

ComS 573: Machine Learning
Spring 2008

Homework 5
Due Friday, April 11, 2008 in class

Note: Please do not hesitate to contact the instructor or TA if you have difficulty understanding or getting started with solving any of the problems.

1. (15 pts.) Consider the Bayesian network in Figure 1.
 - (a) (7 pts.) True or false?
 - i. $dsep(T, \emptyset, B)$
 - ii. $dsep(T, X, B)$
 - iii. $dsep(A, \{X, S\}, B)$
 - iv. $dsep(A, \{D, C\}, B)$
 - v. $dsep(T, D, S)$
 - vi. $dsep(A, P, \{X, D\})$
 - vii. $dsep(\{A, X\}, \{P, S\}, \{B, D\})$
 - (b) (5 pts.) List the local Markovian assumptions asserted by the DAG.
 - (c) (3 pts.) Express $P(a, s, t, c, p, b, x, d)$ in factored form (the chain rule for BNs).
2. (10 pts.) Give all the DAGs which are independence (d-separation) equivalent to the DAG in Figure 1.
3. (15 pts.) Consider the DAG G in Figure 2. Suppose that this DAG is a P-MAP of some distribution $Pr(\cdot)$. Construct a minimal I-MAP for $Pr(\cdot)$ using each of the following variable orders:
 - (a) A, D, B, C, E
 - (b) A, B, C, D, E
 - (c) E, D, C, B, A
4. (10 pts.) Assume that sore throat (S) can be caused by either cold (C) or flu (F), and they are related by a noisy-or model. We have the following information: the probability that a cold does not cause sore throat is .2, the probability that a flu does not cause sore throat is .1, and the probability that a patient will have a sore throat without suffering either cold or flu is .02. Construct the CPT $\theta_{S|C,F}$.

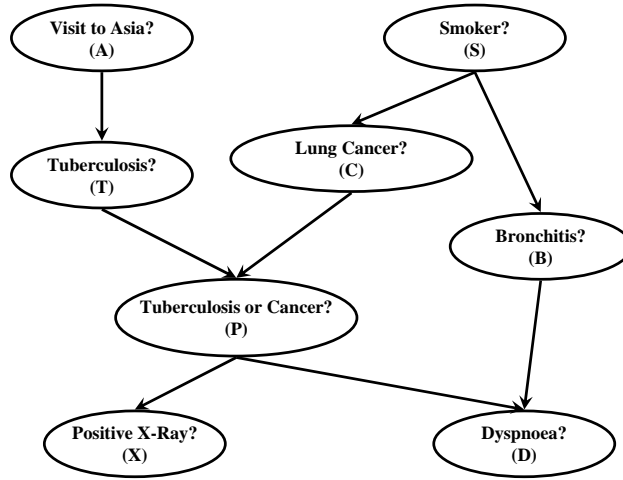
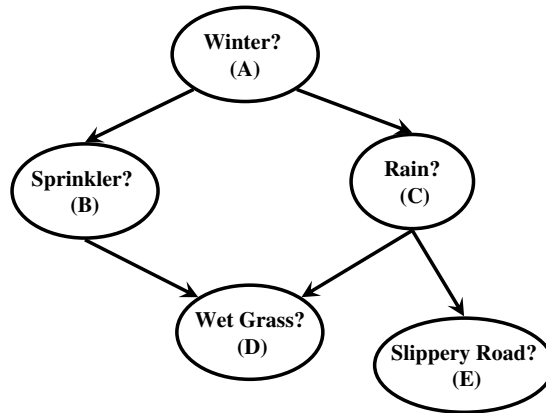


Figure 1: A Bayesian network



A	Θ_A
true	.6
false	.4

A	B	$\Theta_{B A}$
true	true	.2
true	false	.8
false	true	.75
false	false	.25

A	C	$\Theta_{C A}$
true	true	.8
true	false	.2
false	true	.1
false	false	.9

B	C	D	$\Theta_{D B,C}$
true	true	true	.95
true	true	false	.05
true	false	true	.9
true	false	false	.1
false	true	true	.8
false	true	false	.2
false	false	true	0
false	false	false	1

C	E	$\Theta_{E C}$
true	true	.7
true	false	.3
false	true	0
false	false	1

Figure 2: A Bayesian network