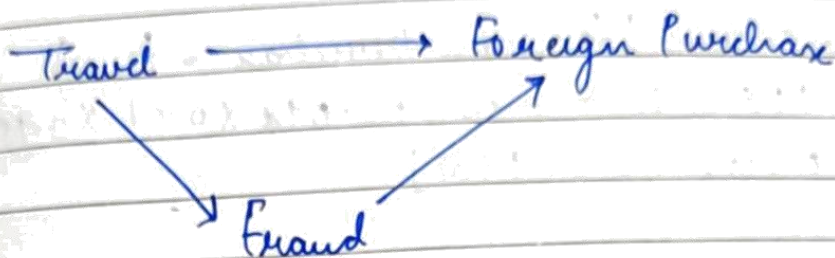


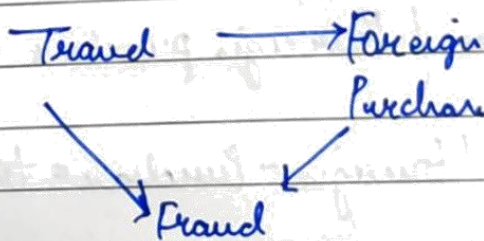
Bayesian Network



Increased probability of travel makes fraud more likely
Travel can cause fraud

Travel and Fraud can each cause foreign purchase. Travel explains foreign purchase and so is evidence against fraud

True	False
0.05	0.95



Travel	Fraud	T	F
True	True	0.9	0.1
False	True	0.10	0.9
True	False	0.9	0.10
False	False	0.01	0.99
True	0		
False			

Classify the hidden variable

[Travel = ?, foreign purchase = True, Fraud = ?]

$$P(\text{Fraud} = \text{True} \mid \text{Foreign Purchase} = \text{True})$$

$$= \alpha * [P(\text{Fraud} = \text{true} \mid \text{Travel} = \text{true}) * P(\text{Foreign Purchase} = \text{true} \mid \text{Travel} = \text{true}, \text{Fraud} = \text{true}) * P(\text{Travel} = \text{true})$$

$$= \alpha * [0.01 * 0.90 * 0.05 + 0.002 * 0.10 * 0.95]$$

$$= \alpha * [0.00045 + 0.00019]$$

$$= 0.00064\alpha$$

$$\begin{aligned} & P(\text{Fraud} = \text{False} \mid \text{Foreign purchase} = \text{true}) \\ &= \alpha * [0.99 * 0.90 * 0.05 + 0.098 * 0.01 * 0.95] \\ &= \alpha * [0.0455 + 0.009481] \\ &= 0.054031\alpha \end{aligned}$$

$$\alpha = \frac{1}{0.00064 + 0.054031} = 18.29$$

$$\begin{aligned} P(\text{Fraud} = \text{true} \mid \text{Foreign purchase} = \text{true}) &= 0.00064\alpha \\ &= 0.00064 * 18.29 \\ &= 0.01170 \end{aligned}$$

$$\therefore P(\text{Fraud} = \text{true} \mid \text{Foreign purchase} = \text{true}) = 1.17\%$$

$$\begin{aligned} 2. \quad & P(\text{Fraud} = \text{true} \mid \text{Foreign purchase} = \text{true}, \text{travel} = \text{true}) \\ &= \alpha * 0.00045 \end{aligned}$$

$$\begin{aligned} & P(\text{Fraud} = \text{False} \mid \text{Foreign purchase} = \text{true}, \text{travel} = \text{true}) \\ &= \alpha * 0.04455 \end{aligned}$$

$$\alpha = \frac{1}{0.00045 + 0.04455} = 22.22$$

$$\begin{aligned} & P(\text{Fraud} = \text{true} \mid \text{Foreign purchase} = \text{true}, \text{travel} = \text{true}) \\ &= \alpha * 0.00045 \\ &= 0.01 \end{aligned}$$

$$\therefore P(\text{Fraud} = \text{true} \mid \text{Foreign purchase} = \text{true}, \text{travel} = \text{true}) = 1.0\%$$