Written Assignment #4

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CS331 - INTRO TO AI
SPRING TERM

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1) Bayesian network D-Separation

   a) $I(B, C \mid A, G)$
      False (Not-blocked)

   b) $I(C, D \mid H)$
      False (Not-blocked)

   c) $I(G, H \mid F)$
      True (Blocked)

   d) $I(A, H \mid F)$
      True (Blocked)

   e) $I(E, D \mid C)$
      False (Not-blocked)

2) Bayesian network probabilities

   a) $P(A = T, B = T, C = F, D = T, E = T)$

$$= P(A = T)P(B = T|A = T)P(C = F|A = T)P(D = T|C = F)P(E = T|B = T, D = T)$$
$$= (0.6)(0.75)(0.8)(0.25)(0.6)$$
$$= 0.054$$

   b) $P(A = T, B = T, D = F)$

$$= \sum_{c} \sum_{e} P(A = T, B = T, C = c, D = F, E = e)$$
$$= \sum_{c} \sum_{e} P(A = T)P(B = T|A = T)P(C = c|A = T)P(D = F|C = c)P(E = e|B = T, D = F)$$
$$= P(A = T)P(B = T|A = T)\sum_{c} P(C = c|A = T)P(D = F|C = c)\sum_{e} P(E = e|B = T, D = F)$$
$$= P(A = T)P(B = T|A = T)\sum_{c} P(C = c|A = T)P(D = F|C = c)$$
$$= (0.6)(0.75)[(0.2)(0.9) + (0.8)(0.75)]$$
$$= (0.6)(0.75)[0.18 + 0.6]$$
$$= (0.6)(0.75)[0.18 + 0.6]$$
$$= 0.351$$

c) $P(D = T | A = F)$

$$= \frac{P(D = T, A = F)}{P(A = F)}$$

$$= \frac{\sum_b \sum_c \sum_e P(A = F, B = b, C = c, D = T, E = e)}{\sum_b \sum_c \sum_d \sum_e P(A = F, B = b, C = c, D = d, E = e)}$$

$$= \frac{\sum_b \sum_c \sum_e P(A = F)P(B = b|A = F)P(C = c|A = F)P(D = T|C = c)P(E = e|B = b, D = T)}{\sum_b \sum_c \sum_d \sum_e P(A = F)P(B = b|A = F)P(C = c|A = F)P(D = d|C = c)P(E = e|B = b, D = d)}$$

$$= \frac{P(A = F)\sum_b P(B = b|A = F)\sum_c P(C = c|A = F)P(D = T|C = c)\sum_e P(E = e|B = b, D = T)}{P(A = F)\sum_b P(B = b|A = F)\sum_c P(C = c|A = F)\sum_d P(D = d|C = c)\sum_e P(E = e|B = b, D = d)}$$

$$= \frac{P(A = F)\sum_c P(C = c|A = F)P(D = T|C = c)}{P(A = F)}$$

$$= \frac{(0.4)[(0.75)(0.1) + (0.25)(0.25)]}{(0.4)}$$

$$= \frac{(0.4)(0.075 + 0.0625)}{0.4}$$

$$= 0.1375$$