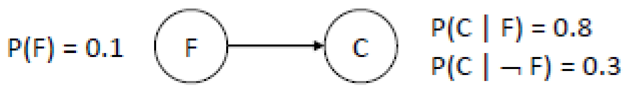
CSC384 Bayesian Networks

Problem 1

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



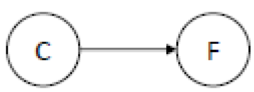
Write down the joint probability table specified by the Bayesian network.

Solution

$P(F, C) = P(C|F)P(F) = 0.8 \cdot 0.1 = 0.08$.
The rest of the table is similar.

F	C	
t	t	$0.1 \times 0.8 = 0.08$
t	f	$0.1 \times 0.2 = 0.02$
f	t	$0.9 \times 0.3 = 0.27$
f	f	$0.9 \times 0.7 = 0.63$

2) Determine the probabilities for the following Bayesian network so that it specifies the same joint probabilities as the given one.



Solution
$P(C) = 0.08 + 0.27 = 0.35$
$P(F|C) = P(F, C)/P(C) = 0.08/0.35 \approx 0.23$ (note the comma means "and" as explained in class)
$P(F|\neg C)/P(\neg C) = 0.02/0.65 \approx 0.03$

3) Are C and F independent in the given Bayesian network (Question 1)?

Solution
No, since (for example) $P(F) = 0.1$ but $P(F|C) \approx 0.23$.
4) Are C and F independent in the Bayesian network from Question 2?

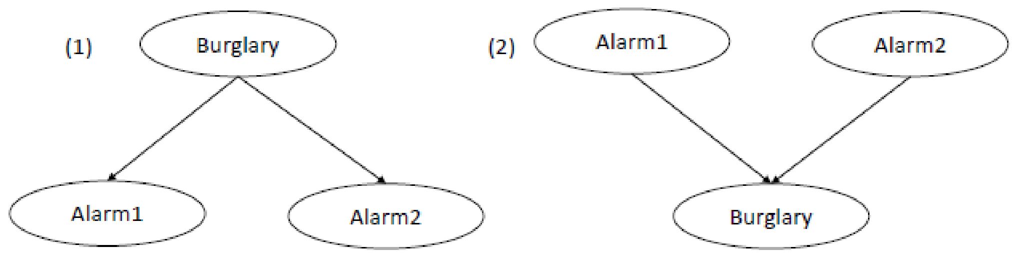
Solution: No, for the same reason.
5) Which Bayesian network would you have specified using the rules learned in class?

Solution: The first one. It is good practice to add nodes that correspond to causes before nodes that correspond to their effects.

Problem 2

To safeguard your house, you recently installed two different alarm systems by two diffeerent 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.



Solution: The second one falsely assumes that Alarm1 and Alarm2 are independent if the value of Burglary is unknown. However, if the alarms are working as intended, it should be more likely that Alarm1 rings if Alarm2 rings (that is, they should not be independent).

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?

Solution: We need to specify 5 probabilities, namely $P(Burglary), P(Alarm1|Burglary), P(Alarm1|\neg Burglary)$ and $P(Alarm2|\neg Burglary)$. A joint probability table would need $2^3 - 1 = 7$ probabilities.