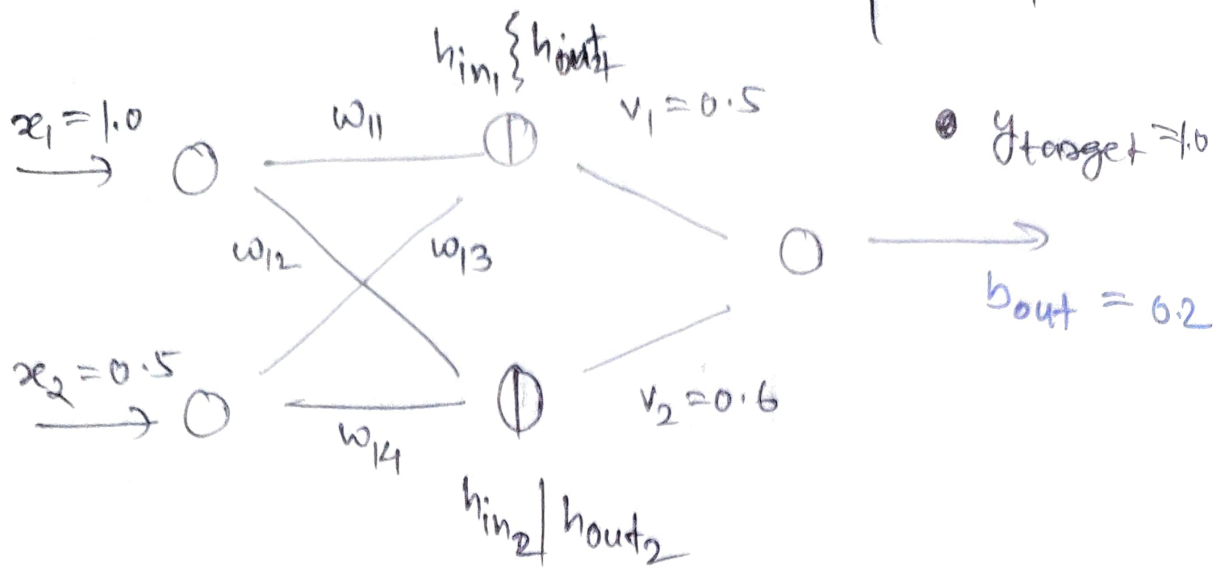


$$\eta = 0.01$$



$$w_{11} = 0.2$$

$$w_{12} = 0.4$$

$$w_{13} = 0.1$$

$$w_{14} = 0.3$$

$$v_1 = 0.5$$

$$v_2 = 0.6$$

Sigmoid

$$h_{in1} = w_{11}x_1 + w_{13}x_2 + b_1$$

$$= 0.2(1) + 0.1(0.5) + 0.1$$

$$= 0.2 + 0.05 + 0.1$$

$$= \underline{\underline{0.25 + 0.1}} = 0.35$$

$$h_{out1} = \frac{1}{1 + e^{-0.35}} = 0.5866$$

Done

$$\begin{aligned}
 h_{in_2} &= w_{12}x_1 + x_2 w_{24} + b_1 \\
 &= 0.4 \times 1 + 0.5(0.3) + 0.1 \\
 &= 0.4 + 0.15 + 0.1 \\
 &= 0.65
 \end{aligned}$$

$$\begin{aligned}
 h_{out_2} &= \frac{1}{1 + e^{-\cancel{0.65} h_{in_2}}} = \frac{1}{1 + e^{-0.65}} \\
 &= \underline{\underline{0.6570}}
 \end{aligned}$$

$$\begin{aligned}
 0 &= v_1 h_{out_1} + v_2 h_{out_2} + b_{out} \\
 &= 0.5(0.5866) + 0.6(0.6570) + 0.2 \\
 &= \underline{\underline{0.6875}} + 0.2 = 0.8875
 \end{aligned}$$

$$\begin{aligned}
 \text{Error} &= (y_{\text{target}} - 0)^2 \\
 &= (y - 0)^2 \\
 &= (1 - 0.8875)^2 \\
 &= \underline{\underline{0.09765}}
 \end{aligned}$$

$$\begin{aligned}\frac{\partial \mathcal{E}}{\partial v_1} &= \frac{\partial \mathcal{E}}{\partial o} \times \frac{\partial o}{\partial v_1} = -2(y-o) \times h_{out,1} \\ &= -2(1-0.8875) \times 0.5866 \quad \text{~~0.0000~~} \\ &= -0.225 \times 0.5866 = 0.13198\end{aligned}$$

$$\begin{aligned}\frac{\partial \mathcal{E}}{\partial v_2} &= \frac{\partial \mathcal{E}}{\partial o} \times \frac{\partial o}{\partial v_2} = -2(y-o) \times h_{out,2} \\ &= -2(1-0.8875)(0.6570) \\ \frac{\partial \mathcal{E}}{\partial o} &= -2(1-0.8875) \\ &= \underline{\underline{-0.225}} \quad \text{~~-0.4106~~} \quad -0.14781\end{aligned}$$

$$\begin{aligned}\frac{\partial \mathcal{E}}{\partial w_{11}} &= \frac{\partial \mathcal{E}}{\partial o} \times \frac{\partial o}{\partial h_{out,1}} \times \frac{\partial h_{out,1}}{\partial h_{in,1}} \times \frac{\partial h_{in,1}}{\partial w_{11}} \\ &= -0.225 \times v_1 \times h_{out,1}(1-h_{out,1}) \times 1 \\ &= -0.225 \times 0.5 \times 0.5866(1-0.5866) \times 1 \\ &= \underline{\underline{-0.01578}} \quad -0.02728\end{aligned}$$

$$\begin{aligned}\frac{\partial \mathcal{E}}{\partial w_{13}} &= \frac{\partial \mathcal{E}}{\partial o} \times \frac{\partial o}{\partial h_{out,1}} \times \frac{\partial h_{out,1}}{\partial h_{in,1}} \times \frac{\partial h_{in,1}}{\partial w_{13}} \\ &= -0.225 \times v_1 \times h_{out,1}(1-h_{out,1}) \times 0.5 \\ &= -0.225 \times 0.5 \times 0.5866(1-0.5866) \times 0.5 \\ &= \underline{\underline{-0.00394}} \quad -0.01364\end{aligned}$$

$$\frac{\partial E}{\partial w_{12}} = \frac{\partial E}{\partial o} \times \frac{\partial o}{\partial h_{out_2}} \times \frac{\partial h_{out_2}}{\partial h_{in_2}} \times \frac{\partial h_{in_2}}{\partial w_{12}}$$

$$= -0.225 \times v_2 \times h_{out_2}(1-h_{out_2}) \times x_1$$

$$= -0.225 \times 0.6 \times 0.6570(1-0.6570) \times 1$$

$$= \cancel{0.08454} \quad 0.03042$$

$$\frac{\partial E}{\partial w_{14}} = \frac{\partial E}{\partial o} \times \frac{\partial o}{\partial h_{out_2}} \times \frac{\partial h_{out_2}}{\partial h_{in_2}} \times \frac{\partial h_{in_2}}{\partial w_{14}}$$

$$= -0.225 \times v_2 \times h_{out_2}(1-h_{out_2}) \times x_2$$

$$= -0.225 \times 0.6 \times (0.6570)(1-0.6570) \times 0.5$$

$$= \underline{\underline{\cancel{0.04225}}} \quad 0.01521$$

↪ first hidden cell

$$\frac{\partial E}{\partial b_1} = \frac{\partial E}{\partial o} \times \left[\frac{\partial o}{\partial h_{out_1}} \times \frac{\partial h_{out_1}}{\partial h_{in_1}} \times \frac{\partial h_{in_1}}{\partial b_1} + \frac{\partial o}{\partial h_{out_2}} \times \frac{\partial h_{out_2}}{\partial h_{in_2}} \times \frac{\partial h_{in_2}}{\partial b_1} \right]$$

↪ second hidden cell

$$= -0.225 \left[v_1 \times h_{out_1}(1-h_{out_1}) \times 1 + v_2 \times h_{out_2}(1-h_{out_2}) \times 1 \right]$$

$$= -0.225 \left[0.5 \times (0.5866)(1-0.5866) + 0.6 \times (0.6570)(1-0.6570) \right]$$

$$= \underline{\underline{\cancel{0.225}}} \quad \cancel{0.08223} \quad 0.225 \times 0.25646 = -0.0577$$

$$\begin{aligned}
 b_1 &= b_1 - \alpha \frac{\partial \mathcal{E}}{\partial b_1} && -0.0577 \\
 &= 0.1 - 0.01 \times (\cancel{0.0988} \quad \cancel{0.2509}) \\
 &= \cancel{0.1} \quad \cancel{0.0988} \quad \cancel{0.2509} \\
 &= \underline{\underline{1.00577}}
 \end{aligned}$$

$$\begin{aligned}
 \frac{\partial \mathcal{E}}{\partial b_{out}} &= \frac{\partial \mathcal{E}}{\partial o} \times \frac{\partial o}{\partial b_{out}} \\
 &= -0.225 \times 1 \\
 &= -0.225
 \end{aligned}$$

$$\begin{aligned}
 b_{out} &= b_{out} - \alpha \left(\frac{\partial \mathcal{E}}{\partial b_{out}} \right) \\
 &= 0.2 - (0.01)(-0.225) \\
 &= \underline{\underline{0.20225}}
 \end{aligned}$$