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1. 解: (1) $P(E=F, S=F, M=F, B=F) = P(M=F) \times P(B=F|M=F) \times P(E=F)$
 $\times P(S=F|E=F, M=F)$

则原式 $= 0.9 \times 0.9 \times 0.6 \times 0.9 = 0.4374$

(2) 即求 $P(CB=T) = P(CB=T|M=T) \times P(M=T) + P(CB=T|M=F) \times P(M=F)$

则原式 $= 1.0 \times 0.1 + 0.1 \times 0.9 = 0.19$

(3) 由题 $P(M=T|B=T) = \frac{P(CB=T|M=T) \times P(M=T)}{P(CB=T)}$

代入: $\frac{1.0 \times 0.1}{0.19} = 0.5263$

(4) 由题 $P(M=T|S=T, B=T, E=T)$

$= P(S=T|E=T, M=T) \times P(E=T) \times P(M=T) \times P(CB=T|M=T)$

$\sum_{M=F, T} P(S=T|E=T, M) \times P(E=T) \times P(M) \times P(CB=T|M)$

代入: $\frac{1.0 \times P(E=T) \times 0.1 \times 1.0}{P(E=T) \times (1.0 \times 0.1 \times 1.0 + 0.8 \times 0.9 \times 0.1)}$

$= \frac{0.1}{0.1 + 0.072} = 0.5814$

(5) $P(E=T|M=T)$ 由题图两事件相互独立

$P(E=T|M=T) = P(E=T) = 0.4$

乙信息熵 $H(D) = -\frac{3}{5} \log_2 \frac{3}{5} - \frac{2}{5} \log_2 \frac{2}{5} \approx 0.97$

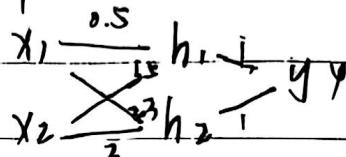
① Gain(天气) $= H(D) - \frac{2}{5} H(D|\text{晴}) - \frac{1}{5} H(D|\text{多云}) - \frac{2}{5} H(D|\text{雨})$
 $= H(D) - \frac{2}{5} (-\frac{3}{2} \log_2 \frac{2}{3}) - \frac{1}{5} (-\frac{1}{2} \log_2 \frac{1}{2}) - \frac{2}{5} (-\frac{2}{3} \log_2 \frac{2}{3})$
 $= 0.97 - 0 = 0.97$

② Gain(湿度) $= H(D) - \frac{3}{5} H(D|\text{高}) - \frac{2}{5} H(D|\text{中})$
 $= H(D) - \frac{3}{5} (-\frac{3}{2} \log_2 \frac{2}{3} - \frac{1}{2} \log_2 \frac{1}{3}) - \frac{2}{5} (-\frac{2}{3} \log_2 \frac{2}{3})$
 $= H(D) - 0.55 - 0$
 $= 0.42$

综上 $Gain(\text{天气}) > Gain(\text{湿度})$, 故天气更适合作根。

3. \

前向传播 $h_1 = w_1x_1 + w_2x_2 = 0.5 \times 1 + 1.5 \times 2.5 = 1.25$



$$h_2 = w_3x_1 + w_4x_2 = 2.3 \times 1 + 3 \times 0.5 = 3.8$$

$$h_1 = 1.25$$

$$h_2 = 3.8$$

$$y_{in} = w_5h_1 + w_6h_2 = 1.25 + 3.8 = 5.05$$

$$y = 5.05$$

误差 (MSE): $L = \frac{1}{2}(y - t)^2 = 0.55125$

$$\frac{\partial L}{\partial y} = (y - t) \quad \delta_y = \frac{\partial L}{\partial y} \cdot \frac{\partial y}{\partial y_{in}} = (y - t) = 1.05$$

$$\delta h_1 = \frac{\partial L}{\partial h_{1in}} = \frac{\partial L}{\partial y} \cdot \frac{\partial y}{\partial y_{in}} \cdot \frac{\partial y_{in}}{\partial h_{1in}} = \delta_y w_5 (ReLu)' = 1.05$$

$$\text{同理 } \delta h_2 = 1.05$$

梯度下降更新 $W^t = W - \eta \frac{\partial L}{\partial W} \quad \eta = 0.1$

$$\frac{\partial L}{\partial w_5} = \frac{\partial L}{\partial y_{in}} \cdot \frac{\partial y_{in}}{\partial w_5} = \delta_y \cdot h_1 = 0.13125$$

$$\frac{\partial L}{\partial w_1} = \frac{\partial L}{\partial h_{1in}} \cdot \frac{\partial h_{1in}}{\partial w_1} = \delta h_1 \cdot x_1 = 1.05$$

iii) $w_5^+ = w_5 - 0.1 \times 0.13125 = 0.86875$

$$w_1^+ = w_1 - 0.1 \times 1.05 = 0.395$$

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核1: $C_1 W_1 = \begin{bmatrix} 1 & 2 & 3 & 0 \\ 2 & 4 & 3 & 3 \\ 3 & 3 & 5 & 1 \\ 0 & 3 & 1 & 2 \end{bmatrix}$

$C_2 W_2 = \begin{bmatrix} 0 & 3 & 2 & 1 \\ 3 & 4 & 2 & 3 \\ 2 & 2 & 6 & 2 \\ 1 & 3 & 2 & 0 \end{bmatrix}$ bias=1

iii) $\begin{bmatrix} 2 & 6 & 6 & 2 \\ 6 & 9 & 6 & 7 \\ 6 & 6 & 1 & 2 & 4 \\ 2 & 7 & 4 & 3 \end{bmatrix}$

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核2 $C_1 W_1: \begin{bmatrix} -1 & -2 & -3 & 0 \\ 1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} -2 & -2 & 1 & 3 \\ -3 & 1 & 1 & 1 \\ 0 & 3 & 1 & 2 \end{bmatrix}$

$C_2 W_2: \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} 0 & -3 & -2 & -1 \\ 3 & 0 & 0 & -3 \\ 2 & 0 & 0 & -2 \\ 1 & 3 & 2 & 0 \end{bmatrix}$

$bios=2$

$m_1: \begin{bmatrix} 1 & -3 & -3 & 1 \\ 3 & 0 & 3 & 2 \\ 1 & 3 & 3 & 1 \\ 3 & 8 & 5 & 4 \end{bmatrix}$

维度公式: $h = \left\lfloor \frac{n_h - f + 2P}{s} \right\rfloor + 1 = 4$

$w = \left\lfloor \frac{m_w - f + 2P}{s} \right\rfloor + 1 = 4$

4x4符合结果

(2) 平均地位:

核1 $\begin{bmatrix} 5.75 & 5.25 \\ 5.25 & 5.75 \end{bmatrix}$ 核2 $\begin{bmatrix} 0.25 & 0.75 \\ 3.75 & 3.25 \end{bmatrix}$

最大地位:

核1 $\begin{bmatrix} 9 & 7 \\ 7 & 12 \end{bmatrix}$ 核2 $\begin{bmatrix} 3 & 3 \\ 8 & 5 \end{bmatrix}$