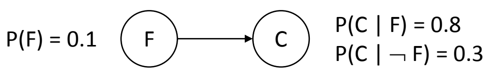
CS360 Homework 8

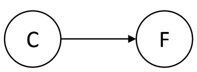
Bayesian Networks

1) Consider the following Bayesian network, where F = having the flu and C = coughing:



a) Write down the joint probability table specified by the Bayesian network.

b) Determine the probabilities for the following Bayesian network



so that it specifies the same joint probabilities as the given one.

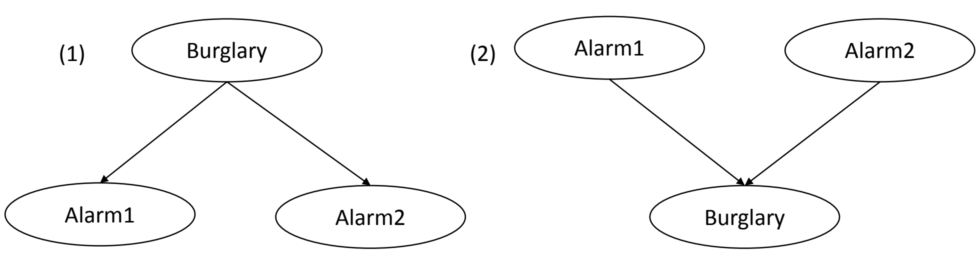
c) Which Bayesian network would you have specified using the rules learned in class?

d) Are C and F independent in the given Bayesian network?

e) Are C and F independent in the Bayesian network from Question b?

2) To safeguard your house, you recently installed two different alarm systems by two different reputable manufacturers that use completely different sensors for their alarm systems.

a) Which one of the two Bayesian networks given below makes independence assumptions that are not true? Explain all of your reasoning. Alarm1 means that the first alarm system rings, Alarm2 means that the second alarm system rings, and Burglary means that a burglary is in progress.



b) Consider the first Bayesian network. How many probabilities need to be specified for its conditional probability tables? How many probabilities would need to be given if the same joint probability distribution were specified in a joint probability table?

c) Consider the second Bayesian network. Assume that:

P(Alarm1) = 0.1

P(Alarm2) = 0.2

P(Burglary | Alarm1, Alarm2) = 0.8

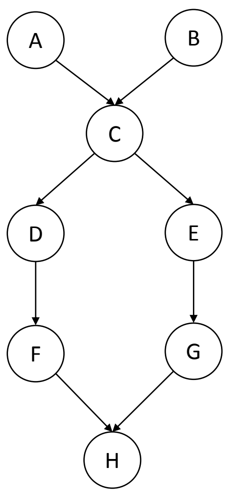
P(Burglary | Alarm1, ¬ Alarm2) = 0.7

P(Burglary | ¬ Alarm1, Alarm2) = 0.6

P(Burglary | ¬ Alarm1, ¬ Alarm2) = 0.5

Calculate P(Alarm2 | Burglary, Alarm1). Show all of your reasoning.

3) Consider the following Bayesian network:

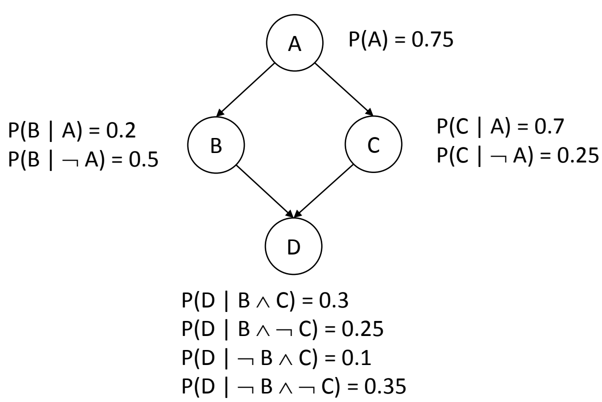


a) Are D and E necessarily independent given evidence about both A and B?

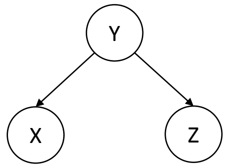
b) Are A and C necessarily independent given evidence about D?

c) Are A and H necessarily independent given evidence about C?

4) Consider the following Bayesian network. A, B, C, and D are Boolean random variables. If we know that A is true, what is the probability of D being true?



5) For the following Bayesian network



we know that X and Z are not guaranteed to be independent if the value of Y is unknown. This means that, depending on the probabilities, X and Z can be independent or dependent if the value of Y is unknown. Construct probabilities where X and Z are independent if the value of Y is unknown, and show that they are indeed independent.

Naive Bayesian Learner

6) A theme park hired you after graduation. Assume that you want to predict when the theme park receives lots of visitors. You gathered the following data:

	Feature 1 Sunny?	Feature 2 High Temperature?	Feature 3 Weekend?	Class Lots of Visitors?
Day 1	yes	yes	yes	yes
Day 2	yes	no	yes	yes
Day 3	no	yes	no	yes
Day 4	yes	yes	no	yes
Day 5	yes	yes	no	yes
Day 6	yes	no	no	no
Day 7	no data since you were on business travel			
Day 8	no	no	yes	no

a) Show the Bayesian network (= hypothesis = model) that a naive Bayesian learner will learn from the data.

b) What's the probability that the learned Bayesian network will predict that the theme park receives lots of visitors on a cloudy and hot weekend day?

7) Construct an example where a naive Bayesian learner predicts for a feature vector that the predicted class must be true with probability 1 when, in reality, it is false.

8) Give an example of a hypothesis (= model, here: joint probability distribution) that a naive Bayesian learner cannot learn correctly.

9) Give an example where the assumptions that a naive Bayesian learner makes are wrong.