COMP5211 2020 Fall Semester Assignment #3 - Written Exercise

The following questions cover KR&R, reasoning under uncertainty, and game theory. These are just for your exercise to prepare for the final exam. There is no need to hand it in. A model solution will be released around Dec 7.

Problem 1 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 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 3 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 4 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.

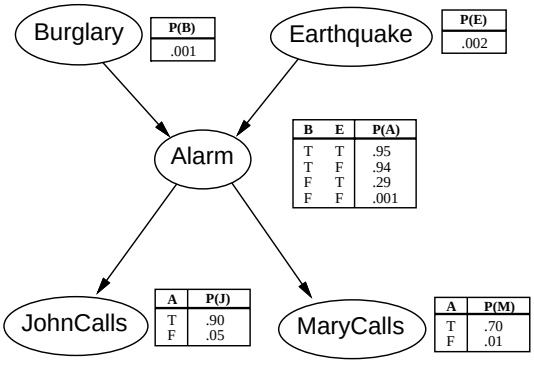
Suppose that you're hired by the company to develop a system that will help the compnay to decide whom to hire, and are given the following examples from the company's hiring record:

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

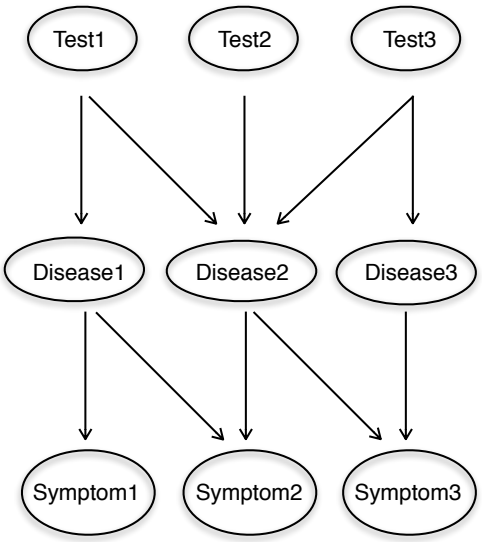
Use GSCA to learn a set of rules from these examples about when to hire an applicant based on the values of the given attributes.

Problem 5

Compute the probablity of $JohnCalls$ given $MaryCalls$ in the following network:



Problem 6 Consider the following belief network about blood tests (positive or negative), diseases, and symptoms:



For the following first three questions, explain your answers, but for the last two, just give your answers. To explain your answers: if yes, either show the d-separation by enumerating all undirected paths between the two variables in question or pointing out an obvious pattern in all such paths; and if no, give a path showing that the d-separation is not true;

1. Are `Test1` and `Test2` independent?
2. Are `Disease1` and `Disease2` independent?
3. Are `Disease1` and `Disease3` independent?
4. Describe set E under which `Disease1` and `Disease2` are conditionally independent.
5. Describe set E under which `Disease1` and `Disease3` are conditionally independent.

Problem 7 (Russell and Norvig) The following payoff matrix shows a game between politicians and the Federal Reserve in the US:

	Fed: contract	Fed: do nothing	Fed: expand
Pol: contract	1,7	4,9	6,6
Pol: idle	2,8	5,5	9,4
Pol: expand	3,3	7,2	8,1

The politicians can expand (increase spending) or contract (cut spending) fiscal policy (or stay idle), while the Fed can expand (lower interest rate) or contract (increase interest rate) monetary policy (or do nothing). Find the Nash equilibria of this game.

problem 8 Consider an auction by first price with two agents, with ties broken randomly. It's a common knowledge that both agents have value 6 for the item, and they bid only positive integers up to their value. Formulate this auction as a game and find all Nash equilibria if there is any.