachment. The PDF file should be named *cs470_hw02_name.pdf* where *name* is replaced by your full name.

This is an individual assignment. You are allowed to use any previously written source in preparing your answers, but if you use any other sources than the textbook and the class notes, you should specify it on your assignment.

2 Problems on Propositional Logic

Problem 1. [10 points] Select all of the propositions from the following list:

- (a) Write your names on the note.
- (b) Where do you come from?
- (c) Look out for that horse!
- (d) Jeju Island is the largest island off the coast of the Korean Peninsula.
- (e) Jupiter is the closest planet to the Sun.
- (f) if $x = 0$ then $x^2 = 0$.
- (g) $x + 9 = 0$

Problem 2. [20 points] Construct truth tables for each of the following propositions. Keep in mind that it may be useful to record the truth values of intermediate expressions as well (e.g., when constructing a truth table for $(q \wedge r) \Rightarrow \neg j$, it may be helpful to first write down the truth values for $q \vee r$).

- (a) $(p \vee q) \Rightarrow (p \wedge q)$
- (b) $(\neg p \Leftrightarrow \neg q) \Leftrightarrow (p \Leftrightarrow q)$
- (c) $(p \Leftrightarrow q) \vee (\neg q \wedge \neg r)$

Problem 3. [30 points] Each item below offers a pair of compound propositions. In each case, prove whether the two are logically equivalent (i.e., prove by deriving one to another by equivalence rules such as De Morgan: $\neg(\alpha \wedge \beta) \equiv (\neg\alpha \vee \neg\beta)$). If they are not, give a truth table that show the two compound propositions have different truth values.

(a) $r \rightarrow (p \vee \neg q), \neg(p \wedge \neg q \wedge r)$

(b) $(p \vee q) \rightarrow (\neg p \vee \neg q), p \rightarrow \neg q$

(c) $p \rightarrow (\neg q \rightarrow r), \neg r \rightarrow p$

3 Problems on First-Order Logic

Problem 4. [10 points] Represent the following sentences in first-order logic using quantifiers. Remember to define a consistent vocabulary and write its semantics in English.

- (a) Some AI topics are symbolic.
- (b) Only one CS class is named “Introduction to Artificial Intelligence”.
- (c) Everybody who takes CS470 needs to take two exams.

Problem 5. [30 points] Using resolution with refutation, construct the resolution tree to show that the given query can be inferred from the given knowledge base.

- Knowledge base:
 - $\forall x \text{ Elephant}(x) \vee \text{ Giraffe}(x) \vee \text{ Ostrich}(x) \Rightarrow \text{Mammal}(x)$
 - $\forall x, y \text{ Offspring}(x, y) \wedge \text{ Elephant}(y) \Rightarrow \text{Elephant}(x)$
 - $\text{Elephant}(\text{Rocky})$
 - $\text{Parent}(\text{Rocky}, \text{Cooper})$
 - $\forall x, y \text{ Offspring}(x, y) \Leftrightarrow \text{Parent}(y, x)$
 - $\forall x \text{ Mammal}(x) \Rightarrow \exists y \text{ Parent}(y, x)$
- Query: $\text{Elephant}(\text{Cooper})$