CS161: FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE

Fall 2017
Assignment 8 - Due 11:55pm Sunday, December 3

Please submit your solutions on CCLE. The submitted file should be plain text or a formatted PDF file (no scans or pictures). Text files should have lines no longer than 100 characters and should be well-aligned when viewed with a monospace font. In addition to your solutions file, you will need to submit two .net files as indicated below.

All modeling, learning, sensitivity analysis and inference for this homework should be done using SamIam. You can download SamIam from http://reasoning.cs.ucla.edu/samiam. Included with SamIam are video tutorials on its use.

1. Consider the following problem which was discussed in class:

   > Suppose that we have a patient who was just tested for a particular disease and the test came out positive. We know that one in every thousand people has this disease. We also know that the test is not reliable: it has a false positive rate of 2% and a false negative rate of 5%. Our goal is then to assess our belief in the patient having the disease given that the test came out positive. If we let the propositional variable D stand for the patient has the disease, and the propositional variable T stand for the test came out positive, our goal is then to compute $Pr(D|T)$.

   You may also recall being surprised that $Pr(D|T) \approx 0.045$. The goal of this question is then to identify conditions under which this probability will be no less than .30. You will need to find the answer to this by constructing a Bayesian Network and using the sensitivity analysis engine of SamIam. You need to turn in:

   - Your complete Bayesian network (Structure and CPTs) in test.net file.
   - A constraint on each of the following, which is sufficient to ensure that $Pr(D|T) \geq 0.3$: The prior probability of having the disease, the false positive for the test, and the false negative for the test.

2. Consider the following scenario:

   > When Sambot goes home at night, he wants to know if his family is home before he tries the doors. (Perhaps the most convenient door to enter is double locked when nobody is home). Often when Sambots wife leaves the house she turns on an outdoor light. However, she sometimes turns on this light if she is expecting a guest. Also, Sambots family has a dog. When nobody is home, the dog is put in the back yard. The same is true if the dog has bowel trouble. Finally, if the dog is in the backyard, Sambot will probably hear her barking, but sometimes he can be confused by other dogs barking. Sambot is equipped with two sensors: a light-sensor for detecting outdoor lights and a sound-sensor for detecting the barking of dogs(s). Both of these sensors are not completely reliable and can break. Moreover, they both require Sambots battery to be in good condition.

Your task is to build a belief network that Sambot will use to reason about the above situation using the modeling and inference tool SamIam. Specifically, given sensory input, Sambot needs to compute his beliefs in various events: whether his family is home, whether any of his sensors are broken, whether the dog is in the backyard, and whether it has bowel trouble. You need to proceed as follows:

(a) Decide on the set of variables and their values. These variables and values must match those in the given data file sambot.dat.

(b) Construct the causal structure.

(c) Learn the network CPTs using the EM algorithm and the data file (sambot.dat) available from the class homepage. Your initial network should have uniform parameters.

You need to turn in sambot.net and a report that contains the following information:

- The most likely instantiation of all variables given that Sambot has sensed the lights to be on, but has sensed no bark. Explain how you obtained this answer (for partial credit in case you get the wrong answer).
- The most likely instantiation of the sensors given that the family is home and no guests are expected. Explain how you obtained this answer (for partial credit in case you get the wrong answer).
- The smallest set of variables **Z** in your network such that the two sensors are independent given **Z**. Justify your answer based on d-separation.
- The type of network you constructed: tree, polytree (singly-connected network), or multiply-connected network.