ECS 170 Homework 5

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1. Give one advantage of using a belief network versus modeling the full joint distribution of a set of random variables.

   Bayesian networks have the distinct advantage of less computationally expensive to calculate than the full joint distribution.

2. Describe the four types of relationships that can occur in belief networks.

   - Direct cause

     Given two nodes A and B with an arrow from A to B, we say that A has a direct cause on B.
   - Indirect cause

     Given three nodes A, B, and C with arrows from A to B and B to C, we say that A has an indirect cause on C.
   - Common cause

     Given three nodes A, B, and C with arrows from A to B and A to C, we say that A is a common cause of B and C.
   - Common effect

     Given three nodes A, B, and C with arrows from A to C and B to C, we say that A and B have a common effect of C.

3. Consider the following.

   (a) Which of the bayesian networks are correct? Explain.

   The correct networks are (ii) and (iii).

   (i) suggests that N is conditionally independent of F_1 given M_1. This is clearly not the case since if we count n stars, there could be at least $n + 3$ actual stars if the focus were off.

   (ii) is a direct implementation of the given problem.

   (iii) is a reordering of the problem, so it is clearly correct. The measurement along with the number of stars can show if the focus is out. M_1 has a direct cause on M_2 because M_2 can never be more than 4 different from M_1. The two measurements provide a lower bound on the number of stars.

   (b) Which is the most efficient network of the accurate network(s) and why?

   (ii) is the more efficient because it has less edges. The full joint distribution of (iii) will be much higher than (ii).

(c) Assuming $N \in \{1,2,3\}$ and $M_1 \in \{0,1,2,3,4\}$, write out the conditional distribution for $P(M_1|N)$ in terms of e and f.

Using graph (ii):

M_1	N	$P(M_1|N)$
0	1	$e+f$
0	2	f
0	3	f
1	1	$(\neg e)\cdot(\neg f)$
1	2	$e\cdot(\neg f)$
1	3	0
2	1	e
2	2	$(\neg e)\cdot(\neg f)$
2	3	e
3	1	0
3	2	e
3	3	$(\neg e)\cdot(\neg f)$
4	1	0
4	2	0
4	3	e