小班讨论三

Readings: AIMA Chapter 9 & 13 & 14

1. Two English sentences "Anyone who takes an AI course is smart" and "Any course that teaches an AI topic is an AI course" have been represented in first-order logic:

$$\forall x\ (\exists y\ \text{AI course}(y) \wedge \text{Takes}(x,\ y))\ ) \Rightarrow \text{Smart}(x)$$

$$\forall x\ (\exists y\ \text{AI topic}(y) \wedge \text{Teaches}(x,\ y))\ ) \Rightarrow \text{AI course}(x)$$

It is also known that John takes CS3243 and CS3243 teaches Inference which is an AI topic.Represent these facts as first-order logic sentences. Now convert all first-order logic sentences into conjunctive normal form and use resolution to prove that "John is smart."

2. An atheist asked two knowledge engineers to write a rule to say that "Nothing is divine." The first engineer wrote $\exists x$ Divine(x) and transformed it into the following clause:

$$\neg\neg \text{Divine}(G1)$$

where G1 is a Skolem constant. The second engineer wrote $\forall x\ \neg$Divine(x) and transformed it into the following clause:

$$\neg\neg\neg \text{Divine}(x)$$

Why did they produce two different versions? Which version is correct?

3. (Slightly modified from Question 9.24 of AIMA) Here are two sentences in the language of first-order logic:

(A): $\forall x \exists y\ (x \geq y)$

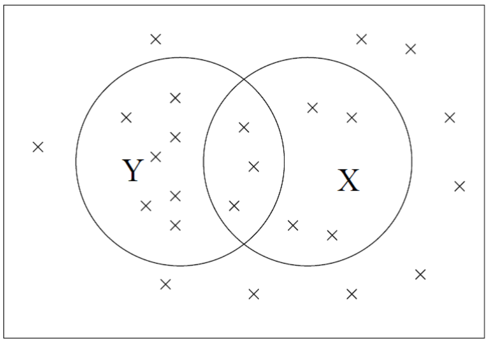
(B): $\exists y \forall x\ (x \geq y)$

(a) Assume that the variables range over all the natural numbers 0, 1, 2, … and that the ">" predicate means "is greater than or equal to." Under this interpretation, translate (A) and (B) into English.

(b) Is (A) true under this interpretation? Is (B) true under this interpretation?

(c) Does (A) logically entail (B)? Does (B) logically entail (A)? Justify your answers.

4. Based on the following Venn diagram, complete the joint probability distribution in the table on its right.



	X	$\neg X$
Y	$\frac{3}{24}$	
$\neg Y$		

Based on the joint probability distribution, find the following: P(X), P(Y), P(¬X), P(¬Y), P(X|Y), P(Y|X), P(X|¬Y), P(¬Y |X), P(¬X|Y), P(Y |¬X), P(¬X|¬Y) and P(¬Y |¬X). Substituting the values of these conditional probabilities, verify the following:

P(X|Y) = 1-P(¬X|Y)

P(X|¬Y) = 1-P(¬X|¬Y)

P(¬Y|X) =P(X|¬Y)P(¬Y)/P(X|¬Y)P(¬Y) + P(X|Y)P(Y)

5. Assume that 2% of the population in a country carry a particular virus. A test kit developed by a pharmaceutical firm is able to detect the presence of the virus from a patient' s blood sample. The firm claims that the test kit has a high accuracy of detection in terms of the following conditional probabilities obtained from their quality control testing:

P(the kit shows positive | the patient is a carrier) = 0.998

P(the kit shows negative | the patient is not a carrier) = 0.996

If a patient is tested to be positive using this kit, what is the likelihood of a false positive (i.e., that he actually is not a carrier but the kit shows positive)?

6. (Question 13.12 from AIMA) Show that the three forms of independence below:

(a) $P(a|b) = P(a)$
(b) $P(b|a) = P(b)$
(c) $P(a \wedge b) = P(a)P(b)$

are equivalent.

7. Assume that the following conditional probabilities are available:

$P(\text{Wet\_Grass} \mid \text{Sprinkler} \wedge \text{Rain})$	0.95
$P(\text{Wet\_Grass} \mid \text{Sprinkler} \wedge \neg \text{Rain})$	0.9
$P(\text{Wet\_Grass} \mid \neg \text{Sprinkler} \wedge \text{Rain})$	0.8
$P(\text{Wet\_Grass} \mid \neg \text{Sprinkler} \wedge \neg \text{Rain})$	0.1
$P(\text{Sprinkler} \mid \text{Rainy\_Season})$	0.0
$P(\text{Sprinkler} \mid \neg \text{Rainy\_Season})$	1.0
$P(\text{Rain} \mid \text{Rainy\_Season})$	0.9
$P(\text{Rain} \mid \neg \text{Rainy\_Season})$	0.1
$P(\text{Rainy\_Season})$	0.7

Construct a Bayesian network and determine the probability

$P(\text{Wet Grass} \wedge \text{Rainy Season} \wedge \neg\text{Rain} \wedge \neg\text{Sprinkler})$.