

CSC384
Assignment 3

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Q1.

- (a) $P(b \mid a) = 0.5$
- (b) $P(c \mid a) = 0.5$
- (c) $P(c \mid a, \sim e) = 0.5714285714285714$
- (d) $P(c \mid a, f) = 0.5$

code: please refer to `__main__` in `bnetbase.py`

Q2.

1. let $V1 = pv$ (Voltage at Plug), $d1 = strong$, $V2 = sq$ (Spark Quality), $d2 = good$, $V3 = bv$ (Battery Voltage):

$$\begin{aligned}P(sq = good \mid pv = strong) &= \\P(sq = good \mid pv = strong, bv = strong) &= \\P(sq = good \mid pv = strong, bv = weak) &= \\P(sq = good \mid pv = strong, bv = dead) &= 0.7\end{aligned}$$

Hence, with knowledge of $V1 = d1$ ($pv = strong$), $V3 = dk$ has no impact on the probability of $V2 = d2$ ($sq = good$).

2. let $V = pv$, $d = strong$, $V1 = ds$, $d1 = okay$, $V2 = mf$, $d2 = okay$, $V3 = bv$, $d3 = strong$:

probabilities for $V_i = d_i$ increases when we know $V = d$:

$$\begin{aligned}P(ds = okay) &= 0.99 \leq 0.9989 = P(ds = okay \mid pv = strong) \\P(mf = okay) &= 0.99 \leq 1.00 = P(mf = okay \mid pv = strong) \\P(bv = strong) &= 0.41 \leq 1.00 = P(bv = strong \mid pv = strong)\end{aligned}$$

increasing probabilities of $V2 = d2$ decreases the probabilities for other causes:

$$\begin{aligned}P(ds = okay \mid pv = strong) &= 0.9989 \geq 0.9988 = P(ds = okay \mid pv = strong, mf = okay) \\P(bv = strong \mid pv = strong) &= 0.9999 \geq 0.9998 = P(bv = strong \mid pv = strong, mf = okay)\end{aligned}$$

3. let $V = pv$, $d = okay$, $V1 = ds$, $d1 = okay$, $V2 = mf$, $d2 = okay$, $V3 = bv$, $d3 = strong$:

$$\begin{aligned}P(pv = okay) &= 0.3633 \leq \\P(pv = okay \mid ds = okay) &= 0.3665 \leq \\P(pv = okay \mid ds = okay, mf = okay) &= 0.3702 \leq \\P(pv = okay \mid ds = okay, mf = okay, bv = strong) &= 0.9\end{aligned}$$

Hence, adding more evidence in this case increases the probability of $pv = okay$ monotonically.

4. let $V = pv$, $d = okay$, $V1 = ds$, $d1 = okay$, $V2 = mf$, $d2 = okay$, $V3 = bv$, $d3 = weak$:

$$P(pv = okay) = 0.3633 \leq$$

$$P(pv = okay \mid ds = okay) = 0.3665 \leq$$

$$P(pv = okay \mid ds = okay, mf = okay) = 0.3702 \geq$$

$$P(pv = okay \mid ds = okay, mf = okay, bv = weak) = 0$$

Having $d3$ changed to weak, we can see the probability of $pv = okay$ increases and then decreases as more evidences are added.