

COMP 3211 2015 Spring Semester Assignment #3

Date assigned: Monday, May 4, 2015

Due time and place: 17:00 on Monday, May 11, in a collection box outside Rm4215

Penalties on late papers: 20% off each day (anytime after the due time is considered late by one day)

Problem 1 (12 pts) Given the following, can you prove that the unicorn is mythical? How about magical? Horned?

If the unicorn is mythical, then it is immortal, but if it is not mythical, then it is a mortal mammal. If the unicorn is either immortal or a mammal, then it is horned. The unicorn is magical if it is horned.

Problem 2 (15 pts) *The lady or the tiger?* There are two rooms. Each of them is occupied by either a tiger or a lady, but not both. There is also a sign on the door of each room. One of the signs is true, but the other is false. Here are the signs:

Room I

In this room there is a lady,
and in the other room there is a tiger

Room II

In one of these rooms there is a lady,
and in one of these rooms there is a tiger

Solve this problem in propositional logic: write down the given facts as sentences, and then prove by refutation using resolution either a lady is in room 1 or a lady is in room 2.

Problem 3 (12 pts) For each of the following, does the consequence follow from the premises? If yes, then prove it by resolution with refutation; if no, then give a counter-example (an assignment that satisfies the premises but not the consequence).

1. Premises: $\{p \vee q, p \supset r, q \supset r\}$. Consequence: r .
2. Premises: $\{p \supset s, q \supset s, r \supset s\}$. Consequence: $(p \wedge q) \supset r$.
3. Premises: $\{p \supset s, q \supset s, s \supset r\}$. Consequence: $(p \wedge q) \supset r$.

Problem 4 (15 pts) Represent the following sentences in first-order logic, using a consistent vocabulary (which you must define):

- a. Not all students take both History and Biology.
- b. Only one student failed History.
- c. Every person who dislikes all vegetarians is smart.
- d. No person likes a smart vegetarian.

- e. There is a student who does homework for those and only those who do not do homework for themselves.

Problem 5 (9 pts) Convert the following to clause form:

1. $(\exists x P(x) \vee \exists x Q(x)) \supset \exists x (P(x) \vee Q(x))$.
2. $\forall x [P(x) \supset \forall y [\forall z Q(x, y) \supset \neg \forall z R(y, x)]]$.
3. $\forall x P(x) \supset \exists x [\forall z Q(x, z) \vee \forall z R(x, y, z)]$.

Problem 6 (12 pts) Sam, Clyde, and Oscar are elephants. We know the following facts about them:

1. Sam is pink.
2. Clyde is gray and likes Oscar.
3. Oscar is either pink or gray (but not both) and likes Sam.

Use resolution refutation to prove that a gray elephant likes a pink elephant; that is, prove $\exists x, y [Gray(x) \wedge Pink(y) \wedge Likes(x, y)]$.

Problem 7 (12 pts) Consider a company in Hong Kong that decides whether to hire someone based on the following features:

- UST: true if the applicant graduated from HKUST.
- HKU: true if the applicant graduated from HKU.
- CU: true if the applicant graduated from CU.
- GPA: true if the applicant received good grades in school.
- REC: true if the applicant got good recommendation letters.
- EXP: true if the applicant had prior experience in related jobs.

Suppose that you're hired by the company to develop a system that will help the company to decide whom to hire, and are given the following examples from the company's hiring record:

Example	Attributes						Hire?
	GPA	UST	HKU	CU	REC	EXP	
1	1	0	1	0	1	1	1
2	1	1	0	0	0	0	0
3	1	0	1	0	1	1	1
4	1	1	0	0	1	0	1
5	1	0	0	1	1	1	1
6	1	0	0	1	1	0	0
7	1	0	1	0	1	0	0
8	0	1	0	0	0	1	0
9	0	0	1	0	0	0	0
10	0	0	0	1	1	0	0
11	0	0	0	1	1	0	0

Use GSCA to learn a set of rules from these examples about when to hire an applicant based on the values of the given attributes.

Problem 8 (13 pts)

There are three balls and two baskets. Each basket can hold only one ball. Use propositional logic to prove that it is impossible to put the three balls into the two baskets: write down the constraints as sentences, convert them into clauses, and then derive the empty clause from them using resolution.