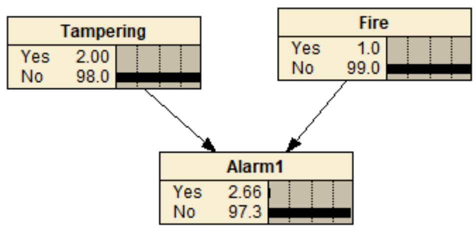
FIT5047 Solutions to Tutorial on Bayesian Networks

Exercise 1: *Bayesian Networks, Netica*

You have a three-node Bayesian Network, which correspond to three events: Alarm = the fire alarm in your apartment sounds, Fire = there was a fire in your apartment, and Tampering = your smoke detector was tampered with. Fire affects Alarm (a fire increases the probability of the alarm sounding) and Tampering also affects Alarm (if someone tampered with your smoke detector, your alarm is more likely to sound when there is no fire, and less likely to sound when there is a fire). The probabilities in your Bayes Net correspond to the following tables:



P(Tampering) = T	P(Tampering) = F
.02	.98

P(Fire=T)	P(Fire)=F
.01	.99

	P(Alarm=T|Tampering,Fire)	P(Alarm=F|Tampering,Fire)
Tampering=T, Fire=T	.5	.5
Tampering=T, Fire=F	.85	.15
Tampering=F, Fire=T	.99	.01
Tampering=F, Fire=F	0	1

Use Netica to answer the following questions:

(a) What is the marginal probability that your fire alarm will sound?
SOLUTION: $\Pr(\text{Alarm} = T) = 0.02663$

(b) Let's assume that you have observed that your smoke detector has not been tampered with. What is the posterior probability that the alarm will sound?
SOLUTION: $\Pr(\text{Alarm} = T|\text{Tampering} = F) = 0.0099$

(c) Still assuming that you have observed that your smoke detector has not been tampered with, what is the posterior probability that there was a fire in your apartment?
SOLUTION: $\Pr(\text{Fire} = T|\text{Tampering} = F) = \Pr(\text{Fire} = T) = 0.01$

(d) Now let's assume that you have observed that your smoke detector has not been tampered with, and that the fire alarm has sounded. What is the posterior probability that there was a fire in your apartment?
SOLUTION: $\Pr(\text{Fire} = \text{T}|\text{Tampering} = F, \text{Alarm} = T) = 1$

Exercise 2: ***Bayesian Networks, Netica***

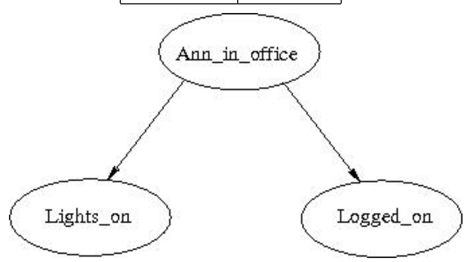
Dr. Ann Nicholson spends 60% of her work time in her office. The rest of her work time is spent elsewhere. When Ann is in her office, half the time her light is off (when she is trying to hide from students and get research done). When she is not in her office, she leaves her light on only 5% of the time. 80% of the time she is in her office, Ann is logged onto the computer. Because she sometimes logs onto the computer from home, 10% of the time she is not in her office, she is still logged onto the computer.

(a) Construct a Bayesian network to represent the *Lecturer's Life* scenario just described. Indicate clearly the CPTs.

SOLUTION:

The BN has the following structure and CPTs:

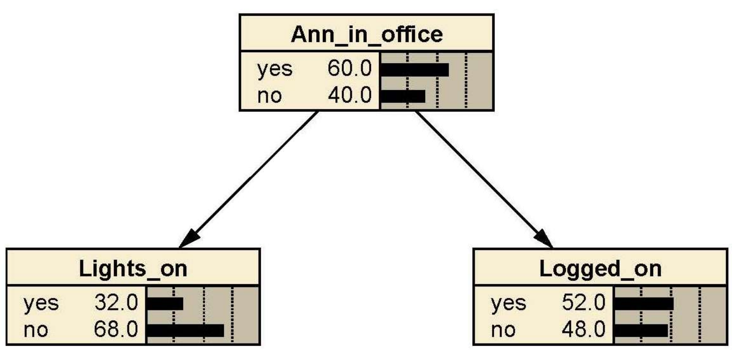
Ann_in_office	
Yes	No
0.6	0.4



	Lights_on	
Ann_in_office	Yes	No
Yes	0.5	0.5
No	0.05	0.95

	Logged_on	
Ann_in_office	Yes	No
Yes	0.8	0.2
No	0.1	0.9

(b) Enter your BN in Netica.



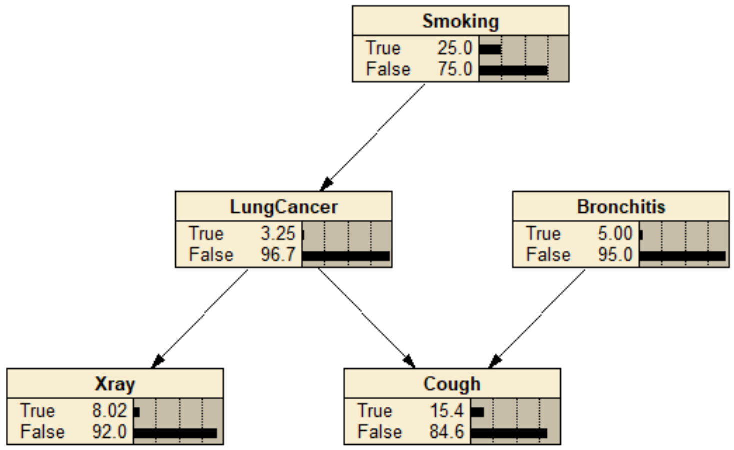
(c) Suppose a student checks Dr. Nicholson's login status and sees that she is logged on. Use Netica to determine the effect this has on the student's belief that Dr. Nicholson's light is on?

SOLUTION:

The answer to this question can be determined by manipulating the network found in `ann.dne`. Before a student checks to see whether Dr. Nicholson is logged onto her computer, their belief in her light being on should be 0.320. However, once they catch her in the process of being logged on, this belief rises to 0.465.

Exercise 3: ***D-separation***

Consider the following Bayesian Network for another version of the medical diagnosis example, where B=Bronchitis, S=Smoker, C=Cough, X=Positive X-ray, and L=Lung cancer and all nodes are Booleans. Suppose that the prior for a patient being a smoker is 0.25, and the prior for the patient having bronchitis is 0.05.



List the pairs of nodes that are conditionally independent in the following situations, **omitting the nodes that are set**:

1. There is no evidence for any of the nodes.
   S and B, L and B, X and B – since there is no evidence for C, it d-separates B from the other nodes (common effect).
2. The Lung cancer node is set to true (and there is no other evidence).
   - **S and X, S and C** – due to the chain rule.
   - **X and C** – due to the common cause rule.
   - **S and B, X and B** – since there is no evidence for C, it d-separates B from the other nodes (common effect), but L is set, so we don't condition on it.
3. The smoker node is set to true (and there is no other evidence).
   L and B, X and B – like A, but S is set, so we don't condition on it.
4. The cough node is set to true (and there is no other evidence).
   There are no conditional independencies in this situation.