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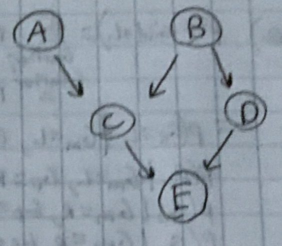
CS 470
Hw 3 - Bayesian Networks



1. a) false
   b) True
   c) False
   d) false
   e) false
   F) True
   g) False
   h) False
   I) false
   J) false

2. a) $P(m) = \sum_{B,a,e} P(B)P(e)P(a|B,e)P(m|a) = \sum_{B} P(B) \sum_{e} P(e) \sum_{a} P(a|B,e)P(m|a)$

$= P(B)P(e)P(a|B,e)P(m|a) + P(\neg B)P(e)P(a|\neg B,e)P(m|a) + P(B)P(\neg e)P(a|B,\neg e)P(m|a) +$
$P(\neg B)P(\neg e)P(a|\neg B,\neg e)P(m|a) + P(B)P(e)P(\neg a|B,e)P(m|\neg a) + P(\neg B)P(e)P(\neg a|\neg B,e)P(m|\neg a)$
$+ P(\neg B)P(\neg e)P(\neg a|\neg B,\neg e)P(m|\neg a) + P(B)P(\neg e)P(\neg a|B,\neg e)P(m|\neg a)$

b) J= True $\quad P(m|j) = \frac{P(m,j)}{P(j)} \qquad \frac{P(m,j)}{P(j)} = \frac{P(m,j,a)}{P(j)} + \frac{P(m,j,\neg a)}{P(j)}$

$\frac{P(m|j,a)P(a|j)\cancel{P(j)}}{\cancel{P(j)}} + \frac{P(m|\neg a,j)P(\neg a|j)\cancel{P(j)}}{\cancel{P(j)}} = P(m|j,a)P(a|j) + P(m|j,\neg a)P(\neg a|j)$

$P(m|a,j) \rightarrow P(m|a)$

$P(m|j) = \frac{P(m|a)P(j|a)P(a)}{P(j)} + \frac{P(m|\neg a)P(j|\neg a)P(\neg a)}{P(j)}$

3. a) C

b) a B, a is most correct But can follow same paths as a,

c) a, because while b can be the same, there are additional edges that don't follow the hypothesis.

d) $G_{child} =$

$P(C_{father})$	$P(C_{mother})$	L	R
L	L	1-m	m
L	R	0.5	0.5
R	L	0.5	0.5
R	R	m	1-m

e) $p(G_{child}=L) = \sum_{G_{mother}, G_{father}} p(G_{child}=L \mid G_{mother}, G_{father})\, p(G_{mother}, G_{father})$

$= p(G_{child}=L \mid G_m, G_f)\, p(G_{mother})\, p(G_{father})$

$= p(G_c=L \mid G_m=L, G_f=L)\, p(G_{mother})\, p(G_{father})\ +$

$p(G_c \mid G_m=L, G_f=R)\, p(G_{mother})\, p(G_{father}=R)\ +$

$p(G_c \mid G_m=R, G_f=L)\, p(\neg G_m)\, p(G_{father})\ +$

$p(G_c \mid G_m=R, G_f=R)\, p(\neg G_m)\, p(G_f)$

$(1-m)q^2 + 0.5q(1-q) + 0.5q(1-q) + m(1-q)^2 = p(G_{child}=L)$

$q^2 - mq^2 + .5q - \cancel{.5q^2} + .5q - \cancel{.5q^2} + m(1-q)(1-q)$

$q + m(1-q)(1-q) - mq^2$

$q + (1-q-q+q^2)m \qquad q - \cancel{mq^2} + m - 2mq + \cancel{mq^2} = q + m - 2mq$

f) $p(G_{child} = L)\, p(G_{mother}=L)\, p(G_{father}=L)$

$p(G_{child}) = p(G_{mother}=L) = p(G_{father}=L) = q + m - 2mq = q$

$m - 2mq = 0$
$-m \qquad -m$

$-2mq = -m$

$-2q = -1$
$\overline{-2} \quad \overline{-2}$

$q = \frac{1}{2}$

The hypothesis must be false because if each generation has 50% chance to be lefthanded, there should be way more left handed people. 50% of the population would be lefthanded, which is not true.