Problem Set 5
Bayesian Network

1. You have a new burglar alarm (A) installed at home. It is fairly reliable at detecting a burglary (B), but also responds on occasion to minor earthquakes (E). You also have two neighbors, John and Mary, who have promised to call you at work when they hear the alarm. John nearly always calls when he hears the alarm, but sometimes confuses the telephone ringing with the alarm and calls then, too. Mary, on the other hand, likes rather loud music and often misses the alarm altogether.

For some given basic facts and conditional probabilities; a) Draw a BN, b) Give expression for Joint probability for this BN, c) Estimate Probability of Burglary when Alarms rings, but John does not make a call, only Marry does and there was no sign of Earthquake.

d) Estimate Probability of Burglary given that you have received call from both neighbors.

Solved in class

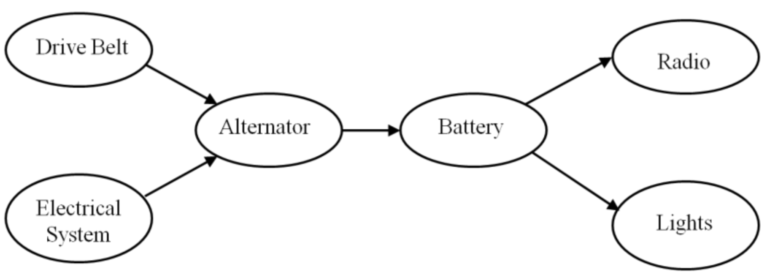
2. The incidence of a disease (D) is about 5 per 100 persons. The probability of testing positive (T+) when someone has the disease is 0.99. The probability of testing negative (T-) when someone does not have the disease is 0.97. Compute

(a) the probability of testing positive i.e. P(T+)

(b) that you have the disease, when the test is positive i.e. P(D|T+) =

Similar problem was solved in class.

3. The following Bayesian network is a model depicting various components of a car. The alternator (A) can stop working due to an electric fault (E) or due to the breaking of the drive belt (D). The failure of the alternator causes complete discharge of the battery (B) that supplies current to the radio (R) and lights (L). The battery, the lights and the radio may also stop working for internal reasons. All random variables are Boolean.



Use following probabilities to **calculate** the joint probability (a) P(d, e, a, b, $\neg r$, $\neg l$) and (b) P($\neg d$, e, $\neg a$, b, r, l)

P(d) = 0.75, P(e) = 0.95

D	E	P(A|D, E)
t	*t*	0.9
t	*f*	0.3
f	*t*	0.1
f	*f*	0.1

A	P(B|A)
t	0.8
f	0.2

B	P(L|B)
t	0.9
f	0.05

B	P(R|B)
t	0.8
f	0.1

a) $P(d, e, a, b, \neg r, \neg l) = P(d)*P(e)*P(a \mid d, e)*P(b \mid a)*P(\neg r \mid b)*P(\neg l \mid b)$

$= 0.75*0.95*0.9*0.8*(1 – 0.8)*(1 – 0.9)$

$= 0.0102$

b) $P(\neg d, e, \neg a, b, r, l) = P(\neg d)*P(e)*P(\neg a \mid \neg d, e)*P(b \mid \neg a)*P(r \mid b)*P(l \mid b)$

$= 0.25*0.95*0.9*0.2*0.8*0.9$

$= 0.0308$

4. Draw Bayesian networks corresponding to each of the following factored probability expressions.

a) P(A | C, D)*P(B | C, E)*P(C | E)*P(D | E, F, G)*P(E | H)*P(F | G, H)*P(G)*P(H | G)

b) P(Intelligence)*P(Attitude)*P(Test Scores| Intelligence, Attitude)*P(Participation | Attitude)*P(Grade | Participation, Test Scores)

Can be solved easily

5. Suppose you have the choice to buy or not to buy a textbook for a course. We consider three Boolean random variables: B $\stackrel{\text{def}}{=}$ indicates your buying of book, M $\stackrel{\text{def}}{=}$ you master the syllabus, and S $\stackrel{\text{def}}{=}$ you are successful on exam. The exam is open book and therefore S is **not** independent of B given M. You have been given following conditional probabilities:

$P(s \mid b, m) = 0.9$

$P(s \mid b, \neg m) = 0.5$

$P(s \mid \neg b, m) = 0.8$

$P(s \mid \neg b, \neg m) = 0.3$

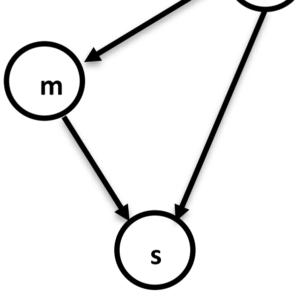
$P(m \mid b) = 0.9$

$P(m \mid \neg b) = 0.7$

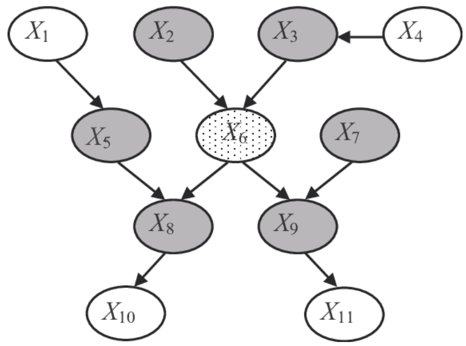
Draw Bayesian network for the problem. And give Probability Distribution Table / CPTs along with each node.

B	P(M)
t	0.9
f	0.7

B	M	P(S)
t	t	0.9
t	*f*	0.5
f	t	0.8
f	*f*	0.3



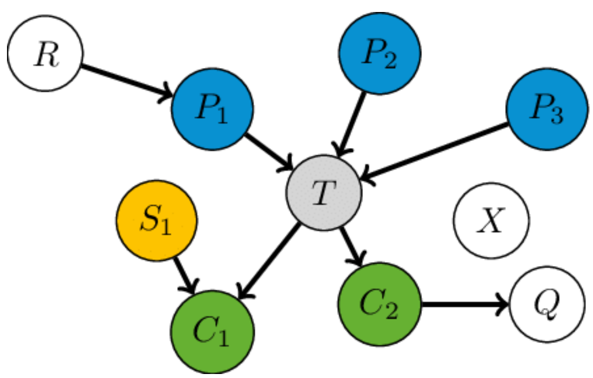
6. Find Markov blanket of node X6 ,also list all the nodes which are conditionally independent on X6



Grey shaded area is Markov Blanket.

X6 is conditionally independent of X1, X4, X10, X11 given Markov Blanket of X6

7. Find Markov blanket of node T ,also list all the nodes which are conditionally independent on T



Can be solved easily

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