CS 445/545 Machine Learning

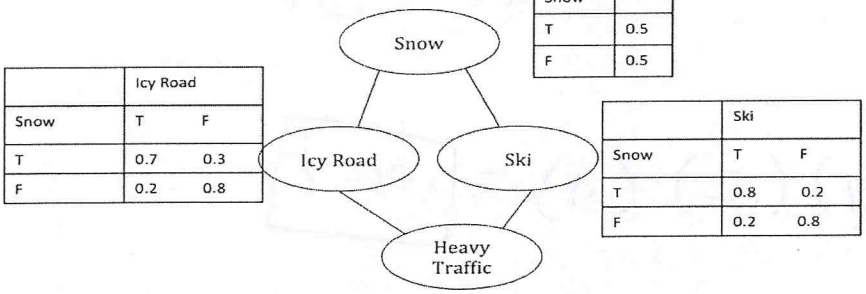
Winter Term, 2014

Quiz 5

Name Solutions

This quiz is closed book/notes. Please write all answers on these sheets.

1. Consider the Bayesian network given below, with the following variables:
   Snow: Whether or not there is new snow at the ski area
   Ski: Whether or not Pat goes skiing
   Icy Road: Whether or not the road to the ski area is icy
   Slow Traffic: Whether or not the road to the ski area has slow traffic.



Snow	
T	0.5
F	0.5

	Icy Road	
Snow	T	F
T	0.7	0.3
F	0.2	0.8

	Ski	
Snow	T	F
T	0.8	0.2
F	0.2	0.8

		Heavy Traffic	
Ski	Icy Road	T	F
T	T	0.95	0.05
T	F	0.8	0.2
F	T	0.9	0.1
F	F	0.5	0.5

Use the network to calculate the probability that there is new snow at the ski area given that Pat is going skiing. Show your work. (2 points)

$$\therefore P(\text{Snow} \mid \text{Ski}) = \frac{P(\text{Ski} \mid \text{Snow})\,P(\text{Snow})}{P(\text{Ski})}$$

$$= \frac{(.8)(.5)}{(.8)(.5)+(.2)(.5)} = \boxed{.8}$$

2. Given the network of problem 1, calculate

P(*Snow* = True, *Icy Road* = True, *Ski* = False, *Heavy Traffic* = False)

Show your work. (2 points)

Hint: Use the following formula:

$$P(X_1 \wedge X_2 \wedge \ldots \wedge X_N) = \prod P(X_i|\text{parents}(X_i))$$

$P(\text{snow})\, P(\text{icy}|\text{snow})\, P(\neg\text{ski}|\text{snow})$ ~~$P(\neg\text{Heavy}|\neg\text{ski}, \text{icy})$~~

$\cdot\, P(\neg\text{Heavy}|\neg\text{ski}, \text{icy})$

$= (.5)(.7)(.2)(.1) = \boxed{.007}$

3. Answer in a sentence or two: Why do most real-world Bayesian Network applications use the Markov Chain Monte Carlo algorithm to do approximate inference, rather than using an algorithm to do exact inference? (1point)

Computationally intractable to do exact inference, & MCMC gives good estimates.

4. For a Markov Chain Monte Carlo algorithm, a *state* of the system is the tuple of values corresponding to the network's variables. For the network of problem 1, the state would be the values of [Snow, IcyRoad, Ski, HeavyTraffic]. For example, if all variables are true, then the state would be written [t, t, t, t].

(a) For the network in problem 1 and the query P(*Snow* = *true* | *Heavy Traffic* = *true*), give an example of possible initial state of the system you might choose for the Markov Chain Monte Carlo (MCMC) algorithm. (1point)

any state in which Heavy traffic is true.

(b) Choose a non-evidence variable to sample next, conditioned on the current state of its Markov Blanket (its parents, children, and the other parents of its children). Say which variable you chose, and give an example of a possible next state of the system for the MCMC algorithm. (1point)

Can choose any variable except Heavy Traffic.
Every variable states the same except the sampled variable.

(c) Choose a different non-evidence variable to sample next, conditioned on the current state of its Markov Blanket. Say which variable you chose and give an example of a possible next state of the system. (1point)

Can choose any variable except Heavy Traffic and the one you chose for part b. Must keep all values the same as in part b except the variable you are sampling

(d) Suppose you have done 50 samples, and found that in 30 of them, *Snow* = *true*. What is your estimate for the query P(*Snow* | *Heavy Traffic*)? (1point)

$P = \frac{3}{5} = 0.6$