CMPT 310 - Artificial Intelligence Survey

Assignment 4

Due date: Dec 5, 2016
10 marks

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Important Note: Students must work individually on this, and other CMPT 310, assignments. You may not discuss the specific questions in this assignment, nor their solutions with any other student. You may not provide or use any solution, in whole or in part, to or by another student.

You are encouraged to discuss the general concepts involved in the questions in the context of completely different problems. If you are in doubt as to what constitutes acceptable discussion, please ask!

1. (5 marks) Consider the following example:

   > Metastatic cancer is a possible cause of a brain tumor and is also an explanation for an increased total serum calcium. In turn, either of these could cause a patient to fall into an occasional coma. Severe headache could also be explained by a brain tumor.

   (a) Represent these causal links in a belief network. Let a stand for "meta-static cancer", b for "increased total serum calcium", c for "brain tumor", d for "occasional coma", and e for "severe headaches".

   (b) Give an example of an independence assumption that is implicit in this network.

   (c) Suppose the following probabilities are given:

   $$\begin{array}{ll} Pr(a) = .2 & \\ Pr(b|a) = .8 & Pr(b|\overline{a}) = .2 \\ Pr(c|a) = .2 & Pr(c|\overline{a}) = .05 \\ Pr(e|c) = .8 & Pr(e|\overline{c}) = .6 \\ Pr(d|b,c) = .8 & Pr(d|\overline{b},c) = .8 \\ Pr(d|b,\overline{c}) = .8 & Pr(d|\overline{b},\overline{c}) = .05 \end{array}$$

   and assume that it is also given that some patient is suffering from severe headaches, but has not fallen into a coma. Calculate joint probabilities for the 8 remaining possibilities (that is, according to whether a, b, and c are true or false).

   (d) According to the numbers above, the a priori probability that the patient has metastatic cancer is .2. Given that the patient is suffering from severe headaches but has not fallen into a coma, are we now more or less inclined to believe the patient has cancer? Explain.

2. (5 marks) Several years ago there was a great deal of concern in BC about the Fraser River flooding. Consequently the government has hired you to come up with a decision tree for assessing flood risk. You are given the following training data.

Location	Risk	Snow pack	High Temp.	High rain	Population
1	high	med	yes	yes	150K-500K
2	high	high	yes	yes	$<$ 150K
3	med	med	no	yes	150K-500K
4	high	med	no	yes	$<$ 150K
5	low	med	no	yes	$>$ 500K
6	low	med	no	no	$>$ 500K
7	high	high	no	yes	$<$ 150K
8	med	high	no	no	$>$ 500K
9	low	low	no	yes	$>$ 500K
10	low	low	yes	no	$>$ 500K
11	high	low	yes	yes	$<$ 150K
12	med	low	yes	yes	150K-500K
13	low	low	yes	yes	$>$ 500K
14	high	high	yes	yes	150K-500K

The goal is to predict the risk of flooding (high, medium, or low), based on the depth of the snow pack (high, medium or low), whether the temperature has been high or not, whether or not there has been high rainfall, and the size of the community affected.

Construct the optimal decision tree that corresponds to this data. For full marks you should show and explain all steps.