

CSC384 Test 3 (Bayesian Inference)

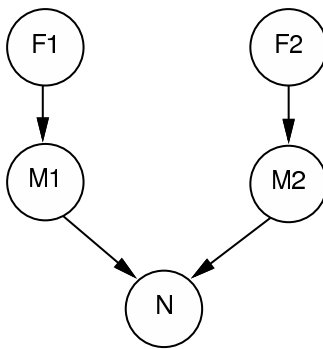
Sample Questions

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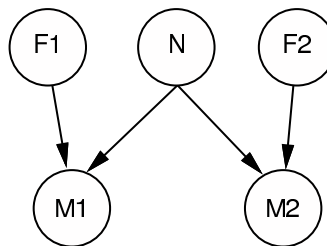
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You will be responsible for the material in Lecture slides-06 (i.e. chapter 13 and 14 of the book). Below are some sample questions for test 3.

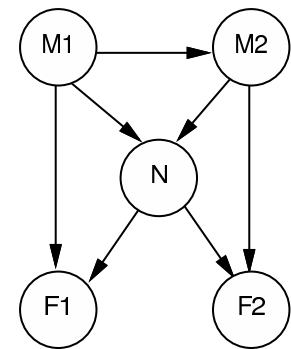
- Two astronomers in different parts of the world make measurements M_1 and M_2 of the number of stars N in some small region of the sky, using their telescopes. Normally, there is a small probability e or error of up to one star in each direction. Each telescope can also be badly out of focus (with probability f , much smaller than e). Let F_1 and F_2 be boolean variables with $F_i = \mathbf{true}$ being that the i -th telescope is out of focus. If the telescope is out of focus then the scientist will undercount by 3 or more starts (or, if N is 3 or less, fail to detect any stars at all). Consider the three networks:



(i)

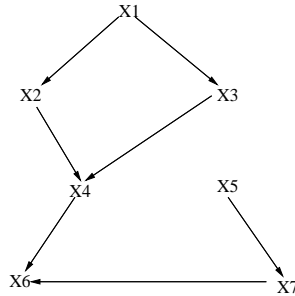


(ii)



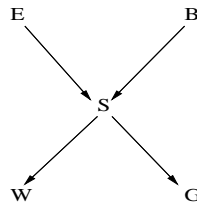
(iii)

- Which of these Bayesian Networks are correct representations of the preceding information?
 - Which is the best network? Explain.
 - Write out the CPT for $Pr(M_1|N, F_1)$ for the case where $M_1 \in \{0, 1, 2, 3, 4\}$ and $N \in \{1, 2, 3\}$. Express the entries in terms of e and f .
 - Use your CPT for $Pr(M_1|N, F_1)$ to compute the CPT for $Pr(M_1|N)$ (again expressed in terms of e and f).
 - Suppose $M_1 = 1$ and $M_2 = 3$. What are the *possible* numbers of stars.
- Consider the Bayes Network given below.



- (a) What is the product decomposition specified by this network?
- (b) Say that variable X_7 has 3 possible values, X_6 has 2 possible values, and X_4 has 4 possible values. How many values will be contained in the conditional probability table for X_6 .
- (c) Are X_1 and X_5 conditionally independent given X_2 , given X_7 , given X_6 , given X_4 ?
- (d) What are the relevant variables given the query X_3 and the evidence items X_6 , given evidence X_5 , given evidence X_4 ?

3. Consider the bayes net



In this network *all* variables are binary (including the alarm sound) having values either true or false. We use upper case to indicate a variable and lower case to indicate the values of a variable. When you are asked to give a probability involving some variables, you must the value of this probability for all values of the variables. *Hint, many of the questions can be answered directly without any numeric calculations.*

Let the conditional probability tables for the network be:

E	e	-e
	1/10	9/10

B	b	-b
	1/10	9/10

S	s	-s
$e \wedge b$	9/10	1/10
$e \wedge -b$	2/10	8/10
$-e \wedge b$	8/10	2/10
$-e \wedge -b$	0	1

W	w	-w
s	8/10	2/10
-s	2/10	8/10

G	g	-g
s	1/2	1/2
-s	0	1

- (a) Given that Mrs. Gibbons phones you (g) what is the probability that the alarm went off (s)?
- (b) Say that there was a burglary (b) and but no earthquake (-e), what is the expression specifying the posterior probability of Dr. Watson phoning you (w) given the evidence. (You do not need to calculate a numeric answer, just give the probability expression).

- (c) What is $\Pr(G|S)$? (i.e., the four probability values $\Pr(g|s)$, $\Pr(-g|s)$, $\Pr(g|-s)$, $\Pr(-g|-s)$).
- (d) What is $\Pr(G|S \wedge W)$? (i.e., the 8 probability values $\Pr(g|s \wedge w)$, $\Pr(g|s \wedge -w)$, \dots , $\Pr(-g|-s \wedge -w)$).
- (e) What do these values tell us about the relationship between G , W and S ?
- (f) What is $\Pr(G|W)$? (i.e., the four probability values $\Pr(g|w)$, $\Pr(-g|w)$, $\Pr(g|-w)$, and $\Pr(-g|-w)$).
- (g) What do these values tell us about the relationship between G and W , and why does this relationship differ when we know S ?