COMP30024 Artificial Intelligence - Tutorial Problems (Part 4)

Questions based on exercises from Russell and Norvig (3rd edition) have the original question numbers shown in brackets. Many of these questions are designed to provoke discussion in tutorials, rather than having a simple, closed-form answer.

8. *Uncertainty*

8.1 (RN13.8) Given the full joint distribution shown in the lecture notes for **P**(*Cavity, Toothache, Catch*), calculate the following:

a. *P*(*toothache*)
b. **P**(*Cavity*)
c. **P**(*Toothache* | *cavity*)
d. **P**(*Cavity* | *toothache* $\vee$ *catch*)

8.2 (RN13.15) After your yearly checkup, the doctor has bad news and good news. The bad news is that you tested positive for the serious disease Leckieitis, and the test is 99% accurate (i.e., the probability of testing positive given that you have the disease is 0.99, as is the probability of testing negative if you don't have the disease). The good news is that this is a rare disease, striking only one in 10,000 people.

a. Why is it good news that the disease is rare?
b. What are the chances that you actually have the disease?

8.3 (RN14.21, adapted from Pearl 1988) You are a witness to a night-time hit-and-run accident involving a taxi in Athens. All taxis in Athens are blue or green. You swear under oath that the taxi was blue. Extensive testing shows that under the dim lighting conditions, discrimination between blue and green is 75% reliable.

a. Is it possible to calculate the most likely colour for the taxi? (Hint: distinguish carefully between the proposition that the taxi is blue and the proposition that it appears blue)
b. What if you are given the extra information that 9 out of 10 Athenian taxis are green?

9. *Probabilistic Reasoning*

9.1 (RN14.1) We have a bag of three biased coins *a*, *b* and *c* with probabilities of coming up heads of 0.2, 0.6 and 0.8, respectively. One coin is drawn randomly from the bag (with equal likelihood of drawing each of the three coins), and then the chosen coin is flipped three times to the generate outcomes X_1, X_2 and X_3.

a. Draw the Bayesian network corresponding to this setup, and define the necessary conditional probability tables.
b. Calculate which coin was most likely to have been drawn from the bag if the observed flips come out heads twice and tails once.
c. Can you think of a practical application where this type of model could be useful?

9.2 (based on RN14.4) Consider the alarm network from the lecture slides.

a. If we observe *Alarm* = *true*, are *Burglary* and *Earthquake* independent? Justify your answer by calculating whether the probabilities involved satisfy the definition of conditional independence.
b. You are driving to work, and you hear on the car radio that a minor earthquake has just occurred near your home. When you get to work, you see that John tried to call you, but left no message. There has been no call from Mary. How would you calculate the probability of a burglary having occurred given the above information?

9.3 (based on RN14.7) Consider the following simple belief network for diagnosing a car.

a. What conditional probability tables would you need to provide use this network, and what is the minimum number of entries you would need to specify in these tables?
b. Assume that the car does not start, but the radio works. How would you calculate the probability that the car is out of petrol?